United States Department of Transportation
Annual Modal Research Plans FY 2021
Program Outlook FY 2022

Federal Highway Administration
May 1, 2020

Nicole Nason
Administrator

Note: The FY 2021-2022 AMRPs will be certified using the President's budget numbers and revised with enacted budget numbers after the budget passes.

Chapter 1 – Executive Summary

The primary goal of the FHWA research and technology (R&T) program is to deliver research, development, and technology (RD&T) that directly supports the strategic goals of FHWA and USDOT. FHWA's R&T program identifies and addresses issues of national significance that cannot or will not be addressed by other research sponsors, including areas that require higher risk, longer term research, higher complexity, or specific Federal responsibility. The FHWA R&T program is responsible for conducting R&T activities that produce a clear public benefit; support Federal stewardship roles; meet and address current and emerging needs; and ensure the coordination of highway R&T activities. Additionally, the FHWA R&T program delivers solutions to meet current and future challenges.

FHWA certifies that the content of this plan does not include duplicative research efforts within the FHWA RD&T programs for FY21. Through coordination with other research partners, FHWA's role is also to conduct research to maximize value and avoid duplication by focusing on innovations with broad applicability and that leverage research investments through programs with successful technology transfer (T2). The FHWA R&T program also ensures that critical technical expertise is available in times of crisis or for sensitive matters, including the ability to provide technical support during natural disasters, participation in sensitive Federal investigations, and work with other Federal agencies on issues related to national security and defense.

The FHWA R&T program covers the entire innovation lifecycle: setting an agenda, conducting R&D, testing and evaluating technologies, and deploying and evaluating market-ready technologies and innovations. This holistic approach to innovation allows FHWA and USDOT to serve as national transportation leaders, thus the Agency and Department can provide a strategic approach in shaping the direction of innovation development that supports national interests. This leadership ensures that in working with partners, FHWA pursues a transportation future aligned with the strategic goals of the Department and promotes the most safe and efficient transportation system for taxpayers. Without the FHWA R&T program, the Nation would lack strategically aligned research and innovation development and deployment activities—not to mention the world-class technical expertise, relevancy, and influence—to ensure that the public has access to the safest, most reliable, and most resilient infrastructure.

FHWA addresses current issues and emerging challenges, creates efficiencies in the highway and transportation sector, and provides information to support policy decisions through its R&T programs. FHWA's Office of RD&T is located at the Turner-Fairbank Highway Research Center (TFHRC), a Federally owned and operated national research facility, in McLean, Virginia. The TFHRC houses 16 laboratories and support facilities and conducts exploratory and applied research. TFHRC staff administer the majority of FHWA's R&D activities in the areas of infrastructure, operations, and safety. Research in the areas of Intelligent Transportation Systems (ITS), policy, innovative finance, planning, and the environment is conducted or administered primarily by FHWA offices located at USDOT headquarters.

FHWA has a long history of success coordinating and communicating research efforts with both internal and external partners through USDOT modal administrations, Topical Research Working Groups (TRWGs), and other more informal processes. The TRWGs ensure that FHWA does not conduct duplicative research within the Department. Particularly important is the relationship and coordination between FHWA and the ITS Joint Program Office (JPO). Each USDOT modal administration is responsible for ITS requirements, guidance, and research relevant to that mode, and each uses a combination of mode-specific funding and legislatively dedicated ITS funding to accomplish that mission. Some ITS JPO funds supplement FHWA research activities where additional revenues are needed to meet Department program objectives or to ensure synchronization with USDOT multimodal needs.

Additionally, FHWA leverages a long history of strong partnerships and collaborations with State and Federal agencies, academic institutions, and private industry organizations to coordinate efforts and benefit from the unique capabilities of each to advance shared goals. Working within this partnership framework, FHWA strategically identifies opportunities for collaboration, coordination, and independent research that advance the goals of the Agency and the Department. FHWA also works closely with the National Academies of Sciences, Engineering, and Medicine's Transportation Research Board (TRB) and with the TRB-sponsored advisory group, the R&T Coordinating Committee (RTCC), which consists of academic and industry specialists, to provide an outside perspective on the direction of the FHWA R&T program and identify future opportunities for coordination and collaboration.

FHWA's core R&T program activities improve safety, reduce congestion, enhance infrastructure design and construction, and provide data and analyses to decisionmakers throughout the transportation community.

- The Safety area addresses the contributing factors for deaths and injuries related to roadway design, construction, and maintenance, and develops robust data analysis tools that enable transportation professionals to match those contributing factors with cost-effective countermeasures.

- The Infrastructure area is forward-looking and supports safety, durability, resilience, environmental sustainability, and asset management. FHWA infrastructure research outcomes stimulate economic growth, productivity, and competitiveness through contributions to improve mobility and accessibility.

- The Operations area develops innovative technologies and processes that lead to system-wide improvements in how FHWA and its State and local partners manage and improve the efficiency and reliability of the National Highway System.

- The Policy area offers comprehensive quality data; evaluates the impacts of a broad range of policy options; and analyzes current and emerging issues that will affect the

way transportation projects are regulated and permitted and how transportation systems are constructed, operated, and maintained.

- The Planning and Environment area assesses new tools and processes that consider the complex relationships among individuals, communities, the economy, and the environment to enable better decision making that leads to improved outcomes.

- The Exploratory Advanced Research Program conducts longer term, higher risk research in all the research areas. The research products from this program have the potential for dramatic breakthroughs in transportation.

R&D Funding Overview

FHWA's R&T program is largely governed and shaped by Chapter 5 of Title 23 of United States Code (USC). Title 23 USC 503(a) provides that the Secretary shall (1) carry out research, development, and deployment activities that encompass the entire innovation lifecycle; and (2) ensure that all research carried out under this section aligns with the transportation research and development strategic plan of the Secretary. Title 23 USC 503 establishes the Highway Research and Development (HRD) Program and the Technology and Innovation Deployment Program (TIDP), which provide funding for FHWA's R&T program.

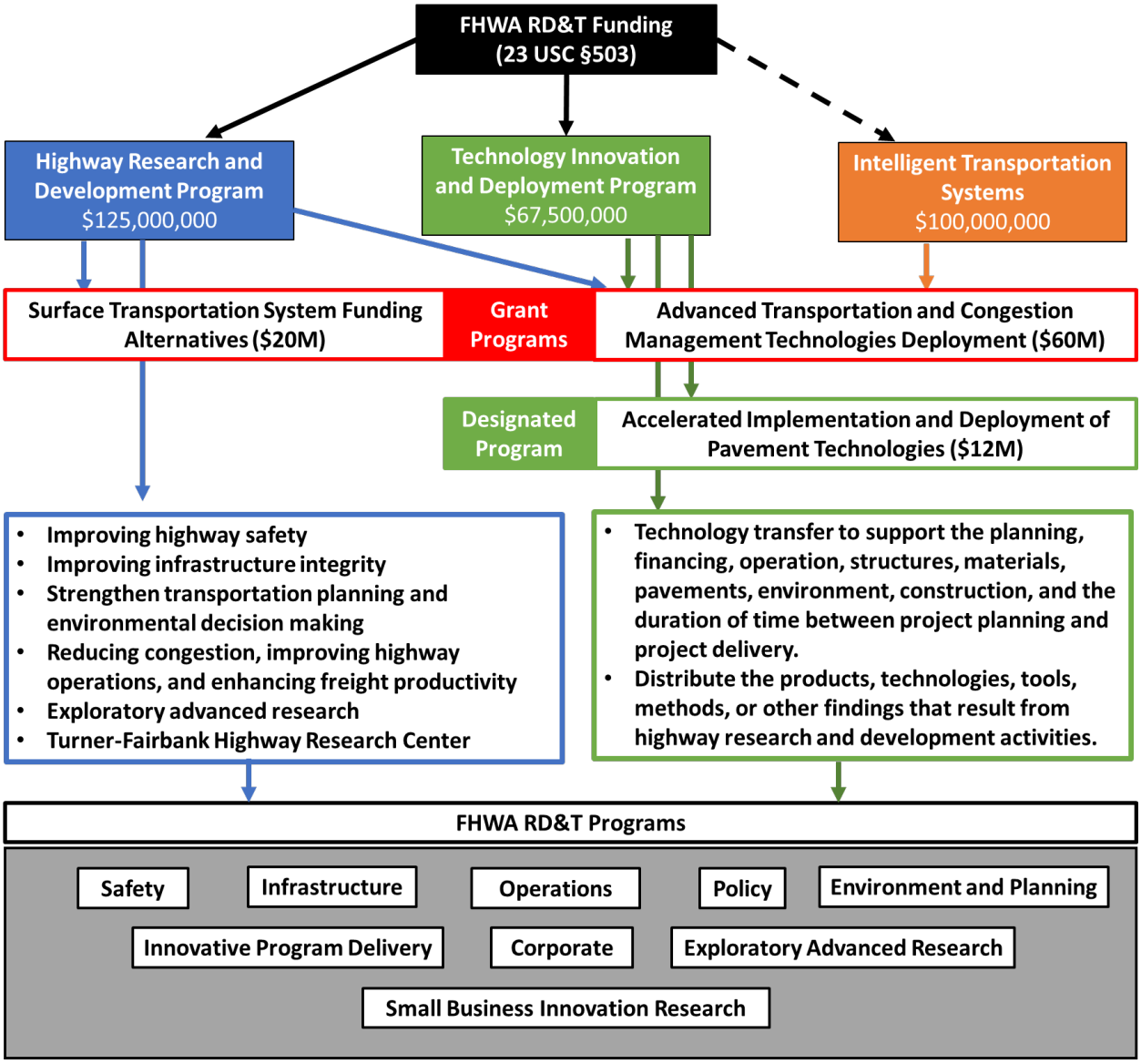
The HRD Program governs the Research and Development portion of FHWA's R&T program. Program objectives may include: improving highway safety, improving infrastructure integrity, strengthening transportation planning and environmental decision making, reducing congestion, improving highway operations, and enhancing freight productivity. The HRD Program also provides for the conduct of exploratory advanced research. Under the FAST Act, $125 million, or about 65% of FHWA's R&T funding, is provided annually to the HRD program. Of the authorized funds for HRD, $20 million is legislatively set aside annually for the Surface Transportation System Funding Alternatives (STSFA) Program to provide grants to States or groups of States to demonstrate user-based alternative revenue mechanisms that utilize a user fee structure to maintain the long-term solvency of the Highway Trust Fund. In addition, 3.2% of the FHWA extramural R&D budget is reserved for awards to small business concerns through the Small Business Innovation Research (SBIR) program. The SBIR Program is a competitive, awards-based program that encourages domestic small businesses to engage in research and development addressing high priority research areas within USDOT.

The TIDP governs the T2 portion of FHWA's R&T program. TIDP relates to all aspects of highway transportation, including planning, financing, operation, structures, materials, pavements, environment, construction, and the duration of time between project planning and project delivery. This includes the responsibility to distribute the products, technologies, tools, methods, or other findings that result from highway research and development activities. Under the FAST Act, $67.5 million, or about 35% of FHWA's R&T funding, is provided annually to TIDP. Of the authorized funds for TIDP, $12 million is

legislatively set aside annually for the Accelerated Implementation and Deployment of Pavement Technologies (AIDPT) to promote, implement, deploy, demonstrate, showcase, support, and document the application of innovative pavement technologies, practices, performance, and benefits.

In addition to HRD and TIDP, FHWA R&T shares some funding, research planning, and research objectives with the U.S. DOT's ITS JPO, which has a separate AMRP. Title 23 USC 512 through 519 establishes the ITS program, which has authorized funding of $100 million annually through the FAST Act. The ITS program provides for the research, development, and operational testing of ITS aimed at solving congestion and safety problems, improving operating efficiencies in transit and commercial vehicles, and reducing the environmental impact of growing travel demand. The ITS program coordinates and jointly funds activities where there is overlapping responsibility and priorities with the other modal administration, including FHWA.

The diagram below shows how FHWA's R&T program is funded.



Title 23 USC 503 also establishes the Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) Program to make competitive grants for the development of model deployment sites for large scale installation and operation of advanced transportation technologies to improve safety, efficiency, system performance, and infrastructure return on investment. The FAST Act provides for a legislative set aside of $60 million annually for ATCMTD from HRD, TIDP, and ITS funding. Currently, $20 million is set aside annually from HRD, $19 million from TIDP, and $21 million from ITS.

Technology Transfer (T2)

FHWA supports numerous T2 efforts to accelerate the implementation and delivery of new innovations and technologies that result from highway R&D and that benefit all aspects of highway transportation. The FHWA R&T Program aims to accelerate the adoption of proven innovative practices and technologies as standard practice to significantly improve

safety, system efficiency, infrastructure health, reliability and performance, and sustainable communities. FHWA uses a series of successful deployment venues in FY 2021, including Every Day Counts (EDC), a State-based model for deployment; the Accelerated Innovation Deployment (AID) Demonstration program; the Accelerating Market Readiness program; and the State Transportation Innovation Council (STIC), a State-based innovation deployment approach. FHWA will also continue to work directly with State and local agencies to provide technical assistance and deployment initiatives through the geographically dispersed FHWA Resource Center.

FHWA has traditionally used a multipronged approach to deploy new and proven technologies and transportation-related innovations and processes. The deployments include direct technical and financial assistance; training; peer exchanges; collaboration with industry groups to disseminate knowledge and information; and evaluation of deployment methods to determine effectiveness, assess needed improvements, and document outcomes.

Key deployment and T2 stakeholders include State departments of transportation (DOTs) and local agencies, Federal Land Management agencies, Tribal Governments, and industry groups. These stakeholders are often the intended audiences for the research deployment outputs. The Local and Tribal Technical Assistance Program centers and other deployment programs play a critical role in T2 activities with these stakeholders.

In the early stages, as an innovation or technology moves from research to development, FHWA will seek out willing State and local transportation agencies to pilot new technologies or be early adopters. The pilot States and other early adopters often receive financial and technical assistance to mitigate the increased risk of using new technologies or initiatives, or to offset unprogrammed costs for implementing a new technology or innovation. As the innovation or technology becomes more mature and is ready for more widespread use, training aids are developed for delivery, and early adopters often become "lead" States. Lead States share best practices, challenges, and successes and encourage other States to adopt the innovations. Peer exchanges and pooled funds are extremely effective ways for States or other transportation organizations to directly share knowledge and information and transfer technology.

FHWA strongly encourages the use of market-ready technologies and innovations. Specific programs provide resources that enable State and local agencies to accelerate the speed with which innovative technologies and practices enter into standard practice. Resource Center technical specialists, program office subject matter specialists, and field office personnel encourage the use of proven technologies during regular office visits and in program discussions with stakeholders. State and local agencies are key motivators in encouraging the use of these technologies by their peers and are best positioned to discuss how these innovations address transportation issues and provide benefits and efficiencies.

Lastly, a robust evaluation program is critical to sharing results and quantifying the overall benefits gained by Federal, State, and local transportation organizations and the traveling public. The R&T Program Evaluation effort shows the value of select innovations and

technologies developed or deployed through the FHWA R&T program. Because of the amount of time between research and deployment, the data needed for evaluations may not be sufficient for measuring individual impacts. In addition, within a short timeframe, it may not be possible to separate out the individual effects of a given product or innovation because other technologies might also be deployed at the same time to address the same goals, problems, or issues. Because of the factors affecting deployment evaluations, FHWA considers and measures the performance of the R&T program from many levels, including the identification of research priorities, effective project management, targeted deployment, and evaluations of deployed innovations and technologies.

New Initiatives within the FY 2021 FHWA RD&T Programs

FHWA plans to build on decades of innovative research and continues to work toward solutions that address the Nation's most critical infrastructure-related needs. The FHWA R&T Program for FY 2021 includes both follow-on initiatives from prior work and new activities that address emerging needs. Specific activities, whether ongoing from prior years or new for FY 2021, are listed and described in the individual program descriptions in Chapter 2. In all cases, the research activities are aligned with the four USDOT Strategic Goals of Safety, Infrastructure, Innovation, and Accountability and address topics outlined in 23 USC § 503, including:

- Improving highway safety.
- Improving infrastructure integrity.
- Strengthening transportation planning and environmental decision making.
- Reducing congestion, improving highway operations, and enhancing freight productivity.
- Strengthening exploratory advanced research.
- Advancing technology and innovation deployment.

Below are examples of new critical activities that will be addressed as part of the FY 2021 FHWA R&T program.

Pedestrian Safety Initiatives

FHWA will work to strengthen the States' abilities to implement a performance-driven safety program by sharing information and by providing training and assistance related to pedestrian safety analysis at intersections. Additionally, FHWA will conduct research to develop Crash Modification Factors for estimating pedestrian injuries and fatalities at intersections. The research will provide resources that help reduce pedestrian and bicyclist fatalities and serious injuries, while improving access to jobs and other essential destinations.

Motorcycle Safety

Data collection sites and agreements will be in place to begin field implementation of the motorcycle countermeasures identified from the Motorcycle Crash Causation Study data analysis. Specifically, FHWA will test prototype signage in real-world environments to determine effectiveness and provide data necessary for consideration in the *Manual of Uniform Traffic Control Devices* (MUTCD).

New Guidance for Ultra-High Performance Concrete
FHWA will finalize guidance for the structural design of ultra-high performance concrete. This guidance will be delivered to the American Association of State Highway and Transportation Officials (AASHTO) Committee on Bridges and Structures for review.

Guidance for Recycled Asphalt in Pavements
FHWA will work with State transportation industries and the asphalt industry to develop guidance for optimizing asphalt mix designs that incorporate Reclaimed Asphalt Pavement (RAP), Recycled Asphalt Shingles (RAS), and other sustainable materials for more durable pavements and preservation treatments.

Emergency Route Working Group (ERWG) Recommendations
FHWA has several research initiatives underway related to recommendations from the ERWG final report. FHWA is researching methods to enhance permitting of loads and responding to emergencies, including permit automation, routing, and communication to expedite movement of trucks involved in emergency response and recovery.

Research on Automated Driving System (ADS) and Roadway Integration
FHWA will build on prior ADS and Roadway Integration research to deliver testing and evaluation capabilities to assess infrastructure readiness for ADS vehicles. The effort will also establish roadway–environment management concepts focused on ADS-roadway integration, such as access and exchange of data between ADS vehicles, road infrastructure, and traffic management systems.

CARMA℠ Collaborative
FHWA will continue to support existing collaboration and coordination of research efforts with the ITS JPO, other USDOT modes, State and local public agencies, academic institutions, industry organizations, and other surface transportation stakeholders. Collaboration with the F1 Tenth community (an open-source initiative for like-minded researchers to collaborate on software development with one another to build, operate, and race automated vehicles in a virtual environment) will be key to success of CARMA F1 Tenth in FY 2021. Transportation pooled fund studies will be leveraged, as appropriate, to engage infrastructure owner/operators (IOOs) in automation and connectivity program activities.

Updating Critical Data Research Data Systems
The Highway Performance Management System (HPMS) will be transitioned into version 9.0 because of a recent reassessment and prior research efforts; the Next Generation National Household Travel Survey (NHTS) will include new data collection methods to improve timeliness, efficiency, and cost; and the Integrated Transportation Information Platform (ITIP) will be transitioned into version 2.0 with new data analytics and direct access for use by field offices.

Shifting Policy Analysis Priorities
Resources have been shifted in FY 2021 toward analysis of highway costs and funding

options and economic impact analysis, with less emphasis on quantifying the impacts of investment on future conditions and performance.

Multimodal Mobility
FHWA will conduct research to support the development of policies that further the implementation of connected multimodal transportation networks, support economic development, and help build capacity among stakeholder agencies to employ safe, integrated, and convenient mobility options for all users.

New Collaboration Initiatives

FHWA will continue to expand on its long history of leveraging and developing strong partnerships with State and local transportation departments, international organizations, academic institutions, and private sector organizations to develop and deploy innovative and critical solutions to America's transportation challenges. Examples of some of these important collaboration opportunities in FY 2021 are included below.

Vehicle Inventory and Use Survey (VIUS)
The VIUS has been the principal data source for the physical and operational characteristics of the U.S. truck population. The primary goal of the survey is to gain an understanding nationally and statewide on how trucks are being used for the transport of various goods. The first survey was conducted in 1963, and subsequent surveys were conducted every 5 years from 1967 to 2002. A VIUS will be conducted in 2022 to obtain updated data on vehicle activity for calendar year 2021, and results are planned for release in 2023. As in past editions, the VIUS will cover vehicles from all sectors of the economy and from households. The sponsor of VIUS 2021 is the Bureau of Transportation Statistics, with support from FHWA, the U.S. Department of Energy, and the U.S. Census Bureau.

Oversize/Overweight (OS/OW) Permit Data Harmonization
As part of the Analysis and Dissemination of *Truck Size and Weight Data and Research Activity*, FHWA supports AASHTO research on effective truck size and weight data use across States to better harmonize OS/OW permitting requirements. This research includes support of an AASHTO proposed Permit Data Harmonization Study. The permit and harmonization study will document the data collected and sequence used by States during permit applications, and then research the potential for harmonization across States.

Commercial Motor Vehicle (CMV) Bridge Strikes Research
FHWA Offices of Infrastructure and Safety are working in partnership with the Federal Motor Carrier Safety Administration (FMCSA), the National Highway Traffic Safety Administration (NHTSA), AASHTO, TRB, and other organizations to develop strategies to mitigate bridge strike occurrences by CMVs. FHWA will research bridge strike data to support operational changes and improve technologies, practices, and countermeasures to reduce bridge strikes. FHWA also supports AASHTO initiatives for additional research on mitigating bridge strikes.

International Collaboration
The United States and Switzerland will collaborate in developing electrically isolated post-tensioning tendons on bridges and on other bridge projects.

New Safety Data Collaborations
FHWA will collaborate with organizations that can provide access to nontraditional data for safety analyses such as the U.S. Census Bureau.

Vehicle Automation Safety Research
FHWA will increase collaboration with industry partners in vehicle automation and driving simulation to increase roadway safety and operational efficiency.

Involvement in TRWG Planned for FY 2021
The statutory guidance related to the USDOT AMRPs states that all modal plans are reviewed by the USDOT Deputy Assistant Secretary for Research and Technology to ensure that no duplication of effort exists between the modes within their research programs. FHWA achieves this lack of duplication through collaborative efforts across all modes. A primary mode of collaboration is participation in the 12 USDOT TRWGs. Below are examples of how FHWA participates in these groups and some of the outcomes of that collaboration.

FHWA staff are currently serving as the lead for USDOT TRWGs, including the groups for State-of-Good-Repair and Systemic Safety Approach. Additionally, staff participate in working groups addressing the Mobility, Human Factors, Data, Automation, Environmental Stewardship, Economic Competitiveness, Emerging/Enabling Technologies, Cybersecurity, and T2 working groups. These TRWGs have increased the level of coordination across all modes. Specifically, the TRWGs have had a direct impact on the development and contents of the FHWA AMRP to ensure there is no duplication of effort and to identify opportunities to compliment research identified within the AMRPs of the other modes. Finally, the TRWGs have also set common expectations across the modes related to critical R&T topics. An example of this common understanding is the inclusion of the statement below in all modal AMRPs related to data expectations:

> The Foundations for Evidence-Based Policymaking Act of 2018 codifies the need for data to be more accessible to both the Department and the public. This increased access to data is intended to enable evidence-based policy making and improve transparency. As part of an intermodal collaboration across the Department, all new projects funded in FY 2021 under the research plan will be examined to identify if the projects are producing data and whether the data can be shared. FHWA will work with its partners in the other modes to establish consistent guidance related to data management plans, data discoverability, and technical assistance to project managers and awardees.

Effects of COVID-19 on the FHWA RD&T Program

FHWA's RD&T Program continues to operate to the fullest extent possible despite the challenges presented by the COVID-19 public health emergency. FHWA has implemented unique and innovative approaches to ensure that the important work of the RD&T program continues to deliver new and innovative solutions to the Nation's most important highway transportation challenges. FHWA will also continue to support the Department of Transportation's identified research needs related to the COVID-19 public health emergency. This includes on-going research related to the impacts the COVID-19 public health emergency has on traffic flows, crashes, and economic activities. FHWA is also participating in a National Cooperative Highway Research Project (NCHRP 23-13), which will identify, prioritize, and fund Transportation Research Related to the COVID-19 public health emergency.

FY 2021 RD&T Program Funding Details

The FY 2021 RD&T Program funding table shows how much funding for FY 2021 is dedicated to each R&T program. It includes the amount of funds for each program that is in the FY 2021 enacted budget and the total amount of funds that is spent on basic and applied research and technology. FHWA does not fund basic research but uses the majority of the funds on technology deployment and applied research. In FY 2021, FHWA expects to allocate 34% of R&T funds toward applied research, 14% for development, and 54% for technology deployment.

RD&T Program Name	FY 2021 Enacted ($000)	FY 2021 Basic ($000)	FY 2021 Applied ($000)	FY 2021 Development[1] ($000)	FY 2021 Technology[2] ($000)
Infrastructure					
Accelerated Implementation and Deployment of Pavement Technologies	10,668	0	0	0	10,668
Construction and Project Management	1,733	0	578	578	577
Geotechnical and Hydraulics	3,467	0	2,623	222	622
Long-Term Infrastructure Performance	7,112	0	4,445	2,667	0
Pavements and Materials	4,543	0	3,654	889	0
Structures	5,601	0	3,823	1,778	0
Transportation Performance Management, Asset Management	1,156	0	0	800	356
Safety					
Safety Program Delivery	2,222	0	0	2,222	0
Safety Design and Operations	3,814	0	0	3,814	0

[1] Development is defined as the systematic application of knowledge or understanding, directed toward the production of useful materials, devices, and systems or methods, including design, development, and improvement of prototypes and new processes to meet specific requirements.

[2] Technology is defined as activities that demonstrate, pilot, or evaluate an R&D output and/or facilitate the transfer of an R&D output to an adoption-ready state. Technology deployment is the final phase of the technology transfer process.

RD&T Program Name	FY 2021 Enacted ($000)	FY 2021 Basic ($000)	FY 2021 Applied ($000)	FY 2021 Development[1] ($000)	FY 2021 Technology[2] ($000)
Safety Data and Analysis	3,485	0	0	2,729	756
Human Factors Analytics	1,396	0	0	1,396	0
Operations					
Transportation Systems Management and Operations	5,272	0	5,272	0	0
Automation and Connectivity	5,156	0	5,156	0	0
Managing Disruptions to Operations	2,489	0	2,489	0	0
Freight Management and Operations	3,022	0	3,022	0	0
Truck Size and Weight	978	0	978	0	0
Environment and Planning					
Accelerating Project Delivery	2,667	0	2,294	0	373
Performance-Based Planning	1,867	0	1,414	266	187
Modeling and Analysis Tools	1,867	0	765	355	747
Resiliency	1,156	0	533	356	267
Planning for Bicycle and Pedestrian Safety, Connectivity, and Multimodal Mobility, including for Underserved Communities	1,156	0	871	143	142
Policy					
Policy Analysis and Global Outreach	4,143	0	2,807	1,336	0
Highway Data and Information	5,725	0	2,562	1,191	1,972
Innovative Program Delivery					
Every Day Counts	5,778	0	0	0	5,778
State Transportation Innovation Council Incentive	4,978	0	0	0	4,978

RD&T Program Name	FY 2021 Enacted ($000)	FY 2021 Basic ($000)	FY 2021 Applied ($000)	FY 2021 Development[1] ($000)	FY 2021 Technology[2] ($000)
Accelerated Innovation Deployment	5,778	0	0	0	5,778
Accelerating Market Readiness	2,223	0	0	0	2,223
Innovative Program Delivery	791	0	80	80	631
Corporate					
Research Infrastructure, Technology Transfer, and Partnerships	12,446	0	8,294	0	4,152
Small Business Innovation Research					
Small Business Innovation Research	1,778	0	1,645	133	0
Exploratory Advanced Research					
Exploratory Advanced Research	4,214	0	4,214	0	0
Designated Grant Programs					
Advanced Transp. and Congestion Management Program	34,671	0	0	0	34,671
Surface Transp. Funding Alternatives	17,780	0	0	0	17,780
Administrative and Facilities Costs					
Administrative and Facilities Costs	5,993	0	2,014	733	3,246
Totals	**177,125**	**0**	**59,533**	**21,688**	**95,904**

FY 2021 RD&T Program Budget Request by DOT Strategic Goal

The following table shows how much FY 2021 funds are being requested for each RD&T Program by the DOT's strategic goal. Most funds requested support the Innovation goal. In FY 2021, FHWA expects to allocate 14% of R&T funds to support the USDOT Safety Strategic Goal, 32% to support the Infrastructure goal, and 49% to support the Innovation goal, and 5% to support the Accountability goal.

RD&T Program Name	FY 2021 Enacted ($000)	Safety ($000)	Infra-structure ($000)	Innovation ($000)	Account-ability ($000)
Infrastructure					
Accelerated Implementation and Deployment of Pavement	10,668	0	8,890	1,778	0
Construction and Project Management	1,733	133	533	534	533
Geotechnical and Hydraulics	3,467	1,600	1,822	0	45
Long-Term Infrastructure Performance Program	7,112	0	7,112	0	0
Pavements and Materials	4,543	0	4,543	0	0
Structures	5,601	0	5,601	0	0
Transportation Performance Management, Asset Management	1,156	0	622	0	534
Safety					
Safety Program Delivery	2,222	2,222	0	0	0
Safety Design and Operations	3,814	3,814	0	0	0
Safety Data and Analysis	3,485	3,485	0	0	0
Human Factors Analytics	1,396	1,396	0	0	0
Operations					
Transportation Systems Management and Operations	5,272	0	5,272	0	0
Automation and Connectivity	5,156	0	0	5,156	0
Managing Disruptions to Operations	2,489	0	2,489	0	0
Freight Management and Operations	3,022	178	2,310	534	0

RD&T Program Name	FY 2021 Enacted ($000)	Safety ($000)	Infra-structure ($000)	Innovation ($000)	Account-ability ($000)
Truck Size and Weight	978	267	533	178	0
Environment and Planning					
Accelerating Project Delivery	2,667	0	1,147	1,067	453
Performance-Based Planning	1,867	267	968	445	187
Modeling and Analysis	1,867	0	898	800	169
Resiliency	1,156	0	622	534	0
Planning for Bicycle and Pedestrian Safety, Connectivity, and Multimodal Mobility, including for Underserved Communities	1,156	445	445	266	0
Policy					
Policy Analysis and Global Outreach	4,143	300	1,252	1,618	973
Highway Data and Information	5,725	1,515	1,627	766	1,817
Innovative Program Delivery					
Every Day Counts	5,778	1,511	1,334	2,666	267
State Transportation Innovation	4,978	1,067	1,245	2,488	178
Accelerated Innovation Deployment	5,778	1,511	1,334	2,666	267
Accelerating Market Readiness	2,223	356	445	1,333	89
Innovative Program Delivery	791	0	396	395	0
Corporate					
Research Infrastructure, Technology Transfer, and Partnerships	12,446	3,112	3,112	3,111	3,111
Small Business Innovation Research					
Small Business Innovation Research	1,778	445	445	444	444
Exploratory Advanced Research					
Exploratory Advanced Research	4,214	0	0	4,214	0

RD&T Program Name	FY 2021 Enacted ($000)	Safety ($000)	Infra-structure ($000)	Innovation ($000)	Account-ability ($000)
Designated Grant Programs					
Advanced Transp. and Congestion Management Program	34,671	0	0	34,671	0
Surface Transp. Funding Alternatives	17,780	0	0	17,780	0
Administrative and Facilities Costs					
Administrative and Facilities Costs	5,993	827	1,926	2,922	318
Totals	**177,125**	**24,448**	**56,922**	**86,371**	**9,383**

Chapter 2 – FY 2021 RD&T Programs

Infrastructure

Accelerated Implementation and Deployment of Pavement Technologies
$ 10,668,000

Program Description:
Together, the Pavement & Materials Research and Development (R&D) Program, the Long-Term Pavement Performance (LTPP) research, and the Accelerated Implementation and Deployment of Pavement Technologies (AIDPT) Program provide a coordinated and cohesive approach to research, development, technology and deployment activities focused on providing tools, technologies and guidance, and supporting updated policies, to improve the safety, durability, sustainability and cost-effectiveness of highway pavements, and the materials from which highway infrastructure is constructed. The AIDPT program serves as the implementation and deployment mechanism for innovations coming out of the Pavement & Materials and LTPP research, and contributes to achievement of the Department's Infrastructure goal through work addressing advanced materials, designs and technologies, risk based asset management, infrastructure system resilience and advanced inspection tools within the state of good repair research topic area.

Program Objectives:
FHWA's 2021 AIDPT Program supports the Department's Safety, Infrastructure and Innovation Strategic Goals. This program is authorized in section 503(c)(3) of title 23, United States Code, which require the Secretary to establish and implement a program under the technology and innovation deployment program to promote, implement, deploy, demonstrate, showcase, support, and document the application of innovative pavement technologies, practices, performance, and benefits. The AIDPT program directly supports the strategic goals relating to Infrastructure and Innovation contained in the FY18-22 DOT Strategic plan. Specific contributions to the strategic goals and the key program objective to optimize pavement performance are as follows.

Safety: The AIDPT Program will contribute directly to highway safety and the Department's Systematic Safety Approach by continuing to advance implementation of friction management programs to improve pavement safety. The activities will focus on strengthening DOT friction management program(s) through projects demonstrating continuous friction measurement. These efforts will provide State technical assistance and increased education and awareness to better consider safety in pavements related decision-making. This program will save lives by expanding the use of data-driven, systemic safety management approaches and by increasing the adoption of proven safety solutions by all road owners. In addition, strategies to increase pavement durability and performance will be advances, which will result in less pavement repairs and the need for less work zones.

Innovation: The AIDPT Program supports the Department's Innovation Goal by accelerating the deployment of innovative pavement technologies. The Program will accelerate the deployment of innovative pavement technologies such as non-destructive testing tools for pavement evaluation, which can be used for Quality Control or Acceptance. These tools save time and money and increases worker safety. This innovation is now available for demonstrations and for loan through the AIDPT program. Furthermore, by advancing performance-related specifications, the program opens the door to further innovation on the part of the construction contracting community. Other entities such as NCHRP, the National Center for Asphalt Testing, and several universities are conducting supporting research in this area. These efforts will provide National standards published for procedures, tests, and equipment as well as technical assistance to States. Tangible outcomes are expected in 2021 and beyond.

Infrastructure: The AIDPT Program supports the Infrastructure goal through technology transfer, training and technical support addressing the areas of pavement performance, life cycle cost analysis and preservation for pavements. The AIDPT program supports the adoption of advanced Mechanistic Empirical pavement design procedures. FHWA will showcase advanced materials characterization and performance engineered mixtures and mixture design through the Mobile Asphalt and Concrete Technology Centers (MATC/MCTC).

Accountability: The AIDPT program will increase the quality of our Nations pavements through the implementation of sound Quality Assurance (QA) practices and by forwarding innovative techniques in the measurement and payment of highway materials. The AIPT program will also focus on the development and national standardization of pavement surface characteristics (rutting, cracking, faulting, smoothness, and friction) measurement. The development of pavement surface characteristic standards is critical for meeting the accountability requirements related to Pavement Performance Measures found in the FAST ACT legislation.

Anticipated Program Activities:
Activities in the AIDPT program include advancement of performance engineered mix design for both asphalt and concrete pavements, support of implementation of Continuous Friction Measurement (SCRIM) to support improved pavement management systems. Implementation activities include providing education and guidance on the use of new tests, demonstration and shadow projects (where new technologies are used side-by-side with existing technologies), and other information sharing opportunities such as peer exchanges and workshops.

Key FY21 FHWA AIDPT R&T Program Activities.

Activity	Period of Performance
Innovation/Infrastructure Deployment and Implementation of Performance Engineered Mixtures	2017-2025
Innovation/Infrastructure Deploy and deliver workshops and supporting materials to advance best practices	2016-2025
Stakeholder Technical Working Groups to gather feedback on technical topics	2020-2024
Infrastructure/Accountability/Safety Pavement management activities to improve pavement management systems and pavement performance measures	2018-2023
Infrastructure Pavement sustainability technical support and resources to educate and promote best practices	2017-2023
Infrastructure Pavement design outreach and technical support to advance the state of practice	2020-2025
Infrastructure Pavement preservation technical support and resources to educate and advance state of practice	2018-2023
Accountability Quality Assurance technical support that promotes best practices	2020-2025

Expected Program Outcomes:
A wide variety of training opportunities, technical documents, and demonstration projects are conducted for the activities funded by the AIDPT Program.
From the FY 2021 AIDPT Program activities, an annual report is published highlighting key program areas and activities and deliverables. Annual reports are located here: https://www.fhwa.dot.gov/pavement/aidpt/.

Collaboration Partners:
FHWA AIDPT program staff regularly engage with key stakeholders in both formal and informal settings to gather input concerning challenges and opportunities that might be addressed through the program, as well as information on work undertaken by other organizations both nationally, and internationally. Stakeholders include representatives of individual state highway agencies, pertinent committees of the American Association of State Highway and Transportation Officials (AASHTO) and the Transportation Research Board (TRB), industry organizations such as the American Concrete Pavement Association (ACPA) and the National Asphalt Pavement Association (NAPA), standard-setting organizations such as the American Concrete Institute (ACI) and ASTM International, and university faculty engaged in related work.

Formal interactions with AASHTO, TRB, and industry organizations generally occur at regular intervals (at least annually, and as often as quarterly), but are not formally tracked or measured. Ad hoc interactions in the form of technical assistance requests are logged on an internal SharePoint site.
FHWA has several technical working groups and expert task groups as a means of gathering stakeholder input on feedback on technical topics specific to pavements and materials. The groups are composed of a mix of representatives from State Departments of Transportation and other public agencies, related industry groups (such as asphalt and concrete paving industries, contractors, etc.), and academia. FHWA also manages and participates in pooled fund studies for some of these activities. Pooled fund activities include representation and input from multiple State DOT technical advisers.

Program partners (both government and non-government), benefits derived from partnerships, and partner contributions are summarized in the table below.

Benefits of Partnership and Partner Contributions to FHWA AIDPT Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard / Goal Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding	Stakeholder Advice	Education and Awareness
AASHTO Committee on Materials and Pavements	X		X		X						
State Departments of Transportation	X			X	X				X		
National Institute of Standards and Technology (NIST)						X	X				
National Asphalt Pavement Association		X						X			
American Concrete Pavement Association		X									
ASTM International			X								
Pavement Preservation Technical Feedback Group[3]	X	X				X					
Asphalt Technical Feedback Group[4]	X	X				X					
Concrete Technical Feedback Group	X	X				X					
Sustainable Pavements Technical Working Group[5]	X	X				X					

[3] The Pavement Preservation Technical Feedback Group provides a forum for State highway agency representatives, academia, and industry stakeholders to discuss experiences and best practices for implementing pavement preservation techniques.
[4] The Asphalt and Concrete Technical Feedback Groups focus on implementation of technologies and innovations to improve pavement performance and advance performance related specifications specifically for asphalt and concrete pavements.
[5] The Sustainable Pavements Technical Working Group provides a forum for State highway agency representatives, academia, and industry stakeholders to discuss concepts and specialty topics related to pavement and materials sustainability and resiliency

Construction and Project Management

$1,733,550

Program Description:
FHWA's Construction and Project Management Research and Technology (R&T) Program is a coordinated and cohesive program of research, development and technology activities focused on providing tools, technologies and guidance, and supporting updated policies, to improve highway construction and project management practices. The program's mission is to transform infrastructure project delivery to minimize the impact of construction on the public.

Program Objectives:
FHWA's Construction and Project Management R&T Program seeks to strategically advance innovative technologies and best practices to accelerate construction and improve quality and durability of as-constructed infrastructure. The program is aligned with and supports achievement of the Department's Infrastructure Strategic Goals. In support of the Infrastructure Goal, the program contributes to improving the nation's infrastructure by improving system performance in support of the Nation's economy, as well as accelerating project delivery. It facilitates expanded infrastructure development, modernization, and construction in both rural and urban communities by fostering more efficient and collaborative advanced construction techniques and supports Economic Competitiveness by increasing foreign market access and opportunities for American businesses and services by engagement on international standards.

Anticipated Program Activities:
Construction and Project Management Program activities include research and development to advance technologies and practices that accelerate highway construction, improve infrastructure quality (and therefore durability), improve project efficiencies, and ensure effective management of construction projects.

Key FY21 FHWA Construction and Project Management R&T Program Activities.

Activity	Period of Performance
Unmanned Aerial Systems Peer Exchanges	2020-2022
Development of State of the Art Report on Partial Depth Precast Concrete Deck Panels	2020-2021
Enhanced major project IT Systems for improved project management.	2020-2021
Quality Assurance Guidelines for Bridge Construction	2020-2022
Research and analysis of major project data for improved performance.	2020-2021
Continued support of the Transportation Construction Management Pooled Fund Program	2012-2021
Innovations in Major Project Cost Estimating	2021-2022
Major Project Policy and Guidance	2020-2021
Support delivery of cost estimate reviews for major projects	2020-2021
Update NHI course on Utility Coordination for Highway Projects	2021-2022
Building information modeling (BIM) Implementation/R&D activities based on BIM for Infrastructure Workplan priority activities	2020-2021
Advance digital construction	2021-2022
Advancing construction with our Federal partners	2021-2022

Expected Program Outcomes:
FHWA's Construction and Project Management R & T Program supports the Department's Infrastructure, Innovation and Accountability Strategic Goals. Investments made in research, analysis, technology transfer and training are ensuring that major projects are timely and within budget, and that highway construction is using best practices and advanced digital techniques to accelerate project delivery and increase the safety of highway construction.

Collaboration Partners:
FHWA Construction and Project Management R&T program staff regularly engage with key stakeholders in both formal and informal settings to gather input concerning challenges and opportunities that might be addressed through the program, as well as information on work undertaken by other organizations both nationally, and internationally. Stakeholders include representatives of individual State DOTs, pertinent committees of the American Association of State Highway and Transportation Officials (AASHTO) and the Transportation Research Board (TRB), industry organizations such as the Associated General Contractors (AGC) and the American Road and Transportation Builders Association (ARTBA), standard-setting organizations such as AASHTO, and university faculty engaged in related work.

Formal interactions with AASHTO, TRB, and industry organizations generally occur at regular intervals (at least annually, and as often as quarterly), but are not formally tracked or measured. Ad hoc interactions in the form of technical assistance requests are logged on an internal SharePoint site.

Program partners (both government and non-government), benefits derived from partnerships, and partner contributions are summarized below.

Benefits of Partnership and Partner Contributions to FHWA Construction and Project Management Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard / Goal Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding	Stakeholder Advice	Education and Awareness
AASHTO Committee on Construction	X				X						
State Departments of Transportation	X			X	X				X		
Associated General Contractors (AGC)		X									
American Road and Transportation Builders Association (ARTBA)		X									
International Intelligent Construction Technologies Group (IICTG)		X			X						
AASHTO Joint Committee on Electronic Engineering Standards	X	X	X								
International Highway Engineering Exchange Program (IHEEP)	X	X			X						
FAA			X				X				
Local Partners (LTAP, TTAP Centers)	X				X		X				
Building SMART			X								

Geotechnical and Hydraulics
$3,467,100

Program Description:
The nation's highway transportation network spans a widespread and diverse geological, riverine, and coastal environment and features. Geotechnical and hydraulic situations encountered traversing mountainous passes, crossing broad plains, or travelling along shorelines necessitates the Geotechnical and Hydraulics R&T Program to reflect and encompass an equally broad composition and focus. The Program aligns with the needs and requirements associated with public safety, statutory and regulatory requirements, and other elements of transportation.

The Program goals seek to support all aspects of FHWA project delivery; including planning, environment, resilience, permitting, design, construction, asset management, and emergency relief. Forward thinking and flexible, the Program has historically been successful in using our funding in producing actionable, relevant, and cost-effective products and outcomes that benefit the transportation community.

The Program provides a coordinated and cohesive approach to research, development and technology activities to improve the geotechnical and hydraulic performance (safety, efficiency, durability, resiliency and cost-effectiveness) of the highway and transportation system.

The Program achieves these objectives by addressing what FHWA describes as "functional" or "focus" areas. For FY 2021 these include Earth and Rock Works; Earth Retaining Structures; Geohazards; Ground Improvement; Structural Foundations; Subsurface Investigations; Hydrology (including floodplains), Highway Drainage, Bridges and Culverts; Scour; and Coastal Engineering. This multi-faceted Program yields an effective, crosscutting approach to addressing the hydraulic and geotechnical challenges of highway infrastructure.

Program Objectives:
FHWA's Geotechnical and Hydraulics R&T Program seeks to drive innovation in geotechnical and hydraulic engineering practice to ensure and enhance the safety and resiliency of highway infrastructure. Within the functional areas of both disciplines, the Program Objectives are aligned with the Department's USDOT RD&T Strategic Goals of Safety, Infrastructure, Innovation, and Accountability. The contributions of the Program support the National Highway System as well as the local and rural road systems.

Anticipated Program Activities:
To support Program objectives, we provide key FY2021 activities in the table below. These activities are linked to Program focus areas, but are not all inclusive; the Program focus areas include the flexibility to respond to new or changing priorities and needs as they arise.

Key FY21 FHWA Geotechnical and Hydraulics R&T Program Activities.

Activity	Period of Performance
Laboratory and Site Characterization, Performance, and Durability of Geotechnical Materials – Virgin and Recycled Backfills, Tremie Concrete, High Strength Steel and Hollow Bars, and Geosynthetics	2020 - 2025
Geotechnical Aspects of Pavements – Condition Assessment of Base Layers and Use of Geosynthetics	2019-2024
Geotechnical Performance Measurement and Asset Management – Bridge Approach Transitions, Corrosion of Buried Steel, Guidance on Management of Slopes and MSE Walls, and Communication of Geotechnical Data	2018 - 2023
Foundation Design and Construction Advances – Resolving Driven Piles Issues, Optimization of Load Transfer in Drilled Shafts, LRFD Refinement, Long-Term Performance of GRS-IBS, Advanced Geotechnical Modeling, Updates to GEC-11, and Quality Assurance Methods	2020 - 2025
NextScour: Geotechnical – Correlation between Soil Erosion Resistance and Geotechnical Properties and Comparison between Different Erosion Test Methods	2020 - 2025
Develop NextScour: Hydraulics design tools for bridge scour, stream stability and scour protection/countermeasures	2019 - 2025
Develop design specifications for pavement drainage to improve curb inlet design and mitigate hydroplaning	2017 - 2023
Develop solutions and design guidelines for hydrological (changes in rain fall and flood frequency) impacts on highway infrastructure	2016 - 2023
Develop solutions to key challenges associated with flow modeling for bridge and culvert hydraulics	2019 - 2023
Develop design specifications for coastal highways and bridges impacted by extreme events	2018 - 2023

Expected Program Outcomes:
In FY21, the Geotechnical and Hydraulics R & T Programs will deliver improved guidance on abutment and embankment scour protection design and detail how scour is aligned with the AASHTO LRFD Bridge Design Specifications. The Program also expects to examine and develop tools to evaluate the erosion resistance of subsurface layers. Other products are also expected, including variability of open-graded structural backfills and a National Academies report on the assessment of corrosion of buried steel. These accomplishments will lead to more safe, reliable, and cost-effective bridge designs.

Knowing and understanding the Program's statutory (and regulatory) requirements and authorities assures we remain focused on efforts and outcomes support those objectives. Finally, the Program has, or shares, responsibility for the following elements and requirements contained within the March 22, 2018 Transportation Appropriation Bill, including producing a report on Resilient Infrastructure (Senate report page 53) and

supporting Geosynthetic Reinforced Soil-Integrated Bridge Systems (Senate report page 54).

Collaboration Partners:
FHWA Geotechnical and Hydraulics R&T Program staff regularly engage with key stakeholders in both formal and informal settings to gather input concerning challenges and opportunities that might be addressed through the program, as well as information on work undertaken by other organizations both nationally, and internationally. Stakeholders include representatives of individual highway agencies, pertinent committees of the American Association of State Highway and Transportation Officials (AASHTO) and the Transportation Research Board (TRB), the National Academies of Sciences, Engineering, and Medicine (NASEM), industry organizations such as the American Society of Civil Engineers, the Geo-Institute of ASCE, the Deep Foundations Institute, the International Association of Foundation Drilling, the Geosynthetic Materials Association, ASTM International, and university faculty engaged in related work.

The Program functional areas also interact with other Federal entities; we have both formal and informal engagement and collaboration activities. For example, engaging in collaborative efforts with the U.S. Geologic Survey, National Oceanic and Atmospheric Administration, and U.S. Army Corps of Engineers.

Formal interactions with AASHTO, TRB, and industry organizations generally occur at regular intervals (at least annually, and as often as quarterly), but are not formally tracked or measured. Ad hoc interactions in the form of technical assistance requests are logged on an internal SharePoint site.

In the table below, the Program summarizes partners (both government and non-government), benefits derived from partnerships, and partner contributions.

Benefits of Partnership and Partner Contributions to FHWA Geotechnical and Hydraulics Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard / Goal Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding	Stakeholder Advice	Education and Awareness
State Departments of Transportation	X			X	X						
Local Public Agencies (LPA) and Metropolitan Planning Organizations (MPO)	X			X	X						
AASHTO Committee on Bridges and Structures	X		X		X						
AASHTO Committee on Hydraulics and Hydrology	X		X		X	X					
US Army Corps of Engineers (USACE)	X		X	X		X					
Department of Energy (DOE)/ Argonne National Lab (ANL)	X					X	X				
Department of Interior (DOI)/ US Geological Survey (USGS)	X			X		X	X				
Department of Commerce (DOC)/ National Oceanic and Atmospheric Administration (NOAA)	X			X		X	X				
Federal Aviation Administration (FAA)	X		X		X	X	X	X			
Federal Railroad Administration (FRA)	X	X	X		X	X	X	X			
American Society of Civil Engineers		X			X		X	X			

Partner Organization	User Perspective on Needs	Industry Perspective	Standard / Goal Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding	Stakeholder Advice	Education and Awareness
Geo-Institute		X		X	X	X	X	X			
Deep Foundations Institute (DFI)		X		X	X	X	X	X			
The International Association of Foundation Drilling (IAFD)		X		X	X	X	X	X			
ASTM International			X								
National Concrete Masonry Association (NCMA)		X		X	X	X	X				
Geosynthetic Materials Association (GMA)		X		X	X	X	X				
United States University Council for Geotechnical Education and Research (USUGER)		X		X		X	X	X			
Transportation Research Board (TRB)					X	X					
National Academies of Sciences, Engineering, and Medicine (NASEM)		X			X	X	X				
National Science Foundations	X		X	X		X	X				
International Programs	X		X	X	X	X	X				

Long Term Infrastructure Performance
$7,112,000

Program Description:
The Long-Term Infrastructure Performance (LTIP) Programs include the Long-Term Pavement Performance (LTPP) Program and the Long-Term Bridge Performance (LTBP) Program. These programs, conducted in close collaboration with the State DOT infrastructure owners, provide for characterization and monitoring of in-service highway pavement test sections (LTPP) and bridges (LTBP) to assemble the data needed to improve infrastructure design and advance the understanding of highway infrastructure performance required to effectively manage transportation assets. The collected data are disseminated to the public through web-based portals. FHWA's investment in obtaining and disseminating the data is leveraged by both public and private sector research organizations that apply the data to address a variety of infrastructure performance needs of local, State, regional, and national interest.

Program Objectives:
FHWA's LTIP Programs seek to advance understanding of how and why highway pavements and bridges perform as they do, knowledge that will enable the improved durability and extended infrastructure life as called for in the FAST Act. The LTIP research is central to FHWA's work to advance Risk-Based Asset Management within the State of Good Repair Topic under the Department's Infrastructure Goal.

Anticipated Program Activities:
In 2021 the LTIP programs will continue collection, processing and analysis of pavement and bridge data required to achieve Program objectives. The LTPP InfoPave and LTBP InfoBridge web portals will be updated with additional data to more fully document the long-term performance of the infrastructure under study. New analysis projects will be undertaken to develop bridge performance models and address to-be-selected objectives identified in the LTPP Data Analysis Plan[6].

[6] A workshop to update the LTPP Data Analysis Plan is planned for the summer of 2020.

Key FY21 FHWA Long-Term Infrastructure Performance R&T Program Activities.

Activity	Period of Performance
2021 LTPP Data Collection	2021-2022
2021 LTPP Program Support	2021-2022
2021 LTPP Data Analysis	2021-2022
2021 LTBP Data Collection	2021-2022
2021 LTBP Program Support	2021-2022
2021 LTBP Data Analysis	2021-2022
2021 LTIP Stakeholder Engagement	2021-2022
Highway Infrastructure Engineering and Research Data Services	2021-2022

Expected Program Outcomes:
The ultimate outcome of the LTIP programs will be more effective management of highway infrastructure performance. Intermediate outcomes include improved knowledge and understanding of pavement and bridge performance to inform infrastructure design and management decisions, improved tools, technologies and practices for assessing pavements and bridges, and more reliable performance prediction models. Achievement of these outcomes in support of the Department's Infrastructure Strategic Goal also contributes to achievement of the Department's Safety and Innovation Strategic Goals.

Collaboration Partners:
The individual State-DOT-owners of the pavements and bridges under study are actively engaged in supporting data collection efforts. Indeed, their active engagements makes the LTIP research possible. Due to the importance of their active engagement, FHWA contracts with the TRB for a Federal Advisory Committee Act (FACA)-compliant Long-Term Infrastructure Performance Committee that provides consensus stakeholder advice on the conduct of the program via letter reports addressed to the Administrator. In addition, FHWA LTIP Program staff regularly engage with stakeholders in both formal and informal settings to gather input concerning challenges and opportunities that might be addressed through the program, as well as information on related work undertaken by other organizations both nationally, and internationally. A State Coordinators group has been established for each program as a forum to strengthen the partnership between the FHWA and the state DOTs. Other stakeholders include the American Association of State Highway and Transportation Officials (AASHTO) and its Committees on Materials and Pavements (LTPP) and Bridges and Structures (LTBP), the Transportation Research Board (TRB), industry organizations such as the National Asphalt Pavement Association and the American Concrete Paving Association, Institute of Steel Construction, National Concrete Bridge Council (NCBC), and university faculty engaged in related work.

Benefits of Partnership and Partner Contributions to FHWA's Long-Term Infrastructure Performance Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard / Goal Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding	Stakeholder Advice	Education and Awareness
State Departments of Transportation	X		X	X	X	X	X	X	X	X	
AASHTO Special Committee on Research and Innovation	X					X					
AASHTO Committee on Materials and Pavements	X		X		X		X			X	
AASHTO Committee on Bridges and Structures	X		X		X		X			X	
Universities		X				X	X				
University Transportation Centers		X				X	X				
National Academy of Sciences (TRB)	X	X				X	X			X	
Industry Associations	X	X	X		X	X	X				

Pavement and Materials
$4,542,790

Program Description:
The goals of the Pavement and Materials Program are to support aspects of FHWA project delivery including: material selection, pavement design, pavement preservation, quality assurance, asset management, and sustainability.

The Pavement & Materials Research, Development and Technology (RD&T) Program together with the Accelerated Implementation and Deployment of Pavement Technologies (AIDPT) Program provide a coordinated and cohesive approach to research, development and technology activities focused on providing tools, technologies and guidance, and supporting updated policies, to improve the safety, durability, sustainability and cost-effectiveness of highway pavements, and the materials from which highway infrastructure is constructed. The Pavement & Materials RD&T Program undertakes research toward improved pavement materials, as well as improve design and analysis practices. This work is aligned with the DOT Infrastructure Goal, and addresses Advanced Materials, Designs and Technologies within the State of Good Repair Topic Area.

Program Objectives:
Research conducted in this program will address future pavement exigencies and advance technologies, including the impact of autonomous vehicles, shrinking work force, and changing material slates and availability. FHWA's Pavement & Materials RD&T Program seeks to drive innovation in pavement materials, design, evaluation and management practices, and seeks to raise the bar on performance for longer lasting, durable, and innovative pavements and preservation treatments while shifting some of the risk and rewards for performance.

Safety**:** The Program contributes to the Department's Safety Goal through research on methods for evaluating pavement surface characteristics with a goal of identifying low pavement friction in the field. Research on improved test methods, material selection, and pavement design will lead to longer lasting pavements. Such pavements will necessitate less maintenance, preservation, and replacement and afford a decrease in work zone accidents and fatalities.

Infrastructure**:** The Program contributes directly to the Department's Infrastructure Goal in multiple ways. Research on performance engineered mixtures will provide contractors with more options with the design of concrete and asphalt pavements. The improved tests and guidance developed in the Program will increase the durability of the pavement. In a recent significant effort, a new "game changing" chemical test for assessing the susceptibility of alkali silica reactivity (ASR) of aggregates was developed. Cracking induced by ASR is one of the principle durability issues with concrete pavements and structures. The chemical test reduced the time to assess materials from one year to 3 weeks and provides insight as to mitigation strategies for ASR.

Accountability**:** The Program contributes to the Department's Accountability Goal through research to enhance the assessment and selection of materials, mixtures and pavements. Performance specifications and test methods will be advanced that address the clarity of their relationship to performance, improve their accuracy, and for some tests, greatly reduce the time to conduct the test. In one Program activity, the existing performance and index based mix test methods are being compared to evaluate their sensitivity, reproducibility and ease and time to conduct. In the course of this, guidance will be provided to enhance the reproducibility and rapidity of conducting the tests. Utilization of these developments will improve the pavement design, provide better assurance of construction materials and quality, and ultimately enhance the durability of the pavements. improve its life cycle cost.

Anticipated Program Activities:

Activities in the Pavement & Materials RD&T Program include research and development of material test methods and specifications to improve the durability of both virgin and recycled materials used in highway construction and preservation, with a focus on advancing performance related specifications (PRS) and performance engineered mixtures (PEM) that provide a fair and rational basis for linking payment to the expected performance of the as-constructed product, while giving contractors the freedom to innovate. Activities also include the development of methods, tools, techniques and best practices for the effective and efficient assessment of in-service pavements to enable informed decisions in the management of pavements over the whole-life cycle and design and construction of safe, sustainable, resilience and long-lasting pavement structures. Additionally, through the Pavement & Materials RD&T Program, FHWA provides technical assistance in support of infrastructure forensic investigations undertaken by the National Transportation Safety Board (NTSB), the Inspector General, State Departments of Transportation, FHWA Division Offices and Federal Lands, and others. Examples of forensic activities include: investigations of premature failures, assistance in fraud cases, and assistance in identifying reasons for low pavement friction that have resulted in crashes.

Key FY21 FHWA Pavement & Materials R&D Program Activities.

Activity	Period of Performance
Develop guidance on generating longer lasting "Mill and Fill" surface lifts using premium materials	2021-2023
Conduct critical assessment of asphalt mixture performance related specifications (PRS) and test methods	2020-2022
Develop and amend asphalt binder performance specifications to accommodate current crude oil based and future non-petroleum based sources	2019-2025
Advance and Validate Performance Engineered Mixtures (PEM) tests and procedures	2018-2024
Develop guidance for optimizing asphalt mix designs incorporating Reclaimed Asphalt Pavement (RAP) and Recycled Asphalt Shingles (RAS) and other sustainable materials for more durable pavements and preservation treatments	2021-2025
Compare methods for determining air void parameters of fresh concrete	2021-2022
Develop solutions for mitigating Alkali-Silica Reactivity (ASR) in concrete mixtures rapidly and accurately	2021-2025
Develop guidance on the use of local materials as aggregate, aggregate replacement and supplementary cementitious materials	2018-2024
Application of NDE to pavement performance	2021-2022
Develop models to evaluate/predict pavement performance, assess pavement capacity	2021-2024
Development of pavement preservation solutions	2021-2022
Pilot studies of pavement structural and risk assessment of super heavy load movement on highway routes	2021-2022
Application of artificial intelligence and big data to pavement issues	2020-2027

Expected Program Outcomes:
The Pavement & Materials RD&T Program will develop innovative and robust technologies, tools, analysis methodologies, and best practices recommendations to support State highway agencies in identifying optimized sequence of treatment actions that considers both structural and functional condition to cost-effectively maintain and preserve their pavement network over the lifecycle. Best practice recommendations, tools and technologies will also be developed to facilitate consideration of sustainability and resiliency during pavement design and construction and assessment of construction quality on long term performance. Additionally, the program enables Federal-aid recipient to better ensure that they are paying for quality pavement construction that require less frequent repairs due to increased durability.

Collaboration Partners:
FHWA Pavement & Materials RD&T program staff regularly engage with key stakeholders in both formal and informal settings to gather input concerning challenges and opportunities that

might be addressed through the program, as well as information on work undertaken by other organizations both nationally, and internationally. Stakeholders include representatives of individual highway agencies, pertinent committees of the American Association of State Highway and Transportation Officials (AASHTO) and the Transportation Research Board (TRB), industry organizations such as the American Concrete Pavement Association (ACPA) and the National Asphalt Pavement Association (NAPA), standard-setting organizations such as the American Concrete Institute (ACI) and ASTM International, and university faculty engaged in related work.

Formal interactions with AASHTO, TRB, and industry organizations generally occur at regular intervals (at least annually, and as often as quarterly), but are not formally tracked or measured. Ad hoc interactions in the form of technical assistance requests are logged on an internal SharePoint site. Program partners (both government and non-government), benefits derived from partnerships, and partner contributions are summarized in the table below.

Benefits of Partnership and Partner Contributions to FHWA Pavement and Materials Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard / Goal Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding	Stakeholder Advice	Education and Awareness
AASHTO Committee on Materials and Pavements	X		X		X						
State Departments of Transportation	X			X	X	X		X	X		
National Institute of Standards and Technology (NIST)						X	X				
National Asphalt Pavement Association		X						X			
American Concrete Pavement Association		X									
ASTM International			X								
Universities				X	X	X	X				
Sustainable Pavements Working Group[4]	X	X				X					
Federal Aviation Administration						X					

Structures
$5,600,700

Program Description:
The Structures Research and Technology (R&T) Program is a coordinated and cohesive program of research, development and technology activities focused on providing tools, technologies and guidance, and supporting updated policies, to improve the safety, structural integrity, longevity, construction processes and cost-effectiveness of highway bridges, tunnels and other structures.

Program Objectives:
FHWA's Structures R&T Program seeks to drive innovation in structural design, construction, inspection, evaluation, and maintenance through the development of best practice guidance and novel solutions to engineering challenges in bridges, tunnels, and ancillary structures, as well as training and technology transfer initiatives directed toward ensuring the safety of the Nation's bridges and structures, and promoting effective management of that infrastructure. It is aligned with the Department's State of Good Repair Topic Area under the Infrastructure goal, and also contributions to achievement of the Department's Safety and Innovation goals. Accordingly, the over-arching objectives guiding FHWA's Structures R&T Program are to:

- Achieve and sustain a state of good repair of bridges, tunnels, and other structures.
- Implement and enhance the effectiveness of transportation performance management.
- Deliver projects faster and more efficiently.
- Improve the sustainability and resilience of highway infrastructure.

Program activities include work addressing Advanced Materials, Designs, and Technologies; Risk-Based Asset Management; Infrastructure System Resilience; Advanced Inspection Tools; and Effective Application of Best Practices.

Anticipated Program Activities:
In FY21, the Structures R&T program will deliver advancements that support the safe and efficient operation of highway structures. Tools to support appropriate responses to fire-damaged bridges will be developed. Guidance for the structural design of ultra-high performance concrete bridges will be delivered to AASHTO. Stakeholder bridge preservation decision-making processes will be supported through the development of resources designed to enable the engagement of best practices. Non-destructive evaluation technologies will be refined such that infrastructure owners can adopt advanced practices that deliver positive return on investment. Bridge deck repair and rehabilitation solutions will be developed, supporting cost-effective maintenance actions that deliver long-term performance. Training solutions aimed to educate professionals in the practice of bridge engineering will be developed.

Key FY21 FHWA Structures R&T Program Activities.

Activity	Period of Performance
Structural Design Guide Specification for Ultra-High Performance Concrete	2021-2022
Advanced Bridge Deck Overlay and Repair Solutions	2021-2022
Prediction of Constraint-Induced Fracture in Steel Bridge Welded Details	2021-2022
Alternative Post-Tensioning Tendon Strand and Filler Testing	2021-2022
Best Practices for Mitigating and Long-term Effects of Tunnel Leakages	2021-2022
Develop Immediate Response Tools for Safety Inspections Following a Fire Event on, under, or near a Bridge	2021-2022
Updates to Anti-Terrorism Planner (ATP) for Bridges	2021-2022
Data-Driven Bridge Evaluation for Extreme Events	2021-2022
Next Generation Data Framework for Developing Data-Driven Preservation Performance Estimates	2021-2022
Develop Bridge Preservation Portal	2021-2022
NDE and Structure Health Monitoring Return of Investment	2021-2022
Integration of NDE into Load Rating Practices	2021-2022
Develop an LRFD-based Ancillary Structures Design Course	2021-2022
Develop Training Solutions to Educate Professionals for Practice in Highway Bridge Engineering	2021-2022

Expected Program Outcomes:
The Structures RD&T Program will deliver solutions that benefit the broader highway community of stakeholders. Research activities will produce guidance on the use of advanced structural materials, facilitating use of novel structural solutions by early adopter agencies. Activities will create solutions that allow state-of-the-art maintenance and rehabilitation practices to be engaged in support of enhancing the performance of bridge decks. Developed solutions will encourage best practices in bridge preservation. The safety and security of highway infrastructure will be bolstered through the development of guidance related to terrorist attack mitigation and bridge fire responses. Tools to ensure appropriate knowledge within the next generation of bridge engineering professionals will be developed, facilitating the promulgation of best practices across the community.

Collaboration Partners:
FHWA Structures R&T program staff regularly engage with key stakeholders in both formal and informal settings to gather input concerning challenges and opportunities that might be addressed through the program, as well as information on work undertaken by other organizations both nationally, and internationally. Stakeholders include representatives of individual highway agencies, pertinent committees of the American Association of State Highway and Transportation Officials (AASHTO) and the Transportation Research Board (TRB), industry organizations such as the Precast/Prestressed Concrete Institute, and the

National Steel Bridge Alliance, standard-setting organizations such as the American Concrete Institute (ACI) and ASTM International, and university faculty engaged in related work.

Formal interactions with AASHTO, TRB, and industry organizations generally occur at regular intervals (at least annually, and as often as quarterly), but are not formally tracked or measured. Ad hoc interactions in the form of technical assistance requests are logged on an internal SharePoint site. Program partners (both government and non-government), benefits derived from partnerships, and partner contributions are summarized in the table below.

Benefits of Partnership and Partner Contributions to FHWA Structures Program.

Partner Organization	**User Perspective on Needs**	**Industry Perspective**	**Standard / Goal Setting**	**Field Trials**	**Deployment**	**Research Collaboration**	**Specialized Expertise or Capabilities**	**Donation of Material or Services**	**Funding**	**Stakeholder Advice**	**Education and Awareness**
AASHTO Committee on Bridges and Structures	X				X						
State Departments of Transportation	X			X	X			X	X		
National Institute of Standards and Technology (NIST)						X	X				
Precast/Prestressed Institute	X	X									
American Concrete Institute		X									
ASTM International			X								
Canadian Standards Association			X								
Research Council on Structural Connections (RCSC)			X								

Transportation Performance Management and Asset Management
$1,155,700

Program Description:
The Transportation Performance Management and Asset Management (TPM and TAM) Research, Development, and Technology (RD&T) Program is a coordinated and cohesive program of research, development and technology deployment activities focused on providing tools, innovations, technologies and on developing guidance and policies to advance the effective management of highway infrastructure and system performance. Research development and deployment activities include: identification and advancement of specific strategies to enhance TPM and TAM; the advancement of TPM & TAM to improve or preserve the condition of our highway infrastructure assets in a state of good repair and improve the performance of the system, and the development and deployment of TPM and TAM training, technology transfer and support initiatives.

Program Objectives:
FHWA's TPM and TAM Program is guided by the TPM Implementation Plan, which is publicly available on FHWA's TPM website. The Plan lays out the implementation activities that will be accomplished in 2018-2022. Investing in these activities will support State DOTs, MPOs, other transportation partners, and industry to implement effective practices to manage the performance and condition of the highway system and with a goal to preserve our assets and minimize the whole life costs; operate in a financially sustainable manner; and provide a framework to improve performance on a long-term basis. In 2021, FHWA's TPM and TAM Program will work to accomplish the activities outlined in the TPM Implementation Plan and will deliver to State DOTs and MPOs a range of technical assistance resources such as training, guidance, best practices, peer exchanges, etc. The objectives of this Program directly support the U.S. DOT Strategic Plan's Infrastructure Strategic Goals of improving the condition of infrastructure assets, and enable the efficient and safe movement of people and goods through innovation and accountability which are the backbone of transportation performance management and asset management.

Anticipated Program Activities:
In FY21, the Transportation Performance Management and Asset Management R&T Program will continue to identify specific strategies to enhance TPM and TAM. This includes identify new performance measures, creating resources to benefit end users, and providing training and technical assistance.

Key FY21 FHWA Transportation Performance Management and Asset Management R&T Program Activities.

Activity	Period of Performance
Identification of next generation performance measures and methodologies and deployment	2021-2022
Develop a handbook, case study & undertake workshops focused on the application of a metric for resilience (risk) for development of asset management investment strategies	2021-2022
Develop resources and conduct workshops for State DOTs, MPOs and other owners of how TAM, TPM, and Performance-based Planning Interface and influence one another. Topics to be addressed include target submissions and integration into long range plans	2021-2022
Develop resources on the application of a State DOT's Asset Management Plan to address the planned recovery from the current 2020 National Emergency that has effected the influx of funds to State DOTs and the work undertaken. This includes revisiting the TAM financial planning and asset management investment strategies to best address asset deterioration and economic recovery.	2021-2022
HERS-ST for TPM	2021-2022
TPM programmatic assessment analysis, guidance & reporting	2021-2022
Performance-based management capacity building support and implementation	2021-2022
TPM & Asset training and technical assistance Delivery	2021-2022
TPM Benefit Cost Analysis Toolkit	2021-2022
TPM training and educational resource development including noteworthy practice development	2021-2022
Develop resources to support life cycle planning	2021-2022
Enable the increased use of leading indicators through the integration of digital as-builts	2021-2022
(1) assess FLMA maturity with respect to risk-based asset management, (2) identify gaps in FLMA risk-based asset management practices and relevant constraints to addressing those gaps, (3) determine which emerging best practices in risk-based management are applicable to FLMAs as tools for addressing identified gaps, and (4) develop guidance for FLMAs to leverage both their existing capabilities and industry best practices to gain the benefits of risk-based asset management.	2021-2022

Expected Program Outcomes:

FHWA's Transportation Performance Management and Asset Management R&T Program primarily supports USDOT Accountability goal. However, the program also makes significant contributions toward all the USDOT Strategic Goals through the efficient investment of Federal transportation funds across national transportation goals; the

increase in accountability and transparency of the Federal-aid highway program; and the improvement of program and project decision-making through performance-based planning and programming. Specific contributions are as follows.

Safety: The TPM & AM R&T Program will contribute directly to highway safety and the Department's Systematic Safety Approach by providing tools, technologies, training and guidance to support infrastructure owners in effectively managing highway bridges, tunnels and other structures, so that such infrastructure is resilient and can safely carry traffic loads and withstand natural disasters. This also includes safety TPM data contributions to the overall Department's Data strategy.

Infrastructure: The TPM & AM R&T Program supports the Life Cycle and Preservation/Preventive Maintenance objective through research development and deployment strategies designed to foster more effective management of highway infrastructure assets. Focus areas include:

Advancing TPM practices; including the development of risk-based AM plans for developing investment strategies to achieve system performance effectiveness and State DOT targets for asset condition, while managing the risks, in a financially responsible manner, at a minimum practicable cost over the life cycle of its assets. A focus of State DOT AM plans is the State DOT's long-term state-of-good-repair (SOGR) objectives for the NHS. FHWA works with State DOTs and MPOs to increase the health and longevity of the Nation's highways by assessing vulnerabilities, considering communities and resilience in the transportation planning process, incorporating resilience in AM plans, and addressing resilience in project development and design.

Innovation & Accountability: The TPM & AM Program supports the Department's Innovation Goal by undertaking research and development toward providing and integrating critical data needed for improved decision-making, developing analytic tools to address critical performance gaps, and providing for a greater level of transparency in communicating transportation performance. The TPM & AM R&T Program is also focused on supporting the development of next generation performance measures; the advancement of benefit cost and trade off analysis tools and methodologies; data collection, management, analysis and integration best practices; identifying and using leading and lagging indicators to better predict and forecast condition and performance; advancement of performance gap analysis, life-cycle planning and risk analysis, and financial planning for developing agency investment strategies; advancing state of the art data visualizing tools and methods to better communicate the national performance story. Lastly, work will be conducted so that agencies can be prepared for autonomous vehicles from a design, maintenance and AM perspective. This program impacts and is of benefit to the highway system in its entirety, including the portion serving rural communities.

Collaboration Partners:
FHWA is committed to supporting effective implementation of TPM to ensure States and MPOs are using a performance-based approach in their transportation planning and programming,

setting meaningful targets for the TPM measures, and reporting at a level of detail needed for a national conversation on transportation performance. FHWA aims to provide State DOTs, MPOs, and other stakeholders with the information and resources they need to implement TPM and achieve a performance-based transportation system. The FHWA TPM and AM program conducted a national survey of State DOTs and metropolitan Planning Organizations to identify the areas of need for implementing TPM and AM. This input from stakeholders is being used to identify and develop technical assistance resources to help State DOTs in meeting the requirements for TPM and asset management.

Benefits of Partnership and Partner Contributions to FHWA's TPM and Asset Management Program.

Partner Organization	**User Perspective on Needs**	**Industry Perspective**	**Standard / Goal Setting**	**Field Trials**	**Deployment**	**Research Collaboration**	**Specialized Expertise or Capabilities**	**Donation of Material or Services**	**Funding**	**Stakeholder Advice**	**Education and Awareness**
State Departments of Transportation	X				X		X		X		
Metropolitan Planning Organizations	X				X		X		X		
AASHTO Performance-based capacity building pooled fund	X				X		X		X		
AASHTO Joint Technical Committee on Electronic Engineering Standards	X	X	X								

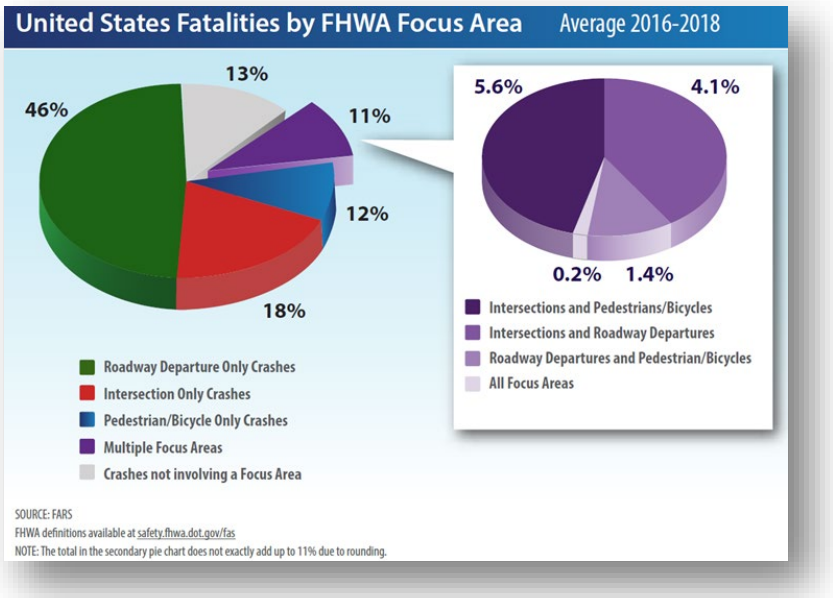
Safety

Safety Program Delivery
$2,222,500

Program Description:
The FHWA Office of Safety, Office of Safety Research and Development, and the Resource Center Safety and Design Technical Service Teams work alongside the safety specialists in the Division offices to provide national leadership on roadway safety. In particular, FHWA is working with States to help them design, operate, and maintain roadways that fully integrate a safe system approach.

A safe system approach aims to eliminate fatal and serious injuries for all road users. It is based on the principle that not a single death or serious injury is acceptable. It is human-centered, takes human fallibility and vulnerability into account, and relies on layers of protection being built into our roadway system, so if one layer fails another takes over. A safe system approach focuses our resources on activities that address the Nation's most critical safety challenges, and emphasizes our shared responsibility in meeting these challenges. Rather than aiming to just reduce the number of crashes, a safe system prioritizes addressing crashes that result in serious injuries or loss of life. Three critical areas that encompass almost 90 percent of the traffic fatalities in the U.S. are:

- Roadway departure
- Intersection crashes
- Pedestrian/bicycle crashes



Through Safety Program Delivery, FHWA assists partners and stakeholders in making the best use of the programs and services available to them to optimize their safety investments and to maximize their safety contributions to realize our shared zero vision. Safety Program Delivery provides support for the $2.6 billion Highway Safety Improvement Program (HSIP) -a core Federal-aid highway program with the purpose to achieve a significant reduction in fatalities and serious injuries on all public roads. The program assists states with the administration of the HSIP by providing needed information, training, policy guidance and technical assistance to FHWA's partners and the public on proven, efficient, cost-effective safety programs and activities; encouraging and supporting partnerships with private and public safety stakeholders; and continuously communicating the necessity and available tools to utilize a data-driven system approach to saving lives on all public roads.

Through the HSIP, the transportation community implements performance-based, data-driven solutions that have the greatest potential to reduce highway fatalities and the most serious injuries using infrastructure-oriented improvements.

Program Objectives:
FHWA's Safety Program Delivery ensures that stakeholders have the tools and resources needed to address emerging and existing roadway safety issues and advance a safe system approach, by providing new tools and innovations, research, and training.
The program has the following specific objectives:

- Promote excellence in safety programs
- Research and advance effective safety solutions
- Fortify partnerships and outreach

Anticipated Program Activities:
To meet the objectives listed above, FHWA Safety Program Delivery will:

- Implement FHWA safety program's legislative requirements.
- Strengthen States' abilities to implement a safety program that is data driven by sharing information, training, and assistance, and provide national leadership to agencies as they design, operate, and maintain roadways that fully integrate safe system principles.
- Improve the technical capacity of transportation safety professionals at all levels of government.
- Evaluate and assess road owners' capabilities, which will enable targeted training and technical assistance to fill knowledge and or technical gaps.

This will be accomplished through the following specific activities:

Implement FHWA Safety Programs' legislative requirements: Communicate the laws, regulations and funding eligibility for the HSIP (23 USC 148 and 23 CFR 924) and ensure oversight and stewardship for the HSIP in coordination with; work alongside modal partners to communicate the laws, regulations, policy guidance and funding eligibility and provides stewardship for the following statutory programs; Implement the Safety-Related Planning Regulations; and provide input on legislative proposals and other technical assistance requests.

Strengthen States' abilities to implement a safety program that is data driven by sharing information, training, and assistance, and provide national leadership to agencies as they design, operate, and maintain roadways that fully integrate Safe System principles: Provide technical assistance to stakeholders on policy and guidance. Communicate Federal safety policy and guidance through various communication forums such as fact sheets, webinars, meetings, and manuals; assess 2019 State safety performance targets to determine which states met or made significant progress toward their safety targets; develop an HSIP Implementation plan that will help them to meet future targets; Review Section 130 National Evaluation recommendations to ensure States have the capability to advance safety at rail grade crossings; integrate Safe System principles into safety programs by providing information, resources, examples and technical assistance to States on how to advance the Safe System approach into existing safety programs; continue supporting Vision Zero communities through the dissemination of successful practices, development of action plans, and other technical assistance; strengthen and expand productive external partnerships with national, state and local transportation agencies and other stakeholders, to spread the reach and impact of FHWA's safety priorities and programs; and support and educate the State Departments of Transportation, Metropolitan Planning Organizations, and other safety stakeholders on national safety goals, policies, and strategic plans.

Evaluate the results of FHWA Safety Program Delivery implementation efforts: Performs program assessments, prepare annual reports, evaluate safety products and tool to identify gaps in existing safety efforts and opportunities for improvement; identify enhancements to the HSIP online reporting tool to address user needs and requirements, ultimately yielding annual outputs and outcomes on the HSIP program; develop the 2020 HSIP National Summary Report to determine the aggregate number and type of projects funded under the HSIP and cost benefit ratio; continue a program evaluation project that helps to determine how States are modifying or enhancing their safety efforts based upon FHWA's safety program delivery efforts; and ensure States have due process when FHWA takes an enforcement action. Institute a sound process that enables States to submit additional supporting documentation that will help to validate or invalidate an action.

Key FY21 FHWA Safety Program Delivery R&T Program Activities.

Activity	Period of Performance
Implement FHWA Safety Programs' legislative requirements.	2021-2022
Strengthen States' abilities to implement a safety program that is data driven by sharing information, training, and assistance, and provide national leadership to agencies as they design, operate, and maintain roadways that fully integrate Safe System principles.	2021-2022
Improve the technical capacity of transportation safety professionals at all levels of government.	2021-2022
Evaluate the results of FHWA Safety Program Delivery implementation efforts.	2021-2022

Expected Program Outcomes:
Implementing FHWA Safety Programs' legislative requirements. Communicate the laws, regulations and funding eligibility for the HSIP (23 USC 148 and 23 CFR 924).

- This activity will ensure States are implementing a safety program that is compliant with legislative requirements, regulations and supporting Guidance, and that States are utilizing their HSIP funds effectively and to the maximum extent possible.

Strengthen States' abilities to implement a safety program that is data driven by sharing information, training, and assistance, and provide national leadership to agencies as they design, operate, and maintain roadways that fully integrate and uses safe system principles.

- The intended outcome of this activity is to help States save more lives and prevent more serious injuries by helping States integrate safe system principles into their safety projects and programs, and focus their resources on activities that address their most critical safety challenges.

Improving the technical capacity of transportation safety professionals at all levels of government.

- The expected outcome of this activity is a proficient and skilled safety professional workforce that will help us deliver a state of the art safety program that keeps up with innovation and best practices.

Evaluating the results of FHWA Safety Program Delivery implementation efforts.

- Evaluating safety program delivery efforts will help determine the effectiveness of the programs, identify gaps, and provide insights into the future direction of the program.

Collaboration Partners:
FHWA's Safety Program Delivery Research Program is built upon focus areas identified from safety data provided by States, as well as stakeholder input and assessment of stakeholder capabilities. Our focused approach to safety research is directed at providing information to transportation practitioners, decision makers, and others to assist in preventing and reducing these severe crashes. We track input from partners through regular reporting and technical assistance.

FHWA gains input on research needs from our stakeholders using a multitude of vehicles including but not limited to:

- Peer exchanges provide opportunities to identify technical skill gaps in evaluating and deploying life-saving countermeasures and advancing the use of scientific methods and data-driven decisions.
- HSIP assessments are conducted regularly in the States and these evaluations identify opportunities to enhance HSIP implementation efforts thru research and technical assistance.
- HSIP reports, due annually facilitate the documentation of stakeholder input and are used to improve products, tools and grow existing services.
- Annual 23 USC Section 130(g) reports from each state documenting the progress being made to implement the railway-highway crossings program, the effectiveness of such improvements, an assessment of the costs of the various treatments employed, and subsequent crash experience at improved locations.
- Federal, state, regional, and local transportation agencies, academic institutions, foundations, or private firms proposed activities through a pooled fund study.
- State SHSP update cycles provide a forum for increased coordination and collaboration among a multi-disciplinary group of State safety stakeholders and FHWA. Update cycles identify needs and input on various program areas.

Coordinating across modes within DOT is vital to ensuring our roads are safe. FHWA works closely with FMCSA, NHTSA, FTA, and FRA to address multiple dimensions of roadway safety. FHWA concentrates on improvements to roadway infrastructure upon which vehicles and users operate. There are many places where the safety mission of other modes overlaps and require coordination to achieve success.

- The US DOT Safety Council serves to tackle the most critical transportation safety issues we face in a coordinated fashion.
- The DOT Traffic Records Coordinating Committee (TRCC) is an interagency group charged with coordinating the support and improvement of safety data collection,

management, and analysis within DOT, among State and Federal partners, and across different State-level traffic records systems.

- The intermodal Managers' Safety Meeting, with senior managers from FHWA, NHTSA, FMCSA, FTA, and FRA meets regularly to discuss common issues and opportunities to coordinate strategies and program activities.
- The FHWA and FRA Working Group serves as the conduit to resources and information on rail grade crossing safety. The group sponsors outreach and training to internal and external partners in a coordinated manner.

In addition, the FHWA Safety Delivery Program coordinates with other FHWA program offices (e.g., Planning, Policy, Infrastructure, Public Affairs) to advance safety program delivery initiatives.

Making dramatic improvements in national, State, and local safety performance depends upon building effective external partnerships with a wide range of safety stakeholders, including national safety organizations, State and local transportation professionals, and the private sector. To build effective national safety partnerships, FHWA actively engages in a broad range of external coordination. FHWA meets regularly to share information with a host of our safety partners. The purpose of these meetings is to strengthen FHWA's relationship with its safety partners to better leverage resources and be more aggressive in accomplishing our mutual safety goals. Discussions with these groups have provided valuable insights into FHWA's safety program research activities.
External Partners include but are not limited to:

- **American Association of State Highway and Transportation Officials** – Collaborates on research problem statements and various outreach projects, in addition to participating on various committees that focus on highway safety policy.
- **American Traffic Safety Services Association** - Represents the road safety, traffic safety, and highway safety industry and collaborates on Road to Zero (RTZ) initiatives.
- **American Road & Transportation Builders Association (ARTBA)** – partners with us on a variety of program activities including training on Safe Guardrail Installation & Maintenance and collaborates on RTZ initiatives.
- **Transportation Research Board** – The mission of the Transportation Research Board is to provide leadership in transportation innovation and progress through research and information exchange, conducted within a setting that is objective, interdisciplinary, and multimodal. FHWA coordinates on research problem statements and safety program staff participates on various safety-related research projects and committees.

- **National Association of County Engineers** – Collaborates on evaluating and deploying life-saving countermeasures and advancing the use of scientific methods and data-driven decisions to address safety on local and rural roads.
- **Roadway Safety Foundation** - Collaborates with this organization to educate the public on road safety issues, and promoting roadway research and technical transfer activities. The RSF cosponsors the National Roadway Safety Awards with FHWA.
- **Road to Zero** – A national safety coalition formed by the National Safety Council in partnership with the National Highway Traffic Safety Administration, the Federal Highway Administration and the Federal Motor Carrier Safety Administration. We collaborate with the National Safety Council and representatives from over 800 multi-disciplinary organizations to help achieve the RTZ vision of zero traffic fatalities by 2050. The coalition brings together multiple stakeholders including not only representatives of roadway, behavioral and vehicle safety, but also nonprofit groups, public health officials and technology companies. Thru the NSC and the Coalition, grants are used to fund safety projects that show evidence of the effectiveness of proven countermeasures, have measurable objectives and have innovative approaches that could be replicated in other locations.
- **Operation Lifesaver, Inc.** – Assists FHWA and other USDOT modes promote rail crossing safety nationwide.
- **Institute of Transportation Engineers** – FHWA partners with ITE on various products and services such as identification of necessary research, technical resources, and exchange of professional information.
- **Federal, state, regional, and local transportation agencies, academic institutions, foundations, or private firms** - Collaborate with FHWA on solving transportation-related problems, research, planning, and technology transfer activities thru jointly funded the Transportation Pooled Fund (TPF) Program.

These internal and external partnerships provide an array of benefits. By collaborating internally with the USDOT, we assure that federal safety programs related to safety program delivery are coordinated and provide coordinated information to our partners. The collaboration with our external partners improves oversight and stewardship with regard to improving roadway safety outcomes.

Benefits of Partnership and Partner Contributions to FHWA Safety Program Delivery.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard / Goal Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding	Stakeholder Advice	Education and Awareness
AASHTO	X				X	X					X
State Departments of Transportation	X				X	X					X
Transportation Research Board	X					X					X
American Traffic Safety Services Association	X				X						X
American Road and Transportation Builders Association	X										X
National Association of County Engineers	X				X						X
Operation Lifesaver, Inc.											X
Road Safety Foundation	X										X
Road to Zero Coalition	X				X						X
Institute of Transportation Engineers	X					X					X
Federal, state, regional and local transportation agencies, academic institutions, foundations and private firms	X				X	X					X

Safety Design and Operations
$3,813,810

Program Description:
The Safety Design and Operations program encompasses core safety engineering work that overlaps traffic engineering, geometric roadway design, transportation planning, and system management and operations, and aims to help stakeholders reduce fatalities and serious injuries on all public roadways. The program focuses on three critical areas identified as providing the greatest potential to reduce highway fatalities using infrastructure-oriented improvements, as follows:

- Roadway departure
- Intersection crashes
- Pedestrian/bicycle crashes

These three areas account for over 90% of roadway fatalities. Through this program, we:

- Conduct research on safety improvements (e.g., to reduce roadway departure crashes in rural communities)
- Evaluate, document and promote noteworthy practices
- Provide technical expertise and leadership
- Support professional capacity building internally and externally, and
- Monitor and encourage innovative, infrastructure-based approaches to improving safety performance

These activities aim to ensure that FHWA assists partners and stakeholders in making the most effective safety investments and reduce fatalities and serious injuries on rural and urban roadways.

Program Objectives:
The main purpose of the Safety Design and Operations program is to improve safety and, ultimately, to save lives. Because the Federal-aid program is a State-administered and Federally-assisted program, the success of our efforts depends on working with stakeholders (e.g., State Departments of Transportation and local road owners). The program identifies the following objectives:

- Identify innovative road safety solutions and develop effective safety countermeasures
- Strengthen States' abilities to implement a performance-driven safety program by sharing information, training, and assistance

- Improve the technical capacity of transportation safety professionals at all levels of government to advance safety programs
- Evaluate the results of FHWA Safety Implementation efforts

Anticipated Program Activities:
The Safety Design and Operations program is leading and collaborating a number of activities in the areas of traffic engineering, geometric roadway design, transportation planning, system management and operations, vulnerable road user safety, speed management, data driven safety analysis, and connected and automated vehicles. The program provides national leadership to agencies as they design and operate roadways in order to fully integrate the needs of all users, accommodate human error, and minimize injury severity. Activities under this program include the promotion of certain infrastructure-oriented safety treatments and strategies, chosen based on proven effectiveness and benefits, to encourage widespread implementation by State, tribal, and local transportation agencies to reduce serious injuries and fatalities on American highways. Specific activities within the FY21 program are provided below:

Identify innovative road safety solutions and develop effective safety countermeasures: Examine how high friction surface treatments can be used to improve intersection safety; develop data-driven safety plans to reduce rural roadway departures by partnering with r with States, LTAP Centers, and Counties; and establish an Intersection Safety Pooled Fund Project to address driver behavior at Multilane Roundabouts to counteract an unexpected rise in crashes.

Strengthen States' abilities to implement a performance-driven safety program by sharing information, training, and assistance: Enhance State knowledge and processes for reviewing crash testing and conducting an in-service performance evaluation of roadside safety hardware; improve the USLIMITS2 tool which can be used to establish appropriate speed limits. Recent research findings need to be incorporated into the system to ensure that it up to date and supports State and local stakeholders. Conduct new research based on the findings of recently completed research; and conduct research and analysis to complete the 2nd Edition of the Highway Safety Manual (HSM). This project will provide needed research/material to complete and implement the HSM 2nd Edition (e.g., inclusion of ped/bike models, systemic analysis, improved injury severity, calibration, etc.).

Improve the technical capacity of transportation safety professionals at all levels of government to advance safety programs: Conduct naturalistic driving data analysis for Curves using the 2nd Strategic Highway Research Program Roadway Information Database to identify geometric factors in curve-related crashes; provide technical assistance related to bikeway selection to improve safety; and develop a resource to outline principles and benefits of offset right-turn lane for application at high-speed unsignalized intersections.

Evaluate the results of FHWA Safety Implementation efforts: Apply a Safe Systems Approach framework to address intersection crashes to develop a national strategy for improving intersection design and safety- partners could include State DOTs and other

transportation agencies. Demonstrate crash reduction potential of the network- level pavement friction measurement on a continuous rather than sampling basis through partnerships with State DOTs to collect and correlate friction and crash data at high-risk locations for roadway departure, intersection, and pedestrian crashes.

Key FY21 FHWA Safety Design and Operations R&T Program Activities.

Activity	Period of Performance
Identify innovative road safety solutions and develop effective safety countermeasures	2019-2024
Strengthen States' abilities to implement a performance-driven safety program by sharing information, training, and assistance	2019-2024
Improve the technical capacity of transportation safety professionals at all levels of government to advance safety programs	2019-2022
Evaluate the results of FHWA Safety Implementation efforts	2019-2022

Expected Program Outcomes:
The outcomes from the Safety Design and Operation program include variety of targeted technical assistance and resources to States, tribal, and local transportation agencies to address the Nation's most critical safety challenges. Agencies are assisted in addressing fatality and injury reductions in any one or all of three critical focus areas: roadway departure, intersection crashes, and pedestrian/bicycle crashes. Another outcome of this program provides insights on the contributing factors of roadway deaths and injuries related to roadway design and operations through data driven safety analysis. Finally, the program will continue to develop and promote tools that will lead to the safe integration of connected and automated vehicles into our roadway system.

Collaboration Partners:
The Safety Design and Operations program relies on its established network of partners in other public agencies, membership organizations, and in academia. Some technical areas have used stakeholder input to develop strategic plans (e.g., a strategic plan to improve pedestrian safety based on stakeholder-identified gaps and needs). FHWA also gains input on research needs from our stakeholders using a multitude of vehicles including but not limited to peer exchanges, conducting presentations and webinars that are open to the public, and seeking other means of sharing information with Federal, state, regional, and local transportation agencies, academic institutions, foundations, or private firms. Stakeholder input from these entities helps shape roadmaps, and other strategic planning documents as the Safety Design and Operations program activities are planned and implemented.

Non-government groups have been and continue to be collaborators. For example, FHWA worked with the National Association of Counties to conduct outreach on rural road safety to county officials. FHWA also works closely with the Institute of Transportation Engineers to learn of and disseminate noteworthy practices with this key constituency.

Key internal partners include but are not limited to:

- **Office of the Secretary ITS Joint Program Office** – ensures that safety needs are addressed in activities related to automated and connected vehicles.
- **Federal Motor Carrier Safety Administration** – to address infrastructure issues related to large truck crashes.
- **National Highway Traffic Safety Administration** –to ensure that a holistic 4 Es (Engineering, Education, Enforcement, and Emergency Services) approach is used to address safety.

In addition, the FHWA Safety Design and Operations Program coordinates with other FHWA program offices (e.g., Operations, Planning, Policy, Infrastructure), the Resource Center, and Federal Lands to advance safety delivery initiatives.

External partners include but are not limited to:

- **American Association of State Highway and Transportation Officials** – Collaborates on research problem statements and various outreach projects, in addition to participating on various committees that focus on highway safety policy.
- **American Traffic Safety Services Association** - Represents the road safety, traffic safety, and highway safety industry and collaborates on Road to Zero initiatives.
- **American Road & Transportation Builders Association** – partners with us on a variety of program activities including training on Safe Guardrail Installation & Maintenance and collaborates on RTZ initiatives.
- **Motorcyclist Advisory Council** – this advises FHWA on infrastructure-related safety issues of concern to motorcyclists.
- **Transportation Research Board** – The mission of the Transportation Research Board is to provide leadership in transportation innovation and progress through research and information exchange, conducted within a setting that is objective, interdisciplinary, and multimodal. FHWA coordinates on research problem statements and safety program staff participates on various safety-related research projects and committees.
- **National Association of County Engineers** – Collaborates on evaluating and deploying life- saving countermeasures and advancing the use of scientific methods and data-driven decisions to address safety on local and rural roads.
- **National Association of Counties** – Collaborates to engage their members, county officials, in the safety conversation.

- **Roadway Safety Foundation** – Collaborates with this organization to educate the public on road hazards, and promoting roadway research and technical transfer activities. The RSF cosponsors the National Roadway Safety Awards with FHWA.
- **Road to Zero Coalition** – A national safety coalition formed by the National Safety Council in partnership with the National Highway Traffic Safety Administration, the Federal Highway Administration and the Federal Motor Carrier Safety Administration. We collaborate with the National Safety Council and representatives from over 800 multi-disciplinary organizations to help achieve the RTZ vision of zero traffic fatalities by 2050. The coalition brings together multiple stakeholders including not only representatives of roadway, behavioral and vehicle safety, but also nonprofit groups, public health officials and technology companies. Thru the NSC and the Coalition, grants are used to fund safety projects that show evidence of the effectiveness of proven countermeasures, have measurable objectives and have innovative approaches that could be replicated in other locations.
- **Institute of Transportation Engineers** – FHWA partners with ITE on various products and services such as identification of necessary research, technical resources, and exchange of professional information.
- **Local Technical Assistance Program** –works with FHWA to ensure that local and rural safety stakeholders are part of the conversation.
- **Federal, state, regional, and local transportation agencies, academic institutions, foundations, or private firms** - Collaborate with FHWA on solving transportation-related problems, research, planning, and technology transfer activities thru jointly funded the Transportation Pooled Fund (TPF) Program.

Benefits of Partnership and Partner Contributions to FHWA Safety Design and Operations Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard / Goal Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding	Stakeholder Advice	Education and Awareness
American Association of State Highway and Transportation Officials	X		X		X	X	X				X
American Traffic Safety Services Association					X						X
American Road & Transportation Builders Association	X										X
Motorcyclist Advisory Council	X					X	X				
Transportation Research Board	X		X			X	X				X
National Association of County Engineers	X		X		X						X
National Association of Counties	X				X						X
Roadway Safety Foundation	X		X		X						X
Road to Zero					X						X
Institute of Transportation Engineers	X		X		X	X					X
Local Technical Assistance Program	X				X						X
Federal, state, regional, and local transportation agencies, academic institutions, foundations, or private firms	X		X		X	X	X				X

Safety Data and Analysis
$3,484,880

Program Description:
The Safety Data and Analysis program area focuses on the use of safety data to inform highway investment decision making through a systemic safety approach based on crash experience, crash potential, crash rate, or other data-supported means. The scope of the program includes research, development, and technology (RD&T) to improve State and local safety data systems commonly record crash, roadway inventory, and traffic volume data. The program directly supports the USDOT Strategic Safety Goal by enhancing State and local partners' capability to use safety data systems for analysis and evaluation supporting highway investment decision making to help ensure efficient and timely detection of critical safety hazards. The program also includes analyses supporting FHWA safety policy decision making, providing a foundation for systemic, performance-based approaches to improving safety. This is reinforced via the Roadway Safety Data Program, which helps States and local agencies advance their data capabilities through resource development, technical assistance, data management, training and data analysis.

Program Objectives:
The Safety Data and Analysis Program reflects a key FHWA theme of data-driven technologies and decision making as a priority for supporting highway infrastructure investment decision making. The main goal of the program is to discover new ways to use data and analysis tools to save lives and improve the ability of road owners and operators to make science-based safety decisions. The Safety Data and Analysis Program identifies five primary objectives to address the broad challenge:

- Research and develop new methodologies and tools for safety data collection, management, analysis, and evaluation.
- Increase the utilization of proven methodologies and tools for safety data collection, management analysis, and evaluation.
- Broaden the integration of safety data and analysis into planning, programming, and project development processes.
- Improve understanding of the benefits of safety data-driven decision making.
- Advance safety data and evaluation as a means of supporting Transportation Performance Management.

Anticipated Program Activities:
The Safety Data and Analyses anticipated program activities mirror the program objectives. "Research and Develop New Methodologies and Tools" activities will develop and evaluate potential safety countermeasures utilizing information from the Second Strategic Highway Research Program (SHRP2) Naturalistic Driving Data (NDS) data and the Roadway Inventory Database (RID), the Motorcycle Crash Causation Study and other novel sources

of data. Additionally, development of holistic and integrated safety analysis that include statistical goodness of fit will ensure the best possible selection of safety improvements. Updating FHWA developed tools with more information from recent research results and reflecting relevant issues such micro-mobility are activities that support "Increase the Utilization of Proven Methodologies and Tools."

Safety Data and Analysis activities that "Broaden the Integration of Safety Data and Analysis into all Processes" include providing traditional data for research and investigating new approaches for acquiring and disseminating data. The investigation will also explore using non-traditional and disparate data in safety analysis. Additional activities include completing the Pilot In-Service Performance Evaluation of Guardrail End Terminal final report and lessons learned.

Activities that "Improve Understanding of the Benefits of Safety Data-Driven Decision Making" include continuing the conduct of low-cost safety improvement evaluations to develop crash modification factors (CMFs) and determine benefit/cost ratios leveraging the support of partner agencies. The partner agencies continue to provide the direction of the research topics such as evaluation methodologies and specific countermeasures. Activities that "Advance Safety Data and Evaluation as a Means of Supporting Transportation Performance Management" providing technical assistance to State and local agencies to improve their data collection, analysis, and management practices with particular focus on meeting the Model Minimum Roadway Inventory of Roadway Elements Fundamental Data Elements (MIRE-FDE) 2026 deadline.

Specific FY21 Safety Data and Analysis Program activities will include:

Research and develop new methodologies and tools: Develop new safety countermeasures based second Strategic Highway Research Program (SHRP2) Roadway Inventory Database (RID) analyses; release of state DOT-based research on SHRP2 based safety countermeasure development and effectiveness; evaluate potential motorcycle crash countermeasures identified through analysis of Motorcycle Crash Causation study data and input from motorcycle safety stakeholders; continue and improve data collection and analysis for estimating lives saved, injuries prevented and cost benefit ratios on safety infrastructure in a GIS data library; enhance a safety performance development tool that incorporates the implementation of statistical goodness of fit; and explore use of realistic artificial data (RAD) as a measure of model fit, explaining safety relationships between variables used in highway safety modeling.

Increase the utilization of proven methodologies and tools: Update the Interactive Highway Safety Design Model (IHSDM) tool to provide decision makers with better information so that they can make cost-effective decisions. Define migration path for AASHTO to host the software. Update the Pedestrian and Bicycle Crash Analysis Tool (PBCAT) crash typology logic to reflect current and emerging roadway conflicts including micromobility conflicts.

Broaden the integration of safety data and analysis into all processes: Maintain and operate the Highway Safety Information System VI for roadway safety analysis; define concept for Highway Safety Information System VII applying new big data analytics; explore use of

disparate data in safety analyses to gain broader perspective and more complete picture of highway crashes and safety; explore the potential open source data management tools that can enable novel data conflations and lead to analyses that consider various infrastructure and operations data in safety analysis; complete Pilot of In-Service Performance Evaluation, providing lessons learned for State DOTs regarding how to collect data to conduct an in-service performance evaluation; support the Advanced Enterprise GIS for Transportation Systems AEGIST to through the development and validation of uniform data collection procedures and reporting; partner with the agencies participating in Evaluation of Low-Cost Safety Improvements Pooled Fund Study to evaluate the safety effectiveness of unproven safety countermeasures and to identify and addresses methodological issues with the development, application, and assessment of CMFs; and continue to improve and update FHWA's Safety Data Dashboard. This resource coverts large and complex datasets into graphical displays that aid in reviewing data trends and making comparisons.

Advance safety data and evaluation as a means of supporting Transportation Performance Management: Administer the Roadway Safety Data Program to include roadway safety data collection, analysis, and management; provide roadway safety data and analysis technical assistance to practitioners in State and local agencies; and reassess and develop the next version of the Model Inventory of Roadway Elements (MIRE) that states collect to develop comprehensive roadway and traffic data inventory for safety management. Expand State collected element/MIRE-FDE alignment to full coverage of MIRE.

Key FY21 FHWA Safety Data and Analysis Program R&T Activities.

Activity	Period of Performance
Research and develop new methodologies and tools	2016-2022
Increase the utilization of proven methodologies and tools	2014-2024
Broaden the integration of safety data and analysis into all processes	2017-2026
Improve understanding of the benefits of safety data-driven decision making	2016-2023
Advance safety data and evaluation as a means of supporting Transportation Performance Management.	Ongoing

Expected Program Outcomes:

Research and develop new methodologies and tools: It is expected that six Phase 1 proof of concept studies in the areas of safety, planning, and operations using the SHRP2 Safety data will be completed indicating the feasibility of conducting a full study that will yield implementable results.

Increase the utilization of proven methodologies and tools: The annual update of the IHSDM will be released and practitioners will be able to use it as a faithful implementation of the Highway Safety Manual. FHWA will coordinate with the AASHTO to explore future

opportunities regarding IHSDM. The updated and revised PBCAT logic reflecting current and emerging roadway conflicts such as micro-mobility conflicts will be implemented into PBCAT version 3.

Broaden the integration of safety data and analysis into all processes: Case studies of possible models for HSIS VII data acquisition and dissemination and of analysis using HSIS data and non-traditional or disparate data will provide insight and direction for future data collection, dissemination, and analysis programs.

Improve understanding of the benefits of safety data-driven decision making: The results of evaluations of mini-roundabouts, wrong-way driving countermeasures, and bike lane configurations will provide crash modification factors and benefit/cost ratios for these highway safety improvements. These measures of effectiveness will provide practitioners with information upon which to make decisions regarding their installation.

Advance safety data and evaluation as a means of supporting Transportation Performance Management: Through training and technical assistance, States and local agencies will improve their roadway inventory and traffic volume data and its integration with crash data and other safety data system components. Assisting our partners in improving their safety data collection, analysis, and management, will improve their ability to make better informed investment and policy decisions. Collection of the MIRE FDE will increase their abilities to locate safety problem areas and apply appropriate countermeasures. Advancing local agency capabilities with collecting and transferring safety data on non-federal roads will improve data sharing and completeness.

Improve data collection: The data systems developed by States to collect, store and manage their roadway data are unique to each State. Creating standardized data collection and reporting procedures will assist FHWA in creating a single nationwide geospatial dataset. Standardized safety data collection and reporting procedures will help to improve the use and analysis of data used for problem identification and program evaluation. Data governance best practices will focus on shared business rules and standards that support the principle of "measure once, use many times," with the goal of a single roadway dataset that meets the needs of multiple groups. Creating national data uniformity in structure and content will assist both FHWA and the States in data collection and reporting.

Collaboration Partners:

The Safety Data and Analysis program relies on its established network of internal and external partners in other public agencies and in academia. The FHWA staff engaged in this program are active participants in national and international committees such as the World Road Association, the Transportation Research Board, the Institute of Transportation Engineers, and the American Association of State Highway and Transportation Officials. We track the input from partners through regular reporting on program status at the meeting (DOT-TRCC; TRB) and other venues.

The Safety Data and Analysis program frequently interacts with the following internal Department partners:

- **DOT Traffic Records Coordinating Committee (DOT|TRCC), Federal Motor Carrier Safety Administration, National Highway Traffic Safety Administration, Office of The Secretary** - This multi-modal group works to improve the collection, management, and analysis of traffic safety data at the State and Federal level.

- **USDOT Safety Data Initiative** - This multimodal initiative, led by OST-P is leapfrogging the department into the next generation of data and tools to inform and improve safety decisions.

The Safety Data and Analysis program collaborates with Planning, Environment, and Realty and the Office of Innovative Program Delivery in matters relevant to MPO/Planning organizations and local agencies. This collaboration has been instrumental in supporting the Performance-Based Practical Design effort led by the Office of Infrastructure. Safety Data and Analysis program activities rely on strong collaborations with the Office of Highway Policy Information staff members who manage the Highway Performance Monitoring System (HPMS) and the All Road Network of Linear Referenced Data (ARNOLD) requirements and strategic initiative. The Safety Data and Analysis program's cross-cutting SHRP2 Safety Data pooled fund program includes the Offices of Operations and Planning support. Also, the program coordinates with the FHWA Office of Operations on a safety analysis needs assessment for Transportation Systems Management and Operations and safety analysis of freeway lane narrowing and shoulder use.

The Safety Data and Analysis program is represented on the FHWA Data Governance and Data Business Planning Committees. At the USDOT level, the Safety Data and Analysis program participates in the USDOT Traffic Records Coordinating Committee and contributes to NHTSA's Minimum Model Uniform Crash Criteria (MMUCC) activities and crash data improvement efforts.

Additionally, the Safety Data and Analysis Program coordinates frequently, but not limited to, the following external agencies:

- **American Association of State Highway and Transportation Officials (AASHTO) –** Collaborates on research problem statements.

- **Transportation Research Board** – Coordinates on research problem statements. Safety program staff participates on various safety-related research projects and committees.

- **National Association of County Engineers** – Collaborates on projects to address safety on local and rural roads.

- **Institute of Transportation Engineers** – Collaborates on an annual Excellence in Highway Safety Data Award Paper Competition to encourage data-driven safety countermeasure development.

Benefits of Partnership and Partner Contributions to FHWA Safety Data and Analysis Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard / Goal Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding	Stakeholder Advice	Education and Awareness
American Association of State Highway and Transportation Officials	X		X		X	X	X			X	X
Transportation Research Board	X		X			X	X			X	X
National Association of County Engineers	X		X		X					X	X
Institute of Transportation Engineers	X		X		X	X				X	X
Federal, state, regional, and local transportation agencies, academic institutions, foundations, or private firms	X		X		X	X	X			X	X

These internal and external partnerships provide many benefits. Collaboration within the USDOT assures the Federal safety programs related to data provide coordinated and clear information to our partners. Because each mode is at a different level of expertise and sophistication regarding data and analysis, working together allows all to benefit from the expertise of the modes with more advanced knowledge. Collaboration with our external partners improves our outreach and technology transfer, encouraging road owners and operations to move toward a science-based approach for making critical safety decisions.

Human Factors Analytics
$1,395,730

Program Description:
The purpose of the Human Factors Analytics program is to better understand human behavior and the relationship between roadway users, infrastructure, and vehicles. This program is responsive to the DOT Research, Development, and Technology deployment strategies for safety. Specifically, this program supports accelerating technology integration by studying the safe integration of people with emerging automated driving systems technology. This program also develops strategies for influencing driving behavior by studying driver interpretations of roadways.

Human Factor Analytics encompasses human factors research and related activities. Human factors studies consider how drivers, pedestrians, and special users' needs can be met through improved roadway designs, countermeasures, and technological innovations. HF research looks at how people respond to highly visible, easy to read signs, improved pavement markings, vehicle automation technology, innovative operational changes, and safer streets with improved walkability.

US crash report data identifies human error as a factor in approximately 94% of vehicle crashes (1). Human factors research is a cross-cutting field that routinely conducts both applied and more fundamental investigations for projects in areas such as traffic control device effectiveness, novel intersection designs, and pedestrian & bicyclist safety, to help reduce vehicle crashes resulting from human behavior and error. The Human Factors Analytics program includes the Highway Driving Simulator (HDS), two Field Research Vehicles, the Highway Sign Design and Research Lab (also known as the Sign Lab), the MiniSim™ driving simulator, and the Virtual Reality Lab, which includes a pedestrian and bike VR simulator.

Some key focus areas for the Human Factors Analytics Program are the following:

- Connected and Automated Vehicles (CAV)
- Traffic Control Devices
- Roadway User Behavior (including traveler information research)
- Roadway Design Evaluation (including alternative intersection and interchange evaluation research)
- Pedestrian, Bike, and Vulnerable Road User Research

Program Objectives:
The Human Factors Analytics program produces valuable research that promotes and improves the safety of our transportation system by gaining a better understanding of road users behavior. The program identifies the following objectives:

- Improve the effectiveness of safety countermeasures as well as tools that promote operational efficiency.
- Understand how connected and automated vehicles can be safety integrated into the Nation's roadway systems by evaluating the human behaviors related to the deployment of cooperative automation.
- Improve roadway designs that meet the needs of drivers, pedestrians and vulnerable users.
- Understand how people respond to the roadway environment, including signs and markings, emerging vehicle and roadway technology, innovative operational changes, safer streets with improved walkability, and other new roadside innovations.
- Identify how human factors for safety may guide safety programs and enable innovative approaches to improving safety.

The Human Factors Analytics program provides a range of research products and guidance that includes guidelines, experimental studies, and visualizations, that result in informed decision-making to help improve roadway design, evaluate safety countermeasures, and provide technology assessments to improve safety. Human Factors staff work regularly with other offices within FHWA, including the Office of Safety, the ITS Joint Program Office, the Office of Operations, and Operations R&D. As part of our research on connected and automated vehicles, we collaborate and receive funding from the ITS JPO to do a variety of human factors research to assess the safety and acceptability of automated vehicles. We collaborate with HRDO, on several truck platooning research efforts, including driving simulator-based and field-based research into the human factors issues related to truck platooning and its potential impacts on other road users. Other activities that we collaborate on include the development of Human Factors training, including a course based on the Human Factors Guidelines for Roadway Systems (NCHRP Report 600), as well as a condensed set of guidelines for rural users. The Human Factors Team also collaborates on a multi-year research effort that will inform the development of a guidelines document for the traffic management centers. The Human Factors Program also coordinates closely with the DOT Human Factors Coordinating Committee, a cross-agency working group, on a systematic view of human factors interactions with vehicle factors and roadway factors to deliver continued improvement to safer roadway design. In addition, the Human Factors staff participates in international coordination efforts on critical human factors vehicle automation issues, including EU Twinning activities, and with the US EU Japan Trilateral Human Factors Working Group.

Anticipated Program Activities:
The Human Factors Program is leading and collaborating a number of activities in the areas of connected and automated vehicles, traffic control device design and evaluation, pedestrian and vulnerable road user safety, and enhancing and upgrading Human Factors Lab capabilities. Many of these activities focus on empirical research using human

participants, that participate in studies in the Highway Driving Simulator, field research vehicles (FRVs), and sign laboratory. These studies provide valuable quantitative and qualitative safety and human performance data, that provide a sound basis for developing guidelines and design recommendations for our different stakeholders. The work will help to promote better and safer TCDs and signing, increase pedestrian and bicyclist safety, and accelerate and facilitate the safe integration of people with emerging automated driving systems technology into our roadway system.

Specific FY21 Human Factors program activities will include:

Improve the effectiveness of safety countermeasures as well as tools that promote operational efficiency: Work with 36 members, including states, related organizations, and FHWA program offices, through the Traffic Control Device Pooled Fund Study and conduct the "Signing for Zipper Merge" project.

Improve roadway designs that meet the needs of drivers, pedestrians and vulnerable road users: Investigate novel TCD applications, by conducting the Evaluation of Aesthetically Treated Crosswalks project; investigate Human Factors issues related to Truck Platooning Operations and their effects on passenger car drivers; and multi-Driver Interaction using Virtual Reality to allow multiple simulators to interact with one another, facilitating multiple participant experimentation.

Understand how people respond to signs and markings, emerging vehicle technology, innovative operational changes, and other new roadside innovations: Study level 1 - 2 Vehicle Automation Applications; integrate human factors considerations into the CARMA Platform℠; conduct research on automated vehicle safety issues related to TSMO (Transportation Systems Management and Operations) and Infrastructure issues; enhance Level 2 Automated Vehicle for field research; upgrade the Highway Driving Simulator capabilities to model Level 2 vehicle automation; and upgrade the Highway Driving Simulator visual presentation to experimental subjects for more realistic testing.

Key FY21 FHWA Human Factors Analytics R&T Program Activities.

Activity	Period of Performance
Improve the effectiveness of safety countermeasures as well as tools that promote operational efficiency	2019-2022
Improve roadway designs that meet the needs of drivers, pedestrians and vulnerable road users	2018-2022
Understand how people respond to signs and markings, emerging vehicle technology, innovative operational changes, and other new roadside innovations	2018-2022

Expected Program Outcomes:
The outcomes from the Human Factors Analytics Program include a better understanding of human behavior and the relationship between roadway users, infrastructure, and

vehicles. This increased understanding will allow us to consider how drivers, pedestrians, and vulnerable users' needs can be met through improved roadway designs, countermeasures, and technological innovations. Our research program will produce data, guidelines, and recommendations that help improve the safety and operational efficiency of our roadway system in a number of areas including TCD and signing research, pedestrian and bicycle safety, and improve automated and vehicle safety and acceptance. In addition, we will also be enhancing our research capabilities to allow us to better meet the needs of our stakeholders, by better supporting our current roadway system, while looking ahead to the more automated roadway and vehicle systems of the future.

Collaboration Partners:
The Human Factors Analytics program collaborates internally and externally to develop research activities and to exchange information among peer organizations. Every year the Human Factors Analytics program is actively engaged in human factors workshops convened through the Transportation Research Board Annual Meeting. The research community, including industry partners, have sustained long-lasting relationships with the program and its activities. The Human Factors Analytics Program most frequently collaborates with internal Department partners indicated below:

- **U.S. Department of Transportation's Human Factors Coordinating Committee** As one of the twelve cross-modal technical research groups tasked with coordinating on high priority research topics and reducing duplication of effort, this committee is comprised of representatives from various modal agencies of DOT. The committee meets every month to coordinate activities and provide updates on human factors projects.
- **Office of the Secretary ITS Joint Program Office** – FHWA Safety R&D staff serve as project managers on the validation, testing, and evaluation of vehicle to vehicle safety applications. The FHWA Safety R&D program attends regular ITS Strategic Planning Group meetings that focus on the progress and identification of new research. Human Factors expertise in the FHWA Safety program enables the ITS program to fully consider the adaptability of vehicle operators responding to dynamic features on the roadway, like adaptive signal systems and changeable message signs.
- **Federal Railroad Administration and Federal Motor Carrier Safety Administration** - collaborate on intelligent transportation systems R&D.
- **National Highway Traffic Safety Administration** – Safety R&D program staff evaluate Cooperative Adaptive Cruise Control (CACC) applications. The collaboration with the Human Factors team with NHTSA and the ITS Joint Program Office explores the adaptability of drivers to new vehicle technology, and the human response to varying degrees of automation. This has helped to refine automated vehicle following algorithms that can be tolerated by everyday people.

External partners include but are not limited to:

- **American Association of State Highway and Transportation Officials (AASHTO)** –Collaborates on research problem statements.
- **American Traffic Safety Services Association (ATSSA)** – As a member the TCD PFS, this organization coordinates on selecting important TCD research topics.
- **The National Committee on Uniform Traffic Control Devices (NCUTCD)** – The NCUTCD coordinates with Safety R&D and MUTCD Staff, and recommends proposed revisions and interpretations to the Manual on Uniform Traffic Control Devices (MUTCD). The Human Factors Team also attends their Research Committee meeting at the NCUTCD annual meeting to provide an update of our research activities.
- **Transportation Research Board** – Coordinates on research problem statements. Safety program staff participates on various safety-related research projects and committees.
- **National Association of County Engineers** – Collaborates on projects to address safety on local and rural roads.
- **Trilateral (EU, US, JPN) Human Factors Working Group** - Identifies opportunities for human factors research collaboration, aligns its research, and identifies differences for a broad set of human factors issues, including driver distraction, Human-Machine Interaction (HMI), and human factors issues in automation.
- **European Commission** – Engage in project 'twinning' with similar projects being conducted by European nations. This includes exchange of experimental design, data collection, data management, and exchange of experimental results.
- **Industry** – Engage with a variety of industry partners to advance the human factors safety mission in a variety of areas, including driving simulation, vehicle automation, and testing, and pedestrian and bicycle safety.

Benefits of Partnership and Partner Contributions to FHWA Human Factors Analytics Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard / Goal Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding	Stakeholder Advice	Education and Awareness
American Association of State Highway and Transportation Officials	X		X		X	X	X				X
Transportation Research Board	X		X			X	X				X
National Association of County Engineers	X		X		X						X
Trilateral (EU, US, JPN) Human Factors Working Group	X					X					
European Commission	X		X		X	X	X				X
Federal, state, regional, and local transportation agencies, academic institutions, foundations, or private firms	X		X		X	X	X				X
Human Factors Coordinating Committee	X		X			X	X				X

Operations

Transportation Systems Management and Operations
$5,271,770

Program Description:
The U.S. has invested billions of dollars in building our existing transportation infrastructure. When these facilities are congested, the efficient movement of people and goods is disrupted, causing impacts to the economy and quality of life. Facilities need to be operated well so that we use them efficiently and effectively to maximize the value of these investments. The TSMO R&T Program helps State and local agencies, and other partners, do that. The *Moving Ahead for Progress in the 21st Century Act* (P.L. 112-141), under Section 1103(a)(30)(A) defined Transportation Systems Management and Operations (TSMO) as "an integrated set of strategies to optimize the performance of existing infrastructure through the implementation of multimodal and intermodal, cross-jurisdictional systems, services, and projects designed to preserve capacity and improve security, safety, and reliability of the transportation system."

Because of the need for alternatives to capacity projects -- due to limited resources, growing customer expectations, emergence of real-time decision support systems and on-demand mobility applications, and an emphasis on performance-based programs -- there is an increasing focus on TSMO in U.S. urban and rural areas. The need continues to grow for a transportation system that provides travel options for the effective movement of people and goods that will mitigate as congestion impacts on urban areas and allow for increasing freight transportation, especially with a growing awareness of the needs of underserved communities. As consumer technologies (smart phones, apps, GPS, etc.) progress, the traveling public expects that transportation agencies will find creative ways to apply these advances to improve their travel experience. TSMO provides a range of strategies that can leverage technology, strategically address the unique issues of an area in a cost-effective manner, and optimize the use of existing and future infrastructure. TSMO has the potential to make significant improvements in safety, reduce congestion and fuel consumption, enable better management of the road network, expand mobility services to underserved communities, improve the convenience of travel, and stimulate the economy through improved freight movement.

TSMO can provide solutions using the opportunities created by technology, real-time information, and innovation. TSMO practitioners are using technology and data to monitor travel conditions, enhance real-time traveler information with public data, coordinate incident and emergency response, manage travel demand, operate managed lanes, minimize impacts of work zones and weather, improve traffic signal operation, and manage agency resources with decision-support capabilities. Research indicates that today most State and local transportation agencies are only starting to apply these strategies in an integrated and systematic manner, and opportunities abound to continue to make U.S.

transportation systems more efficient, safe, and responsive through TSMO. These agencies are also beginning to focus on both long-term and catastrophic impacts to ensure the system is resilient to impacts such as the increasingly common extreme weather events, cybersecurity threats, and natural disasters.

The activities proposed in this TSMO R&T Program continue critical research and deployment support to help State and local agency partners realize the true potential of TSMO. The TSMO Program has three primary elements:

- Foundation for Successful Operations
- Data-Driven Operations Decision-Making
- Implementing Operations Strategies

Foundation for Successful Operations

The Foundation for Successful Operations program element advances state-of-the-art institutional structures and capabilities to ensure that advanced and emerging innovative operational strategies and technologies are successfully delivered and sustained for the public and private sectors. This element of the program will provide the tools and organizational support to enable agencies to evaluate, plan, fund, design, and quickly capitalize on emerging cost-effective transportation technologies and operational strategies to improve reliability, mobility, safety, and economic competitiveness, and support the professional capacity building of agencies and the TSMO workforce to meet the transportation needs of today and tomorrow. This element of the program will also provide the foundation to enable the successful implementation of other Operations Programs Areas (Managing Disruptions to Operations and Connected and Automated Vehicles) and the other elements within this Program (Data-Driven Operations Decision-Making and Implementing Operations Strategies).

Data-Driven Operations Decision-Making

This element of the program estimates and evaluates the transportation impacts of operations strategies using data management and analytics; analysis modeling and simulation (AMS) tools; and transportation performance management techniques. The research, development, and deployment efforts will help make more effective use of scarce transportation resources by helping agencies determine:

- More effective and suitable strategies for efficient operations of our existing facilities, and
- Where and how to make future transportation, investments based on a better understanding of the causes of mobility and safety issues and what solutions will be efficient and effective.

This program element will also support the storage and documentation of data acquired from operations projects, improving consistency and making them accessible to the public.

Implementing Operations Strategies

This element of the program supports the use and deployment of operational strategies and practices to improve the performance of existing transportation infrastructure. It targets a range of traffic, demand, and parking management tools and strategies that agencies can employ (largely with existing resources) to reduce congestion, improve safety, and improve travel time reliability. Its core mission is to more effectively apply and integrate readily available (but perhaps underutilized) and innovative operational strategies, practices, and technologies for more efficient day-to-day management of the surface transportation system. This element of the TSMO Program will enable agencies to advance their current state of operations to a more proactive, integrated, performance-driven, and holistic approach.

Road User Charge

The TSMO Program also provides administration, evaluation, outreach, and results dissemination for the STSFA Program, required under Section 6020 of the Fixing America's Surface Transportation (FAST) Act. No administrative funds were provided under the STSFA legislative language, requiring the use of alternative research and deployment funds to support the program. The STSFA Program supports States in advancing STSFA strategies designed to provide alternate funding mechanisms to the gas tax for financing transportation infrastructure improvements.

Manual on Uniform Traffic Control Devices (MUTCD) Program

The *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD) is the national standard for traffic control devices on any street, highway, bikeway, or private road open to public travel, in accordance with 23 U.S.C. §§ 109(d) and 402(a). It is incorporated by reference in 23 CFR Part 655, Subpart F. The MUTCD is administered by FHWA, which issues revisions and updated editions through the Federal rulemaking process. The last edition was published in 2009, with two revisions in 2012.

The TSMO Program is synergistic with other proposed Operations-related research programs areas, including Managing Disruptions to Operations, Connected and Automated Vehicles, and Freight Management and Operations.

Program Objectives:

The TSMO R&T Program primarily supports the USDOT RD&T Strategic Goals of Infrastructure and Innovation by enabling efficient movement of people and goods across the transportation system using operational strategies and technologies. Many of these strategies and technologies are innovative and leverage emerging technologies, data sources, and public and private services. These efforts also support safety by smoothing traffic flow, mitigating disruptions, consistent motorist guidance and information about current conditions. This program also supports the innovation goal by exploring alternate funding mechanisms for transportation.

The objectives of the TSMO R&T Program are to:

- Equip State and Local transportation agencies to effectively manage and operate the transportation system to gain the most from their existing infrastructure and technology investments and enhance safety and mobility.
- Increase understanding of current system performance and the strategies that are available to address performance issues.
- Support agencies in their use of performance-based planning and programming, and analysis, modeling, and simulation tools, to use data-driven decision-making find the best solutions for their unique transportation problems.
- Support the development of strong agency organizational and workforce capabilities to plan for, deploy, and manage TSMO technologies and operational strategies and strengthen the key institutional underpinnings and linkages that are needed for effective TSMO.
- Provide mechanisms to assess and programmatically address emerging trends including multi-modal, mobility on demand, mobility as a service, and shared use mobility services and leverage emerging technologies and data.
- Ensure that the MUTCD is maintained and is updated in a timely manner to reflect current and forthcoming needs of practitioners and road users, and that it accommodates automated driving systems.
- The Road User Charge effort to develop and pilot test alternate funding mechanisms to the gas tax for financing transportation infrastructure improvements.

Key FY21 FHWA TSMO R&T Program Activities.

Activity	Period of Performance
Develop outreach and training materials and conduct targeted outreach and technology transfer to advance the state-of-the-practice and improve the capabilities of agencies for developing and delivering TSMO programs.	2018-2023
Provide assistance, support and communications between the USDOT Mobility Data Business Plan and the FHWA Governance Group and facilitate the development of regional mobility data business plans for states and local jurisdictions	2021-2022
Research and develop policy options that support mainstreaming TSMO. Conduct strategic planning.	2019-2022
Develop research, publication updates, desk references, and outreach linking TSMO with emerging issues.	2018-2022
Research the nexus between TSMO and safety strategies and their benefits. Assess research done to date and existing tools for analyzing this nexus, and define gaps for future research and development.	2020-2023
Integrate risk management into TSMO	2021-2022
Convert workshops with stable content in mature TSMO program areas to long-term, self-sustaining training courses.	2020-2025
Support the advancement of TSMO through initiatives with the NOCoE and AASHTO on TSMO workforce development, strategy deployment, and preparing for emerging trends and technologies.	2019-2024
Planning and organizing for effective regional and corridor management.	2021-2023
Support, topical learning and development, technology transfer and sharing of operations best practices across all FHWA units (Headquarters and Field) through the Operations Discipline	2021-2025
Administer and support the delivery of the Surface Transportation System Funding Alternatives (STSFA) grant program, evaluate program outcomes, and conduct outreach and technology transfer.	2018-2023
Conduct outreach to educate and inform State legislators about tools available to States interested in advancing STSFA strategies designed to provide alternate funding mechanisms to the gas tax for financing transportation infrastructure improvements.	2019-2022
Develop tools and resources to monitor national transportation system performance and conduct outreach and technology transfer to advance state and local agency performance management capabilities.	2018-2022
Based on experiences from implementation of the congestion and reliability performance measurement rule (PM3), develop resources to support travel time measure/target setting. Conduct follow-up	2020-2022

Activity	Period of Performance
research on multimodal system performance measures and complete trip data.	
Develop and disseminate resources to enable holistic analyses of operational improvement benefits at system, network, and facility levels.	2018-2022
Enhance tools and decision support systems for operational/tactical and executive/organizational TSMO decisions by adding functionality for emerging technologies.	2019-2022
Provide technical assistance to advance the practice on data analytics/business intelligence, operational project evaluation using empirical data, and multi-objective tradeoff analysis.	2018-2022
Develop case studies and videos to share results of reliability data and analysis tool deployment projects, increase agency capabilities for reliability analysis, and grow use of reliability evaluations in systems planning and operational activities.	2018-2022
Collect and use trajectory-level driving data characterizing the vehicle's behavior and the behavior of the surrounding vehicles to calibrate existing behavior models and generate new models that can be used in microsimulation. This will introduce avenues to analyze the behavior of a diverse group of drivers in a broad range of operational conditions on numerous roadway types.	2020-2022
Develop methods for fusing and assessing various data sources, including but not limited to crowd sourced data, private data sources, public data sources, data management and TMC outlets, and demonstrating how integrated data from multiple sources and the analysis of that data can influence decisions.	2019-2022
Develop the capabilities, tools, and guidance to enable more proactive, dynamic, integrated and performance-driven management and operations.	2017-2022
Research and document best practices and conduct targeted outreach and technology transfer to share early deployment lessons learned and to proactively advance the adoption of ATDM and ICM solutions and strategies.	2018-2023
Develop and support ATDM continuous implementers through a cohort/shadow deployers model.	2020-2022
Research and document best practices and develop new tools and methodologies for linking active parking management strategies and active demand management.	2021-2022
Research and develop a broader understanding of ATDM impacts on traveler behavior and network performance.	2020-2023
Provide technical support to transportation agencies interested in implementing congestion pricing under one of the four tolling programs.	2021-2022

Activity	Period of Performance
Support and manage the High Occupancy Vehicle (HOV)/Managed Lane and TMC Pooled Fund Studies to advance the state-of-the-practice.	2018-2023
Conduct targeted outreach and technology transfer on best practices and lessons learned to promote and advance the use of automated traffic signal performance measures and signal phasing and timing applications.	2018-2023
Provide support and technical assistance on change of clearance interval to address safety and operational performance of signalized intersections.	2020-2022
Develop a coordinated collaboration plan and provide knowledge and technology transfer, consistent messaging, team playbook, briefing decks and conduct customer base assessment for the Innovative Operations Strategies Team.	2019-2024
Develop and issue Notice of Proposed Amendments (NPA) for a new edition of the MUTCD and manage rulemaking process.	2019-2020
Distill public docket comments and develop new edition of the MUTCD.	2020-2021
Manage technical corrections, support the administration of MUTCD statutory requirements, and conduct outreach and implementation support activities.	2018-2023
Support pooled fund studies that contribute to the MUTCD's development/update.	2018-2023
Evaluation of Aesthetically Treated Crosswalks	2020-2021

Expected Program Outcomes:

Foundation for Successful Operations

This element of the program will provide the tools and organizational support to enable agencies to evaluate, plan, fund, design, and quickly capitalize on emerging cost-effective transportation technologies and operational strategies to improve reliability, mobility, safety, and economic competitiveness. It will support efforts to mainstream TSMO in agencies nationwide and the professional capacity building of agencies and the TSMO workforce to meet the transportation needs of today and tomorrow. It will help agencies capitalize on efforts for performance management, including through better understanding of the causes of congestion and other operational issues, benefit-cost analysis of potential investments in transportation system improvements, and planning and design that includes consideration of TSMO strategies and use of emerging technologies and approaches. It will facilitate cross-organizational collaboration, data sharing, and integration of roadway travel mobility data within U.S. DOT to address data gaps resulting from inconsistencies in the definition of performance measures, default values for data elements, redundancies and duplicative efforts due to lack of coordination in the collections efforts that has resulted in wasted resources, varying standards and lack of minimum data quality standards for data collection and processing. It will also provide

federal leadership by assisting State DOT and local partners with the development of their regional Mobility Data Business Plans to address the above data gaps, as we move into the Connected Vehicle Era for which data management and integration is essential.

Through online training this element will provide state and local partners with easy access to TSMO-related training that they can use to integrate into their standard practices. In addition, with emerging issues, such as MOD/MaaS and System Resiliency, these efforts will identify how this impacts an agency's TSMO efforts. Operations Discipline support will lead to a more informed and coordinated FHWA workforce, which is more capable of providing helpful and nationally consistent support and stewardship and oversight to our partners.

Road User Charge

Support for the STSFA grant program enables administration of the program, independent evaluation, and dissemination of research results.

Data-Driven Operations Decision-Making

This element of the program will support the storage and documentation of data acquired from operations projects, improving consistency and making them accessible to the public. It includes developing and supporting advanced data storage, management, and analytics practices. It will help make more effective use of scarce transportation resources by helping agencies determine more effective and suitable strategies for efficient operations of our existing facilities, and where and how to make future transportation investments based on a better understanding of the causes of mobility and safety issues and what solutions will be efficient and effective. It will improve the use of Transportation Performance Management for investment decision making by State DOTs and MPOs by providing the necessary information and communication tools, analyses and analysis tools and primers necessary to fully implement the PM3 measures.

Implementing Operations Strategies

This element of the program provides practitioners with tools and techniques for traffic management at various levels and an understanding of how and when to apply different tools. Current research will illuminate the impact of various traffic management approaches on travel choices and resulting network performance, and will identify barriers to adoption of effective techniques. Funds also support technology transfer of research results and resources to help practitioners implement traffic management strategies. Ultimately activities in this area help agencies proactively and dynamically manage their transportation system to achieve established performance objectives in trip reliability, mobility, and safety.

Manual on Uniform Traffic Control Devices (MUTCD)

Research activities in this area ensure that the MUTCD is maintained and updated in a timely manner to reflect current and forthcoming needs of practitioners and road users, and that it accommodates automated driving systems.

Collaboration Partners:
Both internal and external partners play a valuable role in helping to identify research needs and emerging issues, guiding the form and focus of outreach and technical assistance efforts to share the results of research and encourage its implementation, and providing real-world feedback on implementation results. Input is gained from external partners through conference sessions and discussions (e.g., TRB, ITE, AASHTO annual conferences), technical committees and working groups (e.g., TRB committees, AASHTO subcommittees), technical project panels, review of partner research reports and plans, workshops and technical assistance to States, MPOs, and regional agencies, and through FHWA Division Office interactions with their State counterparts. Internally collaboration occurs on key topics of mutual interest through joint review of research products and research ideas, participation in project panels, and periodic coordination meetings.

The input obtained through interactions with partners is considered by program staff as they identify and formulate a program of research and technology initiatives that, in accordance with 23 USC 502(a)(3),:

- Is of national significance;
- Delivers a clear public benefit and occurs where private sector investment is less than optimal;
- Supports a Federal stewardship role in assuring that State and local governments use national resources efficiently;
- Meets and addresses current or emerging needs;
- Addresses current gaps in research;
- Presents the best means to align resources with multiyear plans and priorities; or
- Presents the best means to support Federal policy goals compared to other policy alternatives.

Program partners (both government and non-government), benefits derived from partnerships, and partner contributions are summarized below.

Benefits of Partnership and Partner Contributions to FHWA TSMO Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard / Goal Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding	Stakeholder Advice	Education and Awareness
State DOTs	X			X	X	X			X		
Metropolitan Planning Organizations	X			X	X	X			X		
Local Agencies	X			X	X						
Universities and other Research Organizations				X		X	X		X		
Engineering Associations		X	X				X				
Roadway Technology Developers		X	X	X	X	X	X				
AMS Developers		X	X		X	X	X				
Information and Data Developers		X	X	X	X	X	X				
AASHTO	X	X	X	X	X	X			X		
TRB	X	X				X	X				
Other national associations/ organizations representing State and local governments and transportation professionals	X	X					X				

Automation and Connectivity
$5,156,200

Program Description:
The FHWA, in collaboration with the ITS Joint Program Office, other USDOT modes, State and local public agencies, Academia, industry, and other surface transportation stakeholders, will conduct an Automation and Connectivity research program to address the challenges of integrating vehicles with Automated Driving Systems (ADS) with the road infrastructure system, and to take advantage of connectivity to improve the safety, efficiency, and equity of the highway transportation system. Many of the activities in this program are jointly funded by, and closely coordinated between, the FHWA and the ITS Joint Program Office.

Program Objectives:
Research in FY 2021 will: develop capabilities and practices that support stakeholders move toward safe and effective operational readiness for ADS-Roadway integration; advance Analysis, Modeling, and Simulation (AMS) tools that are applicable to the operations of ADS-equipped vehicles in traffic; develop and test Cooperative Driving Automation (CDA) functions that support shared maneuvers by AVs in response to Transportation Systems Management and Operations (TSMO) use cases; and assess opportunities to revolutionize Traffic Management Systems (TMSs) through advances in computing (including but not limited to Artificial Intelligence (AI) and Machine Learning (ML)), communications, and automation. These efforts support USDOT RD&T Strategic Goals for Safety and Innovation through collaborative public/private efforts to stimulate and rapidly deploy innovation while ensuring that automation brings significant safety benefits.

Anticipated Program Activities:
ADS-Roadway Integration will be advanced through the development of new strategies and capabilities that can be applied by stakeholders to enable a collective understanding on how to jointly move forward to address challenges to safe and efficient integration, especially during a period of mixed human-driven and ADS vehicle operations. Activities include work to expand stakeholder collaboration, to develop testing and evaluation capabilities to assess infrastructure readiness for ADS vehicles, and to establish roadway environment management capabilities focused on ADS-roadway integration, such as access and exchange of data between ADS vehicles, road infrastructure, and traffic management systems. FHWA will also launch an investigation on how MUTCD and traffic control device (TCD) maintenance practices might be adapted to accommodate ADS and how ADS can use redundant systems to account for when a TCD is missing or not detected/recognized.
Building on prior development of an AMS framework and initial model improvements, AMS tools will be advanced through the collection and dissemination of new and existing datasets of on-road observations of and experimental data on the behavior of AVs in traffic for future integration into microsimulation programs and analytical processes. Collected datasets will be documented and made available. Based on and initial concept study of hardware-in-the-loop (HIL) simulation, FHWA will develop and test initial HIL capability for CARMA3.

FHWA will use agile software development to integrate and coordinate CARMA efforts; support stakeholder adoption of CARMA open source technology through technical assistance and access to engineering support to accelerate partner engagement; conduct closed-course and open road testing, validation, and evaluation of CDA features; engage stakeholders in development of new TSMO use cases; and support a community of users to advance understanding and collaborative development of CDA to accelerate market readiness. Specific efforts include testing and evaluation of an initial set of shared maneuver functions for CDA developed in FY20. These tests will be conducted on closed-course facilities. An independent evaluation of benefits will also be conducted. Shared maneuver functions for an additional set of priority TSMO use cases will be developed and undergo initial testing. A new activity will be launched to engage high schools, technical schools, and universities with educational and research resources on CDA through a scaled down version of the CARMA research vehicles, known as CARMA 1tenth. Partnering with the F1 Tenth community, FHWA will provide tools to support hands on learning for students, and may develop a national challenge focused on benefits of CDA, to include the role of infrastructure in improving the safety and efficiency of surface transportation.

Development of a "toolbox" of materials for use by Infrastructure Owners and Operators (IOOs) to plan for the modernization of their TMS, including insights into decision support subsystems, developing concepts of operation, and preparing for transitions from legacy systems will be continued from FY2020. Additionally, development of a process that State and local agencies can use to support assessment of current capabilities of their TMSs will be initiated.

Key FY21 FHWA Automation and Connectivity R&T Program Activities.

Activity	Period of Performance
ADS-Roadway Integration: Strategies, Testing, Data, and Collaboration.	2019-2024
ADS-Roadway Integration: Transfiguration of the *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD) for Connected and Automated Vehicles.	2021-2022
Analysis, Modeling, and Simulation (AMS): Data Collection and Model Development	2019-2023
Analysis, Modeling, and Simulation (AMS): Hardware-in-the-Loop (HIL) capability development	2019-2023
Cooperative Driving Automation (CDA): Development, Technical Support, Testing, and Collaboration.	2019-2023
Cooperative Driving Automation (CDA): Professional and Capacity Building	2021-2023
Next Generation TMS: Assessing current capabilities	2019-2022

Expected Program Outcomes:
Foster the coordination and collaboration necessary to move toward implementing roadway investments that support ADS-Roadway integration. Stakeholders will collectively identify and coordinate implementation strategies that support and take

advantage of advances in ADS technologies to improve roadway safety, efficiency, and equity.

Collect the necessary data to support development of modeling capabilities that will enable AMS tools to assess the changes in traffic that will occur as AVs and CDA-capable vehicles enter the fleet. This will provide IOOs with actionable information on which to base infrastructure investment and traffic management decisions to improve roadway safety and efficiency.

Introduce and demonstrate the benefits of automate driving technology combined with connectivity to enable Cooperative Driving Automation (CDA). CDA enables the machine-to-machine sharing of information that will enable roadways users (e.g. vehicles, traffic signals, mobile devices, etc.) to operate more efficiently and improve safety with a goal of improving transportation system performance and potentially reduce cost of new construction by maximizing current infrastructure capacity limited today by human drivers.

Develop a Next Generation TMS "toolbox" that provides IOOs with well documented processes and approaches to successfully modernize their TMSs considering advances in technology, including data, processing, AI, connectivity, and CDS. These processes and approaches are based on sound systems engineering practices and informed by stakeholders so that they are directly relevant and target specific needs of TMS operators and IOOs. IOOs will use the "toolbox" to begin designing and developing their next generation TMSs.

Collaboration Partners:
The Automation and Connectivity research program collaborates internally and externally to develop and conduct research activities. The input obtained through these interactions is considered by program staff as they identify and formulate a program of research and technology initiatives that, in accordance with 23 USC 502(a)(3),

- Is of national significance
- Delivers a clear public benefit and occurs where private sector investment is less than optimal
- Supports a Federal stewardship role in assuring that State and local governments use national resources efficiently
- Meets and addresses current or emerging needs
- Addresses current gaps in research
- Presents the best means to align resources with multiyear plans and priorities; or
- Presents the best means to support Federal policy goals compared to other policy alternatives.

Benefits of Partnership and Partner Contributions to FHWA Automation and Connectivity Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard / Goal Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding	Stakeholder Advice	Education and Awareness
State Departments of Transportation (DOTs)	X		X	X	X	X	X				
AASHTO	X	X		X	X	X	X		X		
Transportation Pooled Fund Studies	X				X				X		
Transportation Research Board (TRB)	X						X		X		
ITS America	X	X									
Institute of Transportation Engineers (ITE)	X			X	X	X			X		
Society of Automotive Engineers (SAE)		X	X			X	X		X		
Academia						X	X				
Automotive OEMs	X	X	X	X	X	X	X		X		
ADS Developers	X	X	X	X	X	X	X		X		
Test Facilities				X		X	X		X		

Managing Disruptions to Operations

$2,489,200

Program Description:
Management of disruptions associated with non-recurring events is a significant and specialized aspect of transportation management. Disruptions to transportation system operations are associated with impacts on safety and mobility and pose management challenges not present in "stable state" systems where congestion is predictable and reflects recurring demand patterns that can be easily understood. The disruptive nature of non-recurring events presents specific, significant risks in terms of personal and economic consequences, and present huge demands on system owners and operators. Non-recurring events account for about half of all the delays, create conditions that are associated with a higher risk of dangerous crashes, and contribute to unfavorable public perception regarding the capability of Infrastructure Owner/Operators (IOOs) to manage public investment in infrastructure.

In support of the USDOT Infrastructure Strategic Goal, the Managing Disruptions to Operations RD&T program ensures organizational preparedness to deal with non-recurring events – and associated disruptions to transportation operations – with specialized attention to the following:

- Understanding disruptive events in the context of their impact on overall transportation operations,
- Strategies to better understand or predict where and when these events are occurring,
- Effective countermeasures to mitigate disruptions as they occur, and
- Processes to assess the effectiveness of strategies for consideration in future improvements.

Non-recurring events (e.g., work zones, traffic incidents, planned special events, or adverse weather) can introduce significant variability in operations through a combination of surge demand, capacity reduction, or increased navigational difficulty. Unplanned nonrecurring events such as incidents or weather occur suddenly and demand a rapid change in driver behavior with little advance notification. Even events such as work zones or special events can impart uncertainty into transportation system management, with variations in event start time, duration, and level of impact not always being precisely understood or conveyed among various stakeholders. The effects of these events can certainly appear chaotic from the perspective of the individual driver; introducing unexpected congestion and poor communication regarding what the impact on an individual driver will be.

Response strategies for disruptive events involve a broad range of stakeholders and touch an equally broad range of applications within the transportation management workflow, some of which are highlighted as follows:

- IOOs who own and manage transportation systems are expected to manage disruptions on their facilities to minimize the impact to the traveling public. Accordingly, allocating of resources to manage disruptions from non-recurring events is an important internal function within transportation agencies. Sometimes this can be accomplished with proactive planning but sometimes it is a matter of being prepared for the unexpected. The need for active management of disruptions in real time is further amplified by the anticipated deployment of connected and automated vehicles in the traffic fleet where any disruption of expected operating conditions poses significant operational challenges.
- Research institutions and similar organizations play a significant role in quantifying the influence of non-recurring events and working in partnership with IOO-led coalitions to advance countermeasures. The Managing Disruptions for Operations program seeks improved processes for collection of real-time or historical information on non-recurring events to conduct studies or assist IOOs in development of countermeasures and in performance management activities.
- Industry, such as automobile Original Equipment Manufacturers (OEMs) and traffic control device manufacturers, are cooperative participants with IOOs in developing products that facilitate transportation management functions. Industry participants such as ATSSA have advocated for a federal role in guiding the development of improved technology to encourage a competitive market environment for developing products that meet core national requirements.
- Other private sector entities, such as data aggregators or digital map providers, serve as a bridge to enhance public accessibility of information used by Traffic Management Centers. This model can be extended to improve traveler information functions.

Despite all the challenges that this dynamic environment creates, public agencies continue to make great advancements to minimize these impacts, especially in the form of proactive management strategies (e.g., decision support systems) and enhanced institutional capabilities. FHWA and its partners are uniquely positioned and play a pivotal role in the development, test, and evaluation of these systems and strategies, as well as through tireless knowledge and technology transfer efforts that enable these operating agencies to improve both their performance and the performance of the transportation system as a whole (i.e., in coordination with the private sector). While some of these products are mature, and require only minimal resources to maintain currency, others are still amid development and require significant levels of funding (e.g., the Integrated Model for Road Condition Prediction that integrates weather, work zone, traffic and incident models to predict road conditions hours into the future). New research and development needs will emerge as the vehicle fleet changes. And the need for extensive coordination across external partners (e.g., the various incident management disciplines), as well as the need for the aforementioned knowledge and technology transfer materials, are expected to

continue for the foreseeable future in order to maintain current or improved level of system efficiency. Work is also needed to account for both long-term and catastrophic impacts, ensuring the system is resilient to impacts such as the increasingly common extreme weather events, cybersecurity threats, and natural disasters.

The scope of the program is broad, starting with applied research (from concept development to field testing and evaluation) and continuing through all the training, outreach and coordination necessary to ensure successful implementation by the operating agencies. The work is done through extensive coordination between the Office of Operations, the ITS Joint Program Office, the Office of Operations R&D, as well as with the Office of Safety, the Office of Infrastructure, and the Office of Safety R&D. Work on climate resilience is done in close coordination with the Office of Environment, Planning and Realty, and the Office of Policy.

Managing Disruptions to Operations Program focuses on those operating conditions that present distinct challenges to our public-sector partners (especially State DOTs). This work is closely coordinated with other research and technology priorities. Continuous and extensive collaboration across offices ensures that the efforts complement each other and there is no duplication. In particular, this work ties to the following cross-cutting priorities:

- Non-recurring events present the most challenging environments under which automated vehicles travel. Work under this program will both inform and learn from the research conducted in this cross-cutting area. In addition, this work will help to better understand any new requirements that automated vehicles may put upon the system and the system owners (e.g., special pavement markings through work zones). The challenges and opportunities for the incident responder community is unknown at this point but warrants responder-focused research.
- The data needs surrounding these non-recurring events go above and beyond the standard elements, and consequently require targeted resources to identify these unique data types, determine how to collect and process the data to make it useful, and how to use the data to better predict how these disruptions will affect highway operations (and, by extension, how transportation system operators can use them to better manage the system.) Data collection, crowd sourcing, and big data work already underway reflect the potential for significant opportunities for more efficient incident mitigation, weather events, and work zones through real time and predictive decision-making. There is also strong potential in using data to interact with vehicles during disruptions.
- The efforts to be conducted under this program area will achieve both safety and efficiency goals as the two are inextricably linked. In addition, the program will address longer-range resiliency issues as they pertain to operations and maintenance. To date, resource materials have been developed to introduce operating agencies to the concepts of climate resilience, and work will continue to

inform them on actions they can take to better prepare for these types of disruptions.

Safety, Durability and Resiliency of Transportation Systems

There are some program dependencies and ongoing research:

- The amount of funding available from other programs (e.g., ITS, Every Day Counts, etc.) will significantly affect the request for Highway Research and Development funds.
- The extent to which connected and automated vehicles put new demands on the operating and responder agencies, particularly under disruptive conditions (i.e., through work zones, during incidents, under adverse weather) will drive the need for new approaches to effective management of non-recurring events.
- The availability of open data – and the willingness and ability of public agencies to share that data – will significantly affect the development and success of advanced management tools. The term "data" in this context applies to diverse range of data types, each with its own unique challenges to implementation and associated benefits from utilization, that are collectively supported by activities within this program. Related focus areas include:
    - Information on planned, real-time or historical non-recurring events and the effect of those events on operations;
    - Output performance measures such as delays, average speeds, or crashes;
    - Specific data sourcing and/or utilization by non-traditional means including connected hardware, crowdsourcing, and connected / automated vehicles.

Program Objectives:

- Understanding the operational impacts of these disruptions enables the development of predictive and real-time decision support systems that facilitate proactive operations and maintenance.
- Comprehending the opportunities that connected and automated vehicles present to better manage disruptive events (e.g., using connected vehicle data to track vehicles through work zones or using automated vehicle data to feed into block-level road weather forecasting), as well as to inform system owners of the actions they need to take to enable these vehicles to navigate through these difficult environments.
- Ensuring coordination across all the agencies that play a part in roadway safety and mobility (DOTs, law enforcement, fire, emergency medical services (EMS), etc.)
- Building the capability and capacity of operating agencies to optimize safety and system performance through the implementation of the capability maturity models for disruptive events.

- Be aware of the most effective messages to disseminate to the traveling public to educate and ultimately change driver behavior under these disruptive events.
- Provide necessary specialized expertise in Work Zone Management, Road Weather Management, Traffic and Incident Event Management to ensure proper integration of non-recurring events in digital infrastructure supporting advanced transportation management functions as well as Connected and Automated Vehicles (Safety/Automation, Innovation/Enabling Technologies, Accountability/Deployment, Accountability/Data)
- In cooperation with IOOs and other national partners, establish consensus for national requirements and framework for Data Supporting Operations for Non-Recurring Events to encourage private sector innovation and development of technology within the scope of that framework (Infrastructure/Economic Competitiveness)

Key FY21 FHWA Managing Disruptions to Operations Program Activities.

Activity	Period of Performance
Develop tools, guidelines and strategies to enable more effective system management under adverse weather, including use of road weather data, standards, and weather-responsive decision support tools that build upon vehicle-based technology advancements and effectively change driver/operator behavior.	2020-2022
Develop and apply performance measures and analysis tools for road weather management and develop strategies that consider resilience and long-term changes in weather trends.	2020-2022
Conduct targeted outreach and T2 of RWM products (i.e., VDT, IMRCP, WDE), reach out to various stakeholders (via Road Weather Management, WRMS, Pathfinder and IMO Stakeholder meetings, regional roundtables, website, webinars), develop/deliver NHI RW courses, and support pooled fund programs and peer exchanges on RWM (Aurora, Clear Roads, TRB, AASHTO)	Ongoing
Capture and use multi-discipline crash and responder fatalities and injury data, and integrate it with emerging technology connected and automated vehicle and other technologies (e.g., integrated Computer Aided Dispatch, Unmanned Aircraft Systems) to meet responders' needs and improve incident response and safety	2019-2022
Promote continued deployment of state and local traffic incident management (TIM) programs including continued capacity building and program maturity through extensive coordination across the TIM community, continued engagement with senior leaders through the executive leadership group.	Ongoing
Advance work zone management by focusing on work zone data collection, developing related analysis tools, and application of performance measures to promote data driven decision-making and consideration of vehicle-based and other technology advancements.	2020-2022
Analyze increase in work zone crashes, fatalities, and injuries, its impact on operations, develop strategic plan and execute it, identify best practices, and conduct WZM research to reduce work zone impacts. Manage work zone grants to ensure products are effective and meet stakeholders' needs.	2020-2022
Advance WZM state-of-the-practice through a range of stakeholder engagement activities that focus on gaps in implementation (e.g., commercial motor vehicle safety in work zones, state-specific Capability Maturity Framework and targeted engagement workshops, process reviews, regional round tables, etc.)	Ongoing
Leverage prior efforts in developing data management platforms for non-recurring events (including the Work Zone Data Initiative & Work Zone Data Exchange, the Road Weather Data Environment, and TIM data strategies information on work zones) to assist development of an operational framework to address management of disruptions from non-recurring events in the context of traditional and emerging transportation management business processes. Technical assistance will be provided to assist IOO-led coalitions in further development and in deploying this framework in stakeholder workflows and integration with enterprise information systems.	2020 - 2022

Expected Program Outcomes:
The Road Weather Management Program will develop tools, guidelines and strategies to enable more effective system management under adverse weather, including use of road weather data, standards, and weather-responsive decision support tools that build upon vehicle-based technology advancements and effectively change driver/operator behavior. The Program will develop and apply performance measures and analysis tools for road weather management and develop strategies that consider resilience and long-term changes in weather trends, as well as conduct targeted outreach and T2 of RWM products (i.e., VDT, IMRCP, WxDE), reach out to various stakeholders (via Road Weather Management, WRMS, Pathfinder and IMO Stakeholder meetings, regional roundtables, website, webinars), develop/deliver NHI RW courses, and support pooled fund programs and peer exchanges on RWM (Aurora, Clear Roads, TRB, AASHTO).

The Work Zone Management Program will advance work zone management by focusing on work zone data collection, developing related analysis tools, and application of performance measures to promote data driven decision-making and consideration of vehicle-based and other technology advancements. The Program will analyze the increase in work zone crashes, fatalities, and injuries, its impact on operations, develop strategic plan and execute it, identify best practices, and conduct WZM research to reduce work zone impacts. Manage work zone grants to ensure products are effective and meet stakeholders' needs, as well as advance WZM state-of-the-practice through a range of stakeholder engagement activities that focus on gaps in implementation (e.g., commercial motor vehicle safety in work zones, state-specific Capability Maturity Framework and targeted engagement workshops, process reviews, regional round tables, etc.).

The Traffic Incident and Events Management Program will capture and use multi-discipline crash and responder fatalities and injury data, and integrate it with emerging technology connected and automated vehicle and other technologies (e.g., integrated Computer Aided Dispatch, Unmanned Aircraft Systems) to meet responders' needs and improve incident response and safety. The Program will also promote continued deployment of state and local traffic incident management (TIM) programs including continued capacity building and program maturity through extensive coordination across the TIM community, continued engagement with senior leaders through the executive leadership group.

Data supporting these programs will also be advanced through the Operational Event Data Framework. This framework will leverage prior efforts in developing data management platforms for non-recurring events (including the Work Zone Data Initiative & Work Zone Data Exchange, the Road Weather Data Environment, and TIM data strategies information on work zones) to assist development of an operational framework to address management of disruptions from non-recurring events in the context of traditional and emerging transportation management business processes. Technical assistance will be provided to assist IOO-led coalitions in further development and in deploying this framework in stakeholder workflows and integration with enterprise information systems.

Benefits of Partnership and Partner Contributions to FHWA Managing Disruptions to Operations Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard / Goal Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding	Stakeholder Advice	Education and Awareness
American Association of State Highway and Transportation Officials (AASHTO)	X		X		X						
American Road and Transportation Builders Association (ARTBA)		X			X						
American Traffic Safety Services Association (ATSSA)		X			X						
State DOTs	X			X	X				X		
International Association of Chiefs of Police (IACP)	X	X		X	X		X				
Towing and Recovery Association of America (TRAA)	X	X			X		X				
National Ocean and Atmospheric Administration (NOAA)					X	X					
National Volunteer Fire Council (NVFC)	X	X			X						
Transportation Research Board (TRB)	X					X					
American Public Works Association (APWA)	X	X		X	X	X	X				
Institute of Transportation Engineers (ITE)	X	X	X		X	X	X				

Partner Organization	User Perspective on Needs	Industry Perspective	Standard / Goal Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding	Stakeholder Advice	Education and Awareness
American Trucking Associations (ATA)	X	X			X	X	X				
Owner Operator Independent Drivers Association (OOIDA)	X	X			X	X	X				
American Meteorological Society (AMS)	X	X					X				
National Weather Association (NWA)	X						X				
National Transportation Safety Board (NTSB)	X						X				
Federal Motor Carrier Safety Administration (FMCSA)	X				X	X	X				
National Highway Traffic Safety Administration (NHTSA)	X						X				
Occupational Safety and Health Administration (OSHA, within Department of Labor)	X						X				
Society of Automotive Engineers (SAE International)	X	X				X	X				
Metropolitan Planning Organizations (MPO)	X				X						

Freight Management and Operations
$3,022,600

Program Description:
Highway mobility and reliability affect our ability to visit family, get to work, deliver products to customers, live our lives, and grow the economy. FHWA's Office of Operations Freight Management and Operations Research, Development and Technology (RD&T) Program is developing innovative technology and processes that lead to system-wide improvements in how FHWA and its State and local partners and other stakeholders manage and increase the reliability of the National Highway System and the movement of people and goods throughout the transportation networks.

These innovations target the daily operations of transportation agencies and other stakeholders, and their planning for operations. Freight Management and Operations RD&T Research areas include performance management, efficient goods movement that enable freight to move where and when it needs to go, active transportation and demand management strategies, resources for transportation management and operations (TSMO) for scheduled or unscheduled events, and improved traffic analysis techniques. Research into new technologies and noteworthy management practices provide State and local agencies and other operations and freight entities with additional tools to implement the institutional changes that will allow them to meet operational challenges.

Program Objectives:
The Freight Management and Operations RD&T Program supports FAST Act NHFP-related goals and requirements and national policy on National Multimodal Freight Network condition, safety, security, efficiency, productivity, resiliency, and reliability. In addition, the Freight Management and Operations RD&T Program supports the following USDOT RD&T Strategic Goals.

Safety: The Freight Management and Operations RD&T Program strives to better understand and improve safe goods movement on the highway system. These activities include:

- Coordinating and investigating truck parking issues.
- Researching freight transportation system resiliency through initiatives such as implementation of the USDOT Emergency Route Working Group recommendations.
- Bringing together FHWA colleagues on safety and resiliency areas impacting freight, including the Office of Transportation Operations Road Weather and Workzone Management and the Traffic Incidents and Event Management Teams, Office of Transportation Management, Office of Infrastructure, Office of Planning, and Office of Safety.

The Freight Management and Operations RD&T Program will also continue to work with other USDOT modal agencies, such as MARAD, FRA, NHTSA, and FMCSA, and other stakeholders, such as the National Coalition on Truck Parking, the Emergency Route Working Group, and Transportation Research Board (TRB) to identify opportunities to investigate freight transportation safety. This program is particularly applicable to rural areas where the freight transportation network is more susceptible to weather or other disruptive events and alternate routes are less available to trucks.

Innovation: The Freight Management and Operations RD&T Program seeks to improve the reliability of travel and freight movement on the Nation's transportation systems by working with State DOTs and other stakeholders to identify data sources and models to assess overall system reliability.

The Freight Management and Operations RD&T Program seeks to improve the ability to measure current and future conditions and operation of the freight transportation network through the incorporation of more accurate, real-time, and localized freight data. These activities include improvements to:

- Data collection methodologies (e.g., data sharing collaboration with industry and dynamic freight data collection and analysis)
- Travel demand models (e.g., incorporating urban and rural freight movements and improvements to the accuracy and scale of the freight flows along the transportation network)
- Strategies to facilitate public-private sector data coordination and sharing (e.g., facilitating peer exchanges and stakeholder outreach)
- Freight-focused performance measures (e.g., incorporating reliability, economic impacts/costs, freight investment analysis, etc.)

The Freight Management and Operations RD&T Program will also enhance freight data resources, such as the Freight Analysis Framework (FAF), which provide national level freight flows and projections critical to understanding the impact of freight movement on the transportation network.

These include initiatives focused on:

- Improving of supply chain information representation into freight planning and modeling, by incorporating, industry dynamics, economic impacts, and commodities moved.
- Enhancing the integration, standards, and consistency among public and private multimodal freight data sources, including accessing more timely data to accurately represent dynamic freight movements on the transportation network.

- Improving the understanding of local, regional, and national freight flows, including enhancements to the Freight Analysis Framework, through a sounder comprehension of freight data limitations and private industry constraints.
- Understanding how freight flows impact the transportation system condition and performance to help support transportation performance management requirements and system planning research.
- Assessing freight infrastructure requirements and demands by analyzing truck parking needs, identifying rural freight transportation issues, and designating critical urban and rural intermodal connectors.
- Developing tools for integrating resiliency considerations into freight transportation planning, asset management, and project development. (Resiliency focuses on freight transportation system ability to move goods in the face of one or more major obstacles, such as extreme weather events, major accidents, and equipment or infrastructure failures.) Initiatives include identification of alternative truck routes and redundant facilities, implementation of USDOT Emergency Route Working Group recommendations, and continued coordination on truck parking issues.

Infrastructure: The Freight Management and Operations RD&T Program seeks to better the highway system physical components - including roads, bridges, pavement, parking facilities, and other elements - that support goods movement. This research area strives to better grasp how freight movement impacts—and is impacted by—this infrastructure. The Freight Management and Operations RD&T Program also seeks to assess the condition and performance of key freight infrastructure, and to provide resources that permits States and other stakeholders to incorporate freight infrastructure improvement projects into transportation program delivery. Objectives include ensuring safe, durable, and high performing infrastructure, as well as identify solutions to mitigate or address the impacts of freight transportation.

Anticipated Program Activities:
Key FY21 FHWA Freight Management and Operations R&T Program Activities include the Freight Data Integration and Visualization, Freight Flow Model Improvements, Freight Infrastructure Needs Identification and Analysis, and Freight Program Delivery and Technology Transfer activities.

The Freight Data Integration and Visualization activity includes improving of supply chain information representation into freight planning and modeling, by incorporating, industry dynamics, economic impacts, and commodities moved. Additionally, it includes enhancing the integration, standards, and consistency among public and private multimodal freight data sources, including accessing more timely data to accurately represent dynamic freight movements on the transportation network.

The Freight Flow Model Improvements activity includes improving the understanding of local, regional, and national freight flows, including enhancements to the Freight Analysis

Framework, through a sounder comprehension of freight data limitations and private industry constraints.

Freight Infrastructure Needs Identification and Analysis activity includes understanding how freight flows impact the transportation system condition and performance to help support transportation performance management requirements and system planning research. In addition, it includes assessing freight infrastructure requirements and demands by analyzing truck parking needs, identifying rural freight transportation issues, and designating critical urban and rural intermodal connectors. Finally, it includes developing tools for integrating resiliency considerations into freight transportation planning, asset management, and project development.

The Freight Program Delivery and Technology Transfer activity includes communication and development of educational and professional development materials/events; noteworthy practices; and tools and technical assistance resources. Peer exchanges can take the format of meetings, roundtables, and workshops that are designed to accomplish a task or effort. This activity facilitates information sharing between public sector freight transportation professionals and provides technical assistance on an as-needed basis. By providing an opportunity for public sector staff and leaders to learn from their peers, the activity identifies and expands state and regional noteworthy practices in the freight transportation field and innovative research, and builds relationships, understanding, and cooperation among key freight stakeholders.

Key FY21 FHWA Freight Management and Operations Program Activities.

Activity	Period of Performance
Freight Data Integration and Visualization	2015-2023
Freight Flow Model Improvements	2015-2023
Freight Infrastructure Needs Identification and Analysis	2016-2023
Freight Program Delivery and Technology Transfer	2015-2023

Expected Program Outcomes:
Moving goods safely and efficiently requires strategically located, adequate, and physically sound infrastructure along with efficient organization capabilities to support them. Within DOT, FHWA is aiming to promote a performance-based approach to transportation project delivery and management. The Freight Management and Operations RD&T Program addresses multiple needs both for DOT and for external stakeholders and leads to enhanced freight data and models that facilitate performance-based, data-driven analysis and decision-making, helping stakeholders more effectively incorporate freight infrastructure considerations into transportation planning and project development. Results from the research activities identified in the Freight Management and Operations RD&T Program will assist in:

- Developing and bettering freight data analytical tools and data collection techniques and standards, and industry data analysis methods

- Assessing the condition and performance of key freight infrastructure.
- Improving the understanding of the impact of freight movement on this infrastructure and vice versa.
- Initiating stakeholder forums and outreach, peer exchanges, pilot implementations, and technology transfer to help ensure safe, durable, and high performing infrastructure.

Collaboration Partners:
Operations and freight programs have developed internal and external stakeholder groups or leveraged stakeholder associations to engage the various transportation and program area communities and modal partners in gathering input through methods such as in-person meetings, peer exchanges, virtual meetings, or web-based events.
Examples of these collaboration initiatives are: DOT policy and ongoing research to help inform the Freight Management and Operations RD&T Program. For example, the draft National Freight Strategic Plan (NFSP) documented the need for improved freight infrastructure to ensure efficient, safe, and reliable goods movement. The NFSP calls for research to review and evaluate the condition of National Highway System (NHS), Outside DOT, related research efforts include National Cooperative Freight/Highway Research Program (NCF/HRP).

- Ongoing USDOT research in this area includes continuation of Exploratory Advanced Research (EAR) Projects, as well as several efforts focused on freight performance measures and innovations in freight data collection, analysis, and dissemination.
- FHWA is also supporting follow-up activities to improve the utility of freight data and behavior-based freight modeling innovations and effective practices as part of the Second Strategic Highway Research Program (SHRP2) C20 suite of products.
- The Freight Operations RD&T Program builds on current and future research to improve the Freight Analysis Framework (FAF) in coordination with US DOT Bureau of Transportation Statistics (BTS). It also incorporates new approaches to economic and supply chain effects as identified from the SHRP2 C20 product and the FHWA Freight Fluidity initiative.
- Other USDOT research includes work to develop new, nationally focused port performance data and metrics as part of the BTS Port Performance Freight Statistics Program (PPFSP). The PPFSP is a FAST Act requirement and involves producing an annual report.
- The Multimodal National Freight and Passenger Analysis and Modeling Program is a joint effort between the FHWA Offices of Operations, Planning, and Policy (HOFM, HEPP, and HPPI). This program has three key components: passenger data, freight data, and network data. The passenger data component is part of the Office of

Policy's overall support data program. Freight data is carried out by the Office of Operations' Freight Management and Operations Office. The multimodal routable network, which enables integrated analysis will be developed by the Office of Planning.

- The Performance Management Data Program (PMDP) is a joint effort with the Office of Infrastructure (HISM). It provides States and MPOs assistance (project planning and performance measurement requirements), completing the analytical elements of the State Freight Plans, and undertaking performance management and system planning. These include the Freight Analysis Framework (FAF), the Fluidity Analysis and Supply Chain and Cost Surveys, and data for Domestic Transport of International Trade.

- FHWA is finalizing research to update a 2015 Jason's Law truck parking survey/analysis to better understand where truck parking shortages exist and tactics to address these shortages. Specifically, Jason's Law requires the US DOT to conduct a survey and comparative assessment in consultation with relevant State motor carrier representatives to 1) evaluate the capability of [each] State to provide adequate parking and rest facilities for commercial motor vehicles engaged in interstate transportation; 2) Assess the volume of commercial motor vehicle traffic in [each] State; and 3) Develop a system of metrics to measure the adequacy of commercial motor vehicle parking facilities in each State. An update of the Jason's Law Survey is expected in 2020.

- The FHWA Office of Transportation Operations Road Weather Management Program seeks to better understand the safety. mobility, and reliability impacts of weather on roadways and promote strategies and tools to mitigate those impacts. Freight and trucking considerations are included in this program.

- The FHWA Office of Transportation Operations Traffic Incident and Events Management Program is a multi-disciplinary process to detect, respond to, and clear traffic incidents so that traffic flow may be restored as safely and quickly as possible. The Traffic Incident Management (TIM) Program of the Federal Highway Administration (FHWA) is part of a larger all-hazards program called Emergency Transportation Operations (ETO). The FHWA ETO team contributes to major program initiatives tied to FHWA and US DOT Strategic Implementation Plans. Major Initiatives related to this include TIM Performance Metrics, basic guidance for State and local TIM programs in promoting safe, quick clearance process and laws, and guidance on developing or improving Service Patrols.

- The U.S. Department of Transportation Organizing and Planning for Operations Program supports the integration of Transportation Systems Management and Operations (TSMO) strategies into the planning process and transportation organizations for the purpose of improving transportation system efficiency,

reliability, and options. This program is led by the FHWA Office of Operations and Office of Planning, Environment, & Realty of the Federal Highway Administration (FHWA) in coordination with the Federal Transit Administration (FTA), which work with metropolitan planning organizations, State and local departments of transportation, transit agencies, and other organizations to maximize the performance of existing infrastructure through multimodal and multi-agency programs and projects. Freight and trucking considerations are included in this program.

Benefits of Partnership and Partner Contributions to FHWA Freight Management and Operations Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard / Goal Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding	Stakeholder Advice	Education and Awareness
American Association of State Highway and Transportation Officials (AASHTO)	X					X			X		
State Departments of Transportation	X				X	X	X		X		
Metropolitan Planning Organizations (MPOs)	X				X	X					
Research and Educational Institutions, such as Massachusetts Institute of Technology (MIT), Texas A&M Transportation Institute (TTI), Oak Ridge National Laboratories, etc.					X	X					
Transportation Research Board (TRB)					X	X					
Trade Corridors Coalitions, such as I-95 Corridor Coalition, North America's Corridor Coalition (NASCO)	X	X			X	X	X		X		
American Trucking Associations (ATA), including American Transportation	X	X			X	X	X				

Partner Organization	User Perspective on Needs	Industry Perspective	Standard / Goal Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding	Stakeholder Advice	Education and Awareness
Research Institute (ATRI)											
Owner-Operator Independent Driver Association (OOIDA)	X	X				X	X				
National Association of Truck Stop Operators (NATSO)	X	X				X	X				
Commercial Vehicle Safety Alliance (CVSA)	X	X				X	X				
Other DOT partners, including Bureau of Transportation Statistics (BTS), Maritime Administration (MARAD), Federal Motor Carrier Administration (FMCSA), Federal Railroad Administration (FRA), etc.	X	X			X	X	X		X		
Department of Commerce (including U.S. Census)	X					X	X				
Department of Agriculture	X					X	X				
Department of Energy	X					X	X				

Truck Size and Weight
$977,900

Program Description:
The Truck Size and Weight (TSW) Research, Development and Technology (RD&T) Program will provide States and other stakeholders with information needed to create safe and efficient systems to ensure fluid freight movement across State borders. Activities will include research on effective truck size and weight data use across States and supporting States in their efforts to better harmonize oversize and overweight (OS/OW) permitting requirements.

In addition, through the Truck Size and Weight RD&T Program, the FHWA Office of Operations is supporting TSW-related research in other FHWA offices, including the Office of Highway Policy Studies and the Office of Infrastructure joint venture to develop a pavement distress evaluation model and create disaggregating vehicle miles travelled (VMT) tools based on vehicle classifications, vehicle weight groups, vehicle registered weight, and vehicle operation weights.

Program Objectives:
The Truck Size and Weight RD&T Program supports the following USDOT RD&T Strategic Goals and objectives.

Safety: Today, approximately 12 States require Pilot Car Certification. States use the FHWA-developed guidelines to support their certification requirements; however, these requirements vary from State to State. As a result, U.S. pilot car operators must navigate a complex web of requirements when making a multi-state move. FHWA research in this program area will support oversize/overweight state and local permits harmonization among States. The work outcome will improve safety on the national highways as well contribute to infrastructure preservation. Research activities will include research, review, and analysis of existing pilot/ escort vehicle operator (P/EVO) training materials, case studies, and other information focused on the oversize loads movement.

Infrastructure: The Truck Size and Weight RD&T Program addresses alternative truck configurations on the highway system and operations. Activities will include general analysis of alternative truck configuration impacts on freight infrastructure, safety, and operations.

The lack of uniformity across State truck size and weight regulations may be a potential barrier to efficient freight movements. There is also a need for truck size and weight research specifically to assess the impact of raising weight limits or allowing longer combination trucks on national highways. Outside DOT, National Cooperative Highway Research Program (NCHRP) analyses have provided a foundation for this topic area. The Truck Size and Weight RD&T Program supports addressing these research and data gaps.

Innovation: The Truck Size and Weight RD&T Program provides States and other stakeholders with information needed to create the safest and most efficient permitting and enforcement systems possible to ensure fluid freight movement across State borders. Activities will include researching effective truck size and weight data use across States and supporting States in harmonizing OS/OW permitting.

The Truck Size and Weight RD&T Program efforts aim to better understand the impacts of alternative truck configurations on freight infrastructure, safety, and operations, through data collection and development of data-driven tools and analytical techniques. Additionally, there is an effort to identify key TSW-related research needs related to pavement, bridge, mode shift, safety, and enforcement. The combination of these activities will lead to improved technical and implementation resources for stakeholder decision-making and analysis.

Anticipated Program Activities:
Key FY21 FHWA Truck Size and Weight RD&T Program Activities include those related to the Completion and Execution of FHWA Truck Size and Weight Research Implementation Plan and Analysis and Dissemination of Truck Size and Weight Data and Research.
The Transportation Research Board (TRB) of the National Academy of Sciences (NAS) was commissioned to develop a Truck Size and Weight Research Roadmap as a follow-up action to the DOT/FHWA Comprehensive Truck Size and Weight Limits (CTSWL) Study, submitted to Congress in April 2016. The five topic areas (pavement, bridge, mode shift, safety; and enforcement) included in the 2016 CTSWL Study provided the key focal areas for TSW research needs and activities. In November 2018, NAS/TRB finalized the TRB Truck Size and Weight Research Roadmap, which outlined research topics and stakeholder coordination needed to develop a Truck Size and Weight Limits Research Program.

A FHWA Truck Size and Weight Research Implementation Proposal is currently underway and expected to be completed in FY20. It is intended to aid in guiding specific resources towards TS&W research projects that are topically cross-cutting and impact multiple agencies and departments. The Truck Size and Weight RD&T Program seeks to implement the highest priority elements of this implementation proposal. While these activities have not yet been determined, they would include research pertaining to the topic areas identified in the 2018 TRB Truck Size and Weight Research Roadmap. For example, activities could include development of enhanced bridge deterioration models that can account for impacts of alternative truck configurations, development of more accurate models that States and others can use to identify impacts of heavy trucks on pavements, analysis of truck types, and safety impact assessments.

The Truck Size and Weight RD&T Program activities will include producing resources to determine needed information for freight vehicle size and weight analysis and examining methods for inventorying and applying these data. The Truck Size and Weight RD&T Program will work to provide States and other stakeholders with the knowledge needed to create the safest and most efficient systems possible to ensure fluid freight movement across State borders.

Key FY21 FHWA Truck Size and Weight Program Activities.

Activity	Period of Performance
Completion and Execution of FHWA Truck Size and Weight Research Implementation Plan	2019-2023
Analysis and Dissemination of Truck Size and Weight Data and Research	2018-2023

Expected Program Outcomes:
The Truck Size and Weight RD&T Program will develop roadmaps and syntheses, improved analytical tools, resources, best practices, stakeholder forums and outreach, peer exchanges, and pilot implementations. The possibility of longer or heavier trucks on highways requires research on how these alternative truck configurations will affect freight operations, and vice versa. Research activities will also consider how to address increased freight demand. The Truck Size and Weight RD&T Program will support practitioners to plan for, prioritize, and implement projects that benefit goods movement. Truck Size and Weight RD&T Program activities include producing resources on what information is needed for analysis of freight vehicle size and weight and examining methods for inventorying and applying these data. Activities will also include research on effective truck size and weight data use across States and supporting States in their efforts to better harmonize OS/OW permitting requirements.

Collaboration Partners:
The lack of uniformity across State truck size and weight regulations may be a potential barrier to efficient freight movements. It also notes a need for TSW research to assess tradeoffs involved in raising weight limits or allowing longer combination trucks on national highways. Outside DOT, National Cooperative Highway Research Program (NCHRP) analyses have provided a foundation for this topic area.

A major Truck Size and Weight RD&T Program activity is the development of a FHWA Truck Size and Weight Research Implementation Proposal. The Truck Size and Weight Research Roadmap developed by the National Academy of Science (NAS) described the activities, dependencies, sequencing, timelines, and cost estimates of a research program that aims to improve US DOT's knowledge of potential impacts from trucks operating at, within, or legally in excess of Federal limits to inform potential policy-making. The FHWA is evaluating the material in the roadmap and is considering next steps, including the development of the Truck Size and Weight Research Implementation Plan. While these activities have not yet been determined, they would include research pertaining to the topic areas (pavement, bridge, mode shift, safety; and enforcement) included in the 2016 Truck Size and Weight Limits Study. FHWA program offices, including the Offices of Infrastructure, Safety, and Environment and Planning, among others, have been involved in the development of the Implementation Plan. Other modal offices, including MARAD and FMCSA, have been similar involved.

Also, the FHWA Offices of Infrastructure and Policy will be conducting research to develop a pavement distress evaluation model and the Office of Policy is currently creating tools for

disaggregating VMT based on vehicle classifications, vehicle weight groups, vehicle registered weight, and vehicle operation weights.

Industry has proposed truck platooning as a technology solution that could bring significant improvements to the cost and efficiency of highway freight movements. However, it has raised concerns on the potential impact on pavements, bridges, and traffic operations. FHWA is collaborating with its DOT modal partners to develop a truck platooning research agenda that will be influenced by truck size and weight issues.

Benefits of Partnership and Partner Contributions to FHWA Vehicle Size and Weight Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard / Goal Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding	Stakeholder Advice	Education and Awareness
American Association of State Highway and Transportation Officials (AASHTO)	X					X			X		
State Departments of Transportation	X				X	X	X		X		
Metropolitan Planning Organizations (MPOs)	X				X	X					
Research and Educational Institutions, such as Massachusetts Institute of Technology (MIT), Texas A&M Transportation Institute (TTI), Oak Ridge National Laboratories, etc.					X	X					
National Academy of Sciences (NAS)					X	X					
Trade Corridors Coalitions, such as I-95 Corridor Coalition, North America's Corridor Coalition (NASCO)	X	X			X	X	X		X		
American Trucking Associations (ATA), including American Transportation Research Institute (ATRI)	X	X			X	X	X				
Owner-Operator Independent Driver Association (OOIDA)	X	X				X	X				
National Association of Truck Stop Operators (NATSO)	X	X				X	X				

Partner Organization	User Perspective on Needs	Industry Perspective	Standard / Goal Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding	Stakeholder Advice	Education and Awareness
Commercial Vehicle Safety Alliance (CVSA)	X	X				X	X				
Specialized Carriers and Riggers Association (SC&RA)	X	X				X	X				
Pilot Car Industry Stakeholders	X	X			X	X	X				
Other DOT partners, including Bureau of Transportation Statistics (BTS), Maritime Administration (MARAD), Federal Motor Carrier Administration (FMCSA), Federal Railroad Administration (FRA), etc.	X	X			X	X	X		X		

Environment and Planning

Accelerating Project Delivery
$2,667,000

Program Description:
The Accelerating Project Delivery research program helps FHWA in expediting project delivery by improving environmental review and permitting processes to reduce regulatory burden, and reduce timeframes and costs. This program supports improving the National Environmental Policy Act (NEPA) process and improves coordination and communication between Federal and State agencies, the public, and other stakeholders to create efficiencies in project review and development. This program supports the USDOT RD&T Strategic Goals of Infrastructure, Innovation, and Accountability through interagency collaboration, capacity building for environmental practitioners, integrating planning and environmental processes, and disseminating information about environmental program and process efficiencies.

Program Objectives:
The main goal of the Accelerating Project Delivery program is to build tools and collaborate on studies to reduce regulatory burden and increase efficiencies in the environmental review process by innovating new ways to expedite project delivery. Examples of initiatives and tools that the program supports to accelerate project delivery include activities related to regulatory reform, rulemaking, guidance, One Federal Decision implementation, "planning and environment linkages" (PEL), programmatic approaches, NEPA assignment program support and audit support, "Eco-Logical: An Ecosystem Approach to Developing Infrastructure Projects," resource agency liaison program support, and the Environment Discipline Support System. The Volpe center supports much of this work. FHWA also works with other agencies outside USDOT to accomplish this program. This program will also increase the effectiveness and efficiency of acquisition and management of highway real property interests by developing methodologies, technology and systems to accelerate the Federal-aid real estate acquisition program with utilization of flexibilities. This research program will improve knowledge and provide tools necessary to ensure that effective stewardship and oversight is provided.

Key FY21 FHWA Accelerating Project Delivery R&T Program Activities.

Activity	Period of Performance
Accelerating Project Delivery Services	2021-2022
Permitting and Mitigation, including the National Liaison Program	2021-2022
Project and Program Action Information (PAPAI) System	2021-2022
INPCT	2021-2022
NEPA Assignment Program	2021-2022
Planning and Environment Linkages (PEL)	2021-2022
Early Acquisition Flexibilities for Real Property	2021-2022

Expected Program Outcomes:
This program leverages Volpe and other Federal agency resources to help the Office Project Development and Environmental Review develop tools and simplify regulations policies to support deployment of advances in technology and innovation as they relate to accelerating environmental review and permitting processes. These tools include programmatic agreements, permitting efficiencies, NEPA Assignment support, and PEL. Additionally, the Office of Environment and Planning partners with other Federal agencies through the liaison program and partners with the private sector, research organizations, and State and local governments on several research topics such as storm-water permitting and Endangered Species Act compliance, among other activities. State DOTs often provide expertise and resources for the program through advisory groups and by field testing research technologies.

Collaboration Partners:
Accelerating Project Delivery research would not be possible without collaboration with Federal and Non-Federal partners. As the Operating Administration responsible for delivering the Federal aid program, FHWA and its Federal partners focus on program activities that are outside the purview of these non-Federal entities, such as research to implement and inform policy, guidance, and regulations. The FHWA works with Federal partners on program activities that seek permitting efficiencies and reform through programmatic approaches under an intra-agency agreement with the Volpe Center as well as interagency liaison agreements with resource agencies. The FHWA maintains agreements with agencies that have permitting oversight or other jurisdiction under several environmental laws and regulations, and these agencies provide dedicated staffing positions that serve as national liaisons to develop policy, guidance, and programmatic approaches to expedite permitting and environmental review times. FHWA currently has agreements for national liaisons with the following agencies: the Advisory Council on Historic Preservation (ACHP), the National Marine Fisheries Service (NMFS), the US Army Corps of Engineers (USACE), the US Coast Guard (USCG), the US Environmental Protection Agency (USEPA), and the US Fish and Wildlife Service (USFWS). The National Transportation Liaisons program funds efforts that benefit FHWA projects by expediting the review of transportation projects.

As a partner within USDOT, Volpe's support of the FHWA's efforts to accelerate project delivery is flexible enough to respond to emerging issues from the public and stakeholders. Volpe often assists with responding to public comments on policy, guidance, and rulemaking. Volpe also helps the FHWA engage stakeholders such as State DOTs and other transportation agencies through workshops and interviews on various topics. Volpe often synthesizes stakeholder input into case studies and other materials for FHWA to consider in developing policies to address issues the public and stakeholders raise. Public and stakeholder input also informs the products that FHWA develops with other Federal agencies under this program. State DOTs and other transportation agencies also collaborate on activities under this program.

Non-governmental input on this program usually comes from public comments and stakeholder engagement related to projects and draft policies, guidance, and rulemaking. Additionally, transportation organizations such as the AASHTO, Transportation Research Board (TRB), and University Transportation Centers (UTCs) contribute to this program by providing in-kind services or by funding research that compliments the Federal side of the program. AASHTO and TRB also support stakeholder engagement in the program to facilitate technology transfer between FHWA, its Federal partners, and the transportation industry.

Benefits of Partnership and Partner Contributions to FHWA Accelerating Project Delivery Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard / Goal Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding	Stakeholder Advice	Education and Awareness
Advisory Council on Historic Preservation (ACHP)	X		X								
National Marine Fisheries Service (NMFS)	X		X								
US Army Corps of Engineers (USACE)	X		X								
US Coast Guard (USCG)	X		X								
US Environmental Protection Agency (USEPA)	X		X								
US Fish and Wildlife Service (USFWS)	X		X								
State DOTs	X		X			X					X
AASHTO	X				X	X			X	X	
TRB	X				X	X			X	X	
University Transportation Centers						X			X		

Performance-Based Planning
$1,866,900

Program Description:
The statutory planning requirements of 23 USC 134 and 135 and implementing regulation of 23 CFR 450 require the United States Department of Transportation (USDOT) to work with States and Metropolitan Planning Organizations (MPOs) and encourage a continued improvement/evolution of the metropolitan and statewide transportation planning through a performance-based planning and programming (PBPP) process. The USDOT is responsible for assisting States and MPOs to identify and meet performance measures and associated targets related to national highway and transit performance goals and provide risk-based oversight and stewardship on performance measures and targets.

FHWA will work with States and MPOs to provide a strategic, data-driven approach to decision-making that enables transportation agencies in implementing PBPP while efficiently allocating resources, maximizing the return on investments, and achieving desired performance goals while increasing accountability and transparency to the public. The PBPP supports the connection between performance measures and performance target levels that lead to data-driven, effective transportation solutions. These measures and targets are connected through transportation plans and programs developed at the statewide and metropolitan levels.

Program Objectives:
FHWA's mission is to improve mobility on our nation's highways through national leadership, innovation, and program delivery. PBPP will support this through the application of performance management within the planning and programming processes and work with States and MPOs to achieve desired performance outcomes for the multimodal transportation system. PBPP ensures that transportation investment decisions are made (both in long-term planning and short-term programming of projects) based on their ability to meet established targets. This research will support USDOTs strategic goals and promote more informed transportation decision-making that improves transportation planning, programming, operations, and coordination.

FHWA will conduct research to collect quality data; analysis; and information for FHWA Divisions, States, MPOs, transportation partners, and decision-makers to use in the planning decision-making. FHWA will continue to work with other Federal, State, and local agencies to develop methods and tools to analyze system performance to identify effective transportation solutions. This will create strategies and activities that will advance comprehensive international, interstate, state, metropolitan, rural, regional, multi-modal, and tribal planning processes. Other planning research initiatives that will support the performance-based planning process and links planning data to the National Environmental Policy Act (NEPA) process includes: environmental justice, public engagement, transportation safety planning, forecasting project benefits and impacts, exploratory modeling, scenario planning, and transportation land use.

Key FY21 FHWA Performance Based Planning R&T Program Activities.

Activity	Period of Performance
Partner with key agencies (domestic and international) to harmonize and market emerging products and technologies to meet planning research needs.	2021
Evaluate planning capacity needs in partnership with key stakeholders to identify risks and opportunities of existing procedures to support the 3-C planning process.	2021
Develop robust decision-making techniques to model and forecast the impact of emerging technologies on the transportation system and be proactive in performance, safety and mobility planning.	2021
Provide educational opportunities for peers to demonstrate new communication technologies and allow for virtual tools and strategies to enhance traditional public involvement techniques for all transportation users.	2021-2023
Detect and deploy innovations for the efficient movement of people and goods in all areas of the state, including urban, rural, and tribal areas.	2021-2022
Partner with key agencies to develop and deploy best practices, case studies, and other capacity building activities that support enhanced small, rural, and mid-sized communities and regions	2021-2023
Continue delivery of customer service and technical support to key FHWA stakeholders through the development of trainings, peer reviews, peer exchanges, workshops, virtual forums, and other mediums that promote planning best practices.	2021-2023
Apply state of the art analytical tools and data resources in the transportation planning decision-making process.	2021
Monitor the effectiveness of the implementation of PBPP in transportation planning and programing at the State and regional levels.	2021
Distribute State and MPO best practices for making investment decisions based on a data driven PBPP and estimate the economic benefits and other cost savings resulting from PBPP.	2021
Enhance coordination with States and MPOs to detect notable practices that prioritize multimodal projects to enhance accessibility and connectivity for all users.	2021
Coordinate with key stakeholders, to ensure consistent monitoring and documentation of performance measures, targets and decision-making in PBPP.	2021
Identify innovative visualization methods to effectively analyze, map, present, and report a wide range of information to transportation practitioners, elected officials, and the public.	2021
Enhance accountability by developing and streamlining efforts in the planning process to further reduce regulatory burdens.	2021

Activity	Period of Performance
Assess the technology readiness of strategic planning models for performance based planning applications	2021

Expected Program Outcomes:
The Performance-Based Planning Program will support the four USDOT RD&T Strategic Goals by creating the following outcomes:

Safety: Performance based planning allows states to development data-driven plans, collect and maintain data, conduct studies, establish priorities, and implement and evaluate the effectiveness of transportation improvements. This research will provide tools, technologies, guidance, and training to support States, MPOs, and other transportation agencies (including rural communities) to achieve desired performance outcomes for the multimodal transportation system.

Infrastructure: This research will provide examples of effective practices to help practitioners advance performance based planning approaches; promote and maintain the highway infrastructure asset system in a state of good repair; identify tools, technologies, and guidance for States and MPOs; offer capacity building opportunities that plan and prioritize investments, accelerates project delivery; and effectively improve connectivity, accessibility, safety, and convenience for all users, including those in rural areas.

Innovation: This research will allow for the consideration of how various factors, such as revenue constraints, demographic trends, economic shifts, or technological innovation can affect a state or region and its transportation system performance. Potential regional investment strategies for the planning horizon include packages of investments in transit, highway capacity, Intelligent Transportation Systems (ITS), and travel demand management strategies, or system preservation. Research will also assess new modes and technologies, notably automated vehicles and automated driving systems linked to data-driven decision-making.

Accountability: The expenditure of limited resources ensures that transportation goals are achieved in accordance with the performance based planning process. Performance based planning will help planners to evaluate and recommend strategies, projects, and programs to policy-makers based on anticipated system-wide impacts and support for goals. This research will provide tools, technologies, guidance, and training to support States, MPOs, and other transportation agencies (including rural communities) to improve mobility while preserving the natural and human environments.

Collaboration Partners:
Collaboration on performance-based planning involves FHWA's continuous engagement with key stakeholders in both formal and informal settings to gather input on planning opportunities and challenges. Stakeholders include representatives of individual State DOTs, MPOs, RTPOs, pertinent committees of the American Association of State Highway and Transportation Officials (AASHTO) and the Transportation Research Board (TRB),

universities engaged in related work, and professional organizations such as the American Planning Association. Interactions with AASHTO, TRB, and professional organizations generally occur at regular intervals (at least annually, and as often as quarterly). Non-government groups also partner and contribute with FHWA in support of performance based planning through planning conferences, symposiums, and relevant workshops.

Benefits of Partnership and Partner Contributions to FHWA Performance-Based Planning Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard / Goal Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding	Stakeholder Advice	Education and Awareness
FHWA Division Offices	X										
Federal Transit Administration	X										
ITSJPO	X										
State DOTs	X										
MPOs	X										
RTPOs	X										
AASHTO and Associated Standing Committees										X	
TRB										X	
Association of Metropolitan Planning Organizations (AMPO)										X	
National Association of Regional Councils (NARC)										X	
National Association of Development Organizations (NADO)										X	
American Public Transportation Association (APTA)										X	
National Association of Counties (NACO)										X	
American Planning Association (APA)										X	
General Public										X	

Modeling and Analysis Tools
$1,866,900

Program Description:
The "Modeling and Analysis Tools" research program focuses on the development of new analytical tools and refines existing tools to help decision makers understand how highway projects improve the performance of our nation's highway system in terms of improving air quality, reducing noise, and addressing congestion caused by the high demand to travel on the highway system. This research supports the efficient delivery of highway projects by accelerating the environmental review and permitting process while at the same time maintaining a healthy environment. The goal of the research program is to provide stakeholders at State departments of transportation (DOTs) and metropolitan planning organizations (MPOs) with the best tools, data, and regulatory framework for efficiently conducting analysis that is required by law to protect the environment.

The research program also explores and adapts modeling methodologies for transportation planning to allow State DOTs and MPOs to better understand their transportation systems and to provide decision-makers actionable techniques and tools to better understand how a complex transportation system reacts to investments and policy changes and efficiently make trade-offs between performance metrics.

Program Objectives:
This research program supports the mission of the Federal Highway Administration and the Infrastructure and Accountability RD&T Strategic Goals of the U.S. Department of Transportation in the following ways:

- Infrastructure: Environmental Stewardship - Develop innovative approaches to preserve the environment and to expedite the environmental review process. Modeling for air quality and noise impacts is required by law and regulations. Modeling and analytical tools are essential for State DOTs and MPOs to demonstrate that their plans and projects comply with the applicable legal standards and projects can therefore move forward. Developing and deploying new and innovative tools and methods make these analyses simpler and more efficient, thereby reducing analytical burdens on transportation plans and projects, accelerating the environmental review process and expediting the delivery of infrastructure projects. Research results also support the updating and streamlining of regulations, guidance, and analytical practices to further simplify analysis requirements for projects with more reliable results.

- Accountability: Technology Transfer/Deployment - Disseminate tools, data and research products to transportation stakeholders. New and refined analytical tools, data, and other research products to be disseminated to stakeholders for application in a timely manner to assess air quality and noise impacts and the performance of the highway system and to support evidence-based decisions making. Models and tools will be deployed and research results will be shared with the public using a

wide range of methods including published reports, workshops, webinars, pilots and demonstration projects, technical assistance and peer exchanges.

Improving current air quality and noise modeling tools to produce more accurate and reliable results will provide decision makers with the best possible information to understand the expected air quality and noise impacts of proposed highway projects when making infrastructure investment decisions. Accurate predictions of these impacts are critical to avoid costly mitigation or legal challenges that may result in slowing down project delivery.

Key FY21 FHWA Modeling and Analysis Tools R&T Program Activities.

Activity	Period of Performance
Continue research to examine and understand potential emissions impacts of new vehicle technologies including connected and autonomous vehicles (CAV), vehicle to infrastructure (V2I), and vehicle to vehicle (V2V) technologies.	2020-2021
Conduct research to analyze features of EPA's air quality dispersion and emissions models to evaluate applicability to highway projects and potential to streamline air quality analysis. Enhance data collection and analytical tools development to support and improve project level air quality.	2020-2023
Use case studies to create an analysis framework for State DOTs and MPOs to 1) identify freight bottlenecks with high emissions and noise levels, 2) create a detailed emissions and noise inventory at those locations, and 3) identify effective mitigation strategies for reducing truck emissions and truck noise levels and these locations.	2020-2022
Develop and deploy state-of-the-art models, tools, data and methods to enhance air quality and noise analyses and to support the acceleration of highway project environmental review process. Disseminate new and refined analytical tools, data, and other research products.	2020-2022
Assess the synergy of various CMAQ project types to enhance cost effective implementation and improved performance management. Modernization of the CMAQ Project Tracking System/Public Access System– upgrade the interface to make it more user friendly and improve functionality to support TPM activities.	2020-2022

FY 2021 will also focus on the deployment of models and analytical tools that were completed in FY2020. These models and tools will be delivered to transportation stakeholders (State DOTs and MPOs) and the public in a variety of ways such as conferences, workshops, webinars, training courses, peer exchanges etc. Documents such as research reports, case studies, model sensitivity and validation analyses, and technical guidance will be posted on line and marketed at industry events.

Expected Program Outcomes:

- Air quality and noise models are required by law, but they are complex and difficult to use. These models take significant time, resources, and expertise to run. In addition, gathering and synthesizing data to use in air quality and noise models can take significant time. Our research aims to develop and update tools and methods that will make the models simpler to use, reducing the time and resources needed to run them.

- Air quality and noise models need to be updated to reflect the most current data and the most up-to-date modeling techniques. This research will ensure that States and MPOs have models that reflect the most recent information and best state of the practice techniques to comply with laws and to assess system performance as accurately as possible.

- Current air quality and noise regulations and guidance are overly burdensome. This research will develop data-driven tools and methodologies to evaluate and demonstrate that clean air and noise regulations and guidance documents that are outdated can be scaled back or eliminated while still providing adequate environmental protections.

- The effectiveness of mitigation strategies for noise and air quality is complex to evaluate and difficult to quantify. Mitigation of air quality impacts and abatement of noise impacts are important to ensure that noise and emissions levels are within the standards established in law, and, in the case of air quality, to meet established performance measure targets. Our research will develop tools to measure the amount of emission reductions from mitigation strategies.

Collaboration Partners:

Collaboration on modeling research regularly involves engagement with key stakeholders in both formal and informal settings to gather input concerning challenges and opportunities that might be addressed through the program, as well as information on work undertaken by other organizations both nationally, and internationally. Stakeholders include representatives of individual State DOTs, MPOs, regional planning agencies, pertinent committees of the American Association of State Highway and Transportation Officials (AASHTO), the Association of Metropolitan Planning Organizations (AMPO) and the Transportation Research Board (TRB), universities engage in related work, and professional organizations such as the Institute of Transportation Engineers, and the American Planning Association. Interactions with AASHTO, AMPO, TRB, and professional organizations generally occur at regular intervals (at least annually, and as often as quarterly). Other Federal agencies including EPA and other non-government groups, such as the Health Effects Institute, partner and contribute to modeling research through both formal (interagency agreements, FACA workgroups) and informal (workshops, modeling staff workgroups) arrangements.

Benefits of Partnership and Partner Contributions to FHWA Modeling and Analysis Tools Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard / Goal Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding	Stakeholder Advice	Education and Awareness	
AASHTO Environment & Sustainability	X									X		
AASHTO Air Quality, Climate Change, and Energy										X		
AASHTO Highway Traffic Noise Working Group	X				X					X		
TRB Committee on Transportation and Air Quality	X						X			X		
TRB Committee on Transportation Related Noise and Vibration	X			X	X		X			X		
State DOTs	X			X	X	X			X	X		
Metropolitan Planning Organizations	X			X	X					X		
Associations of Metropolitan Planning Organizations	X				X					X		
US EPA				X		X	X		X			
Health Effects Institute						X	X		X			
USDOT Volpe Center				X	X	X	X					

Resiliency
$1,155,700

Program Description:
The Resiliency research program focuses on development and deployment of tools, techniques, strategies and methodologies for assessing the resiliency, efficiency, and sustainability of transportation plans, projects and programs. Addressing the risk of damage and service disruption and increases in lifecycle cost of infrastructure caused by extreme weather events and natural hazards is essential in ensuring the continued integrity, safety and function of the highway system. To better address these risks and vulnerabilities, FHWA will conduct research and development activities to integrate resiliency, efficiency, and sustainability into transportation planning, project development and design. FHWA will also work with other Federal agencies to better predict and estimate the future levels of exposure of infrastructure to extreme weather events, including changes in precipitation patterns, temperature, and cyclonic storm surge and waves. FHWA will also conduct research and development activities to ensure transportation decisions are informed by economic, social and environmental effects and trade-offs. This program will also support the expansion of alternative fuel use, and encourage the development of alternative fuels through the designation of alternative fuel corridors, technical assistance, training, and research.

Program Objectives:
The goal of this program is to integrate consideration of resiliency and sustainability into the transportation planning, project development and design processes. The program objectives are:

- Develop and deploy tools, techniques, strategies and methodologies for assessing the resiliency and sustainability of transportation plans, projects, programs, and infrastructure (jointly with Infrastructure programs).
- Identify, share, and promote best practices for assessing and addressing system vulnerabilities.
- Develop and update training on engineering resilient highways in coastal and riverine environments (jointly with Infrastructure programs).
- Conduct studies with other Federal agencies to improve predictions and estimates of future levels of extreme weather exposure for use in planning and design of highways and bridges (jointly with Infrastructure programs).
- Provide tools to help decision makers analyze economic, social, and environmental effects and considerations, smoothing interactions with stakeholders and resulting in more efficient project delivery.

- Reduce costs in highway construction by researching opportunities for increased material efficiency and material recycling.
- Increase energy security by creating opportunities for domestically sourced alternative fuels; conducting research on best practices, usage, behavior, stakeholder needs; designating alternative fuel corridors; and providing technical assistance and training to state DOTs and MPOs.
- Explore opportunities to use highway right-of-way to generate additional benefits that are consistent with operational and safety concerns, review restrictions on right-of way use, and address relevant technical analysis and data needs to inform decision making.

This research program directly supports the strategic research goals of Infrastructure and Innovation. Under the Infrastructure Goal, our research supports the State of Good Repair priority, particularly the components pertaining to Risk-Based Asset Management and Infrastructure System Resilience. This research area also supports the Environmental Stewardship strategic priority within the Infrastructure Goal, by conducting research that supports the development and adoption of alternative fuel passenger vehicles, highway infrastructure and corridors.

Anticipated Program Activities:
Key FY21 FHWA Resiliency R&T Program Activities.

Activity	Period of Performance
Partner with State DOTs and others to improve processes, tools and methods through developmental and applied research and demonstration projects for incorporating resiliency and sustainability	2021-2022
Create technical assistance on resilience for all stages of highway planning, design, construction, operations and maintenance, and asset management in multiple geographic settings, with a particular focus on coastal and riverine environments	2021-2022
Support expansion of alternative fuels through designation of alternative fuel corridors, technical assistance, training, and research	2021-2022

Expected Program Outcomes:
Expected program outcomes include new partnerships with State DOTs and others to improve resiliency and sustainability processes, tools and methods, and the development and delivery of technical assistance and training on coastal and riverine resilience. In addition, outcomes would include training and technical assistance developed and delivered on alternative fuels, resulting in expanded national designations of alternative fuel corridors.

Collaboration Partners:
Collaboration on resiliency and sustainability involves engagement with key stakeholders in both formal and informal settings to gather input concerning research challenges and

opportunities that might be addressed through the program, as well as information on work undertaken by other organizations both nationally, and internationally. Primary stakeholders include representatives of individual State DOTs and metropolitan planning organizations, Federal land management agencies (FLMAs), and pertinent committees of the American Association of State Highway and Transportation Officials (AASHTO) and the Transportation Research Board (TRB). Interactions with AASHTO, TRB, and professional organizations generally occur at regular intervals (at least annually, and as often as quarterly), but are not formally tracked or measured.

In addition, resiliency and sustainability research is conducted in coordination and partnership with several other FHWA program offices. Non-governmental groups also partner with this program. In particular, AASHTO provides stakeholder perspective and collaborates on research projects.

Benefits of Partnership and Partner Contributions to FHWA Resiliency Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard / Goal Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding	Stakeholder Advice	Education and Awareness
AASHTO Environment & Sustainability						X				X	
AASHTO Committee on Transportation System Security & Resilience						X				X	
TRB Executive Task Force on Resiliency						X				X	
TRB Special Task Force on Climate Change and Energy						X				X	
TRB Committee on Hydrology and Hydraulics						X				X	
TRB Transportation System Resilience						X				X	
State DOTs	X			X	X						
Metropolitan Planning Organizations	X			X	X						
FLMAs	X			X	X						
Other FHWA Offices (Infrastructure, Operations, Federal Lands)							X		X	X	
NOAA						X	X		X		
USGS						X	X				
DOE and National Labs						X	X				

Planning for Bicycle and Pedestrian Safety, Connectivity, and Multimodal Mobility, including for Underserved Communities

$1,155,700

Program Description:
The goals of this program are to lower the number of pedestrian and bicyclist fatalities and serious injuries because of traffic crashes, and to improve the connectivity of the multimodal transportation system to allow travelers improved mobility options. The program will integrate improved pedestrian and bicycle systemic safety analysis techniques and design into transportation planning and project development. The program will also support mobility innovation, active transportation, accessibility planning, multimodal connectivity, context sensitive design solutions, and economic development to help ensure competitiveness of the U.S. economy. The program will help improve multimodal mobility options for all users of the transportation system, including underserved populations such as people with disabilities, older adults, low income individuals, and those in rural communities, and by efficient multimodal transportation planning for the National Highway System (NHS).

Program Objectives:
This research program supports the mission of the Federal Highway Administration and the Safety, Infrastructure, and Innovation RD&T Strategic Goals of the U.S. Department of Transportation in the following areas:

- Research, develop, and promote proven pedestrian and bicycle infrastructure designs that improve safety and reduce fatalities and serious injuries.
- Identify, share, and promote effective and successful tools and information necessary to integrate systemic pedestrians and bicycle analysis into transportation planning and project development.
- Research and technology deployment to support a connected surface transportation system for all users, including curb space management considerations in a manner that is efficient, equitable, safe, environmentally sustainable, and supports economic revitalization.
- Develop resources that improve access and mobility for all users, including low income and minority populations, and people with disabilities or mobility challenges by implementing innovations that can provide more efficient, affordable, and accessible multimodal mobility options.
- Identify, share, and promote innovative mobility options such as micromobility, shared mobility, and mobility as a service.
- Integrate emerging mobility technologies in the transportation planning process.

- Improve the way transportation contributes to economic development and communities' quality of life. Research, develop, and promote strategies that encourage multiagency collaboration that supports successful economic development outcomes.
- Identify and promote strategies that strengthen national security and economic development through transportation planning, programming, operations, and management.
- Identify and promote strategies that support multimodal mobility options, equity, access, and public engagement to strengthen the ability of States and communities to respond to citizens' needs.

Anticipated Program Activities:
In FY21, the Planning for Bicycle and Pedestrian Safety, Connectivity, and Multimodal Mobility, including for Underserved Communities R&T Program will undertake a number of activities. These include developing resources for the ped/bike community, conducting research to integrate ped/bike and into emerging technology systems, planning resources, and integration with national data systems.

Key FY21 FHWA Planning for Bicycle and Pedestrian Safety, Connectivity, and Multimodal Mobility, including for Underserved Communities R&T Program Activities.

Activity	Period of Performance
Operate a national pedestrian and bicycle information center (PBIC); conduct pedestrian and bicycle safety and connectivity research, and provide technology transfer and technical assistance. Address emerging technologies such as micromobility and automation and the impact of new transportation providers on the transportation system.	2021
Research and implement the integration of pedestrian and bicycle network connectivity performance measurement and scalable risk analysis with transportation planning and project development.	2021
Support cross-modal research to implement Innovative Technology Collaborative Evaluations for road user safety.	2021-2022
Research and deploy innovations in the funding, financing, development, and implementation of multimodal transportation projects that improve connectivity, accessibility, safety, and convenience for all users, including underserved communities.	2021-2023
Develop resources to support delivery of national summits on pedestrian safety and micromobility.	2021
Develop resources to support implementation of USDOT access and mobility for all initiatives, including the Compete Trip- ITS4US Deployment Program and strategic accessibility planning.	2021
Research and deploy innovations to support improved context sensitive solutions and design, community impact assessment, and public engagement to accelerate project decision-making and improve mobility options for underserved communities.	2021
Administration of the National Highway System (NHS) Official Record and GIS Database to facilitate National Highway Performance Program eligibility determination and NHS system performance tracking	2021
Evaluation of whether National Highway System (NHS) Intermodal Connector threshold criteria established in the 1990s are relevant and valid to meet current NHS stakeholder needs	2021
Research into State Economic Development and Transportation	2021

Expected Program Outcomes:
This research will improve multimodal mobility options, including safer and more connected pedestrian and bicycle options, for all users, including communities with underserved populations such as people with disabilities, older adults, low income individuals, and rural communities. This research will address mobility innovations that involve emerging technology; such as shared mobility, mobility as a service, and new mobility options that automation may provide.

This research will expedite program delivery by providing timely information critical to project programming and performance management. It will assist partner agencies by providing concise and clear tools, data, methods, and information to maximize economic development outcomes supported by highway investments.

Collaboration Partners:
Collaboration on planning for bicycle and pedestrian safety, connectivity, and multimodal mobility, including for underserved communities regularly involves engagement with key stakeholders in both formal and informal settings to gather input concerning challenges and opportunities that might be addressed through the program, as well as information on work undertaken by other organizations both nationally, and internationally. Stakeholders include representatives of individual State DOTs, MPOs and other regional planning agencies.

FHWA partners regularly with nongovernment groups on this research, such as with the pertinent committees of the American Association of State Highway and Transportation Officials (AASHTO) and the Transportation Research Board (TRB), universities that engage in related work, and professional organizations such as the Institute of Transportation Engineers, the Association of Pedestrian and Bicycle Professionals, the National Association of City Transportation Officials, and the American Planning Association. Interactions with AASHTO, TRB, and professional organizations generally occur at regular intervals (at least annually, and as often as quarterly), but are not formally tracked or measured.

Benefits of Partnership and Partner Contributions to FHWA Planning for Bicycle and Pedestrian Safety, Connectivity, and Multimodal Mobility, including for Underserved Communities Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard / Goal Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or	Funding	Stakeholder Advice	Education and Awareness
AASHTO Active Transportation Council										X	
AASHTO Center for Environmental Excellence						X	X			X	
TRB Standing Committee on Pedestrians										X	
TRB Standing Committee on Bicycle Transportation										X	
TRB Standing Committee Environmental Justice in Transportation										X	
TRB Standing Committee on Transportation and Economic Development						X	X			X	
TRB Standing Committee on Public Involvement										X	
State DOTs	X			X	X				X		
Regional Transportation Planning Agencies	X			X	X						
National Association of City Transportation Officials										X	

Partner Organization	User Perspective on Needs	Industry Perspective	Standard / Goal Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or	Funding	Stakeholder Advice	Education and Awareness
Association of Metropolitan Planning Organizations						X	X			X	
Association of Pedestrian and Bicycle Professionals										X	
University of North Carolina Highway Safety Research Center						X	X				
Portland State University's Transportation Research and Education Center						X	X				
National Association of Development Organizations										X	
Institute of Transportation Engineers						X	X				

Policy

Policy Analysis and Global Outreach
$4,142,740

Program Description:
The domestic component of the Policy Analysis and Global Outreach program provides empirical assessments of the potential for national transportation strategies and policies to improve the overall value of transportation investments to the American people.

This program supports the Safety, Infrastructure, Innovation and Accountability USDOT Strategic Goals by conducting research that provides empirical analysis of potential Federal transportation policies and strategies that will cost-effectively enhance transportation system performance in the United States. It uniquely integrates economic, public policy, geography, engineering, and statistics disciplines, to improve FHWA and U.S. DOT forecasting and policy analysis capabilities, with a focus on the role of highways within the context of changing – and somewhat uncertain -- transportation technologies, modes and travel behavior, and the economy.

Two broad lines of policy research address the supply and demand considerations essential to assessing the efficacy of national transportation policies and strategies in enhancing transportation access, system performance, and competitiveness:

- Transportation Investment
    - Impacts of Investment on Conditions and Performance
    - Economic Impact Analysis
    - Benefit-Cost Analysis

- Emerging Trends, Policy, and Strategy Analysis
    - Highway Costs and Funding Options
    - Emerging Trends and Future Demand
    - Geo-Economics of Multi-Modal Systems
    - Symposia, Strategic Planning and Policy Program Delivery

Transportation Investment research provides the empirical basis for assessing the value and cost-effectiveness of future highway investments. The conditions and performance (C&P) area of research provides analyses of the cost-effectiveness of highway investment strategies. Reflecting the long-term nature of infrastructure investments, this research looks out 20 years in the future and includes sensitivity analyses reflecting uncertain future about VMT and other factors affecting investment choices. In addition to evaluating the conditions and performance associated with different funding levels, this research enables evaluation of strategies focused on specific types of investment, such as capital and maintenance. The Economic Impact Analysis research emphasis area addresses the

relationship between transportation investments and the economy. At the national level, this research program provides estimates of the impacts of transportation funding, financing, and investments on gross domestic product (GDP), employment, and private sector returns on investments over time and during different phases of the business cycle. The research area is being extended to address critical differences in local, regional, and sectoral level economic impacts of transportation investments. It includes a new research element to better understand the economic competitiveness tension between the value of agglomeration to the economy (firms co-locating in denser areas) and the congestion costs that entails. The Benefit-Cost Analysis research emphasis area supports the development of regulatory impact evaluations for regulatory and deregulatory actions for all of FHWA, develops training to support reviews of benefit-cost analyses submitted with discretionary grant applications, and explores approaches for expanding the analytical capabilities of benefit-cost tools in general.

Emerging Trends, Policy, & Strategy research assesses the potential for emerging transportation technologies, modal options, and socio-demographic factors to reshape future travel demand and transportation system performance. An area of focus for this 'demand side' research addresses the potential costs and performance implications of policy options on emerging issues, including AVs, on-demand modes, tolling, and mileage-based user fee, for future travel behavior and associated future system needs and performance. Building on previous research on rural access, this research program also explores issues pertaining to system access, with a focus on underserved communities; in particular, rural communities.

Another area of focus is to evaluate transportation strategies that might enable more effective use of existing highway capacity to guide future transportation investments. Studies conducted last year help lay the foundation for evaluating alternative funding or financing strategies with the potential to improve transportation market performance and reduce future investment costs. A unique geo-economic modeling framework initiated in FY2018 will enable FHWA, for the first time, to assess the potential to identify cost-effective alternatives to adding new lane miles to enhance system performance by modeling the potential for technological/modal options utilizing existing rights-of-way across geotypes and travel patterns. This geo-spatial approach recognizes that the economics of transportation can be fundamentally different across differing areas including urban, suburban, exurban, town, and country environments which are defined under geotypes in this effort.

The third area of focus is to utilize policy research to facilitate informed communication and dialogue on strategic planning and policy development within FHWA/USDOT and with partners and stakeholders. The Transportation Policy Symposia series provides a formalized platform for FHWA to gain insights and perspectives on policy questions, and also share evidence through policy dialogue with stakeholders and leadership. This area also includes contributions to FHWA strategic planning process to minimize corporate risk.

This domestic policy research is enabled through the development and use of a selected suite of analysis tools and models focused heavily on understanding the role of

transportation policy and investments in furthering economic competitiveness. They include benefit-cost analysis models aimed at performance-based investment prioritization; broader-based economic tools that consider a broader range of investment impacts, tools to monitor construction cost development, models to capture vehicle operating costs and pavement performance, and models that improve understanding of market failures such as congestion externalities. Other tools under development will facilitate the analysis of user-pricing strategies. A major focus of this research program is the identification of new approaches to link data from multiple sources to support policy analysis and provide the basis for more informed policy decision-making. The geo-economic model explores options to optimize system performance within the constraint of existing right-of-way.

The international component of the Policy Analysis and Global Outreach program has three main international program elements, Global Benchmarking, Binational and Multinational Relations. The three program elements are under the purview of the Office of International Programs. Through collaboration with international and domestic partners, the three elements address the Secretary's and FHWA's priorities. They work together and cross-pollinate, with developments in one area sometimes leading to opportunities in others. For example, a one-time visit to a country for Global benchmarking may lead to a long-term exchange as part of a binational relationship. A successful binational exchange may lead to a multinational research project. Information or developments gleaned during a multinational meeting may attract the interest of FHWA subject matter experts and lead to a Global Benchmarking study. In this way, the programs work in complementary ways to address different aspects of FHWA's international efforts, all while focusing on U.S. priorities and the objectives of the agency.

Global Benchmarking Program – The Global Benchmarking Program supports FHWA's leadership role and strategic priorities by seeking out and adapting foreign innovations that could significantly improve highways and highway transportation services in the US. The program focuses on acquiring and adapting technologies and best practices already available and used abroad. This not only helps avoid duplicative research, but it also reduces overall costs and accelerates the deployment of innovative technologies and practices.

Multinational Relations Program – The FHWA's involvement in multinational relations spans a wide range of program and research activities that cover Department and Agency priorities. These relationships include global and regional organizations, such as the World Road Association (WRA), the Forum of European National Highway Research Laboratories, the European Union/European Commission, and the Conference of the International Transport Forum. Participation in the WRA provides a means through which FHWA can exchange information on innovative road practices with 120-member governments.

Binational Relations Program – The Binational Relations Program facilitates knowledge exchange by leveraging binational government-to-government partnerships. The exchanges address priority issues in a complementary manner to other ongoing initiatives, focusing on best practices and technologies related to FHWA and DOT high-priority

topics. These prioritized engagements support Departmental and Agency strategic goals, and U.S. foreign and trade policy. Topics include safety, innovative financing, freight, infrastructure resilience, bridges, binational planning and coordination, and pavement, among others. Examples of binational partnerships include: Japan, Korea, the Netherlands, Australia, Sweden, Mexico, South Africa, Brazil, and Israel.

Program Objectives:

Impact of Investments on Conditions and Performance. Key anticipated FY 2021 accomplishments in the Impact of Investments on Conditions and Performance research emphasis area include completion of the next biennial "Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance" report to Congress (C&P report). Contributing to DOT's Infrastructure strategic goal (specifically the State of Good repair research element), the C&P report provides empirical documentation of the state of the nation's highway infrastructure and forecasts infrastructure investment needs over the course of the next two decades based on forecasted vehicle travel and detailed pavement deterioration. Analyses generated from two benefit-cost analysis models, the Highway Economic Requirements System (HERS), and the National Bridge Investment Analysis System (NBIAS), identify and prioritize potential future investments to achieve a range of condition and performance goals. Key Accountability accomplishments anticipated for FY2021 will include selection of a framework for a web-based interactive C&P report providing enhanced access to and efficiency in data analyses for decision making by FHWA, USDOT, Congress, State DOTs, and the general public. Additionally, HERS will be re-coded from FORTRAN to Python both allowing the analytical software to be used by a wider audience and paving the way for a next-generation HERS incorporating advanced computational methods and an improved user interface for higher efficiency, effectiveness and accountability in analyzing infrastructure investment needs.

Economic Impact Analysis. Planned FY2021 research includes continuing efforts to modernize current investment models for improved computational capabilities and usability. Accomplishments under the Economic Impact Analysis emphasis area will include the updates of an enhanced USAGE-Hwy v1.2 model and its application in quantifying the macroeconomic impacts from highway investment. This new model will incorporate continuous improvements in the parameters of HERS and USAGE-Hwy models, update macroeconomic variables from other Federal agencies and BTS, and distinguish between rural and urban areas. The policy simulation will present investment impacts at different economic conditions. Another accomplishment will be a new research project to evaluate the economic impact and distribution of highway investment on land values as an initial basis for understanding the wider economic benefits from transportation. The role of transportation investment in sectoral and geographic changes in the economy will be explored on how it facilities freight movement and trade. These products address the Department's strategic goal of Infrastructure by linking investment in infrastructure to economic growth and productivity and by informing decisions concerning the impacts of these investments on our broader national economy. Another accomplishment will be the ongoing effort to update the Economic Impact Analysis webpage by presenting methodologies and research findings on FHWA webpage to support the Department's strategic goal of Accountability.

Benefit-Cost Analysis. Planned 2021 accomplishments in the Benefit-Cost Analysis emphasis area include the completion of regulatory and deregulatory impact analyses as directed by FHWA's Office of the Chief Counsel, in cooperation with program offices, as well as support for the FHWA application of benefit-cost analysis in discretionary grant reviews. These activities support the USDOT goal of Accountability by ensuring more consistent and methodologically-sound application of benefit cost analysis, lifecycle-cost and related economic-impact analysis for policy, strategic, programmatic, and project decision-making. In addition, exploratory research to improve the ability of benefit-cost analysis methods to reflect infrastructure resiliency will be conducted. This research will support the Infrastructure goal by providing basis for including resilience in the investment decision-making and planning response to natural and man-made threats.

Costs and Funding Options. In FY 2021, the following accomplishments are anticipated in the costs and funding options emphasis area. First, this research will enhance and maintain the highway revenue forecasting model, and determine and analyze the impacts and costs of potential implementable national Mileage-Based User Fee (MBUF) options. The research, a joint effort between HPTS and the Office of Operations, will analyze the potential distributional, economic, financial, logistic, administrative structures and entities, travel behavior and other impacts of potentially implementable MBUF options at the national level. These activities contribute to support the Department's Accountability strategic goal. Second, this research will improve the National Highway Construction Cost Index (NHCCI) estimates and component contributions to its changes over time by producing both seasonally adjusted and unadjusted estimates, which are critical for measuring the real costs of highway construction, supporting the agencies infrastructure goals. Third, this research will develop a prototype and validate the Unified Pavement Distress Analysis and Prediction Systems (UPDAPS) to support different FHWA pavement performance predictions needs including the Highway Economic Requirements System (HERS) model, National Pavement Cost Model (NAPCOM), and Pavement Health Tracking (PHT) Analysis Tool. The UPDAPS will be implemented in a computer shared library accessible for use by different FHWA offices. This is a joint effort with the Office of Infrastructure and Office of Infrastructure Research & Development. Finally, this research will explore methods and data to estimate user marginal costs of highway infrastructure. This research is anticipated to provide marginal cost measures by vehicle type, highway type, and rural and urban roads, which are critical information for supporting Infrastructure, Accountability and Innovation strategic goals.

Emerging Trends and Future Demand. Key FY 2021 accomplishments for the Emerging Trends and Future Demand emphasis area support the Innovation and Safety Strategic Goals through the assessment of emerging transportation trends on future travel demand. This includes extensive coordination among stakeholders and exploration of emerging trends in the context of user needs, transportation performance, and policy. Innovation is also applied to data analytic and methodological approaches for assessing outcomes and policy alternatives, including the analysis and estimation of pedestrian safety with the Safety Data Initiative Rural Pedestrian & Cycling study and measures of user impacts of emerging technologies, including mobility access, benefits, and barriers, with an emphasis

on underserved populations. Accomplishments for FY2021 include the annual Emerging Trends and Transportation Report, the identification of travel demand factors, enhanced estimates of user responses to supply and policy changes, and improved VMT and other forecasts of travel demand important for transportation policy analysis.

Geo-Economics of Multi-Modal Systems. The key FY 2021 accomplishment in the Geo-Economics emphasis area will be defining geo-types based on differences of density and travel patterns across the nation to reflect economics of transportation modes. It will also be developing a set of cost curves for different modes within different geo-types which allows exploration of multi-modal geo-economic variations in transportation infrastructure costs, travel demand, and transportation services to better understand how technology and socio-economic changes may be reshaping future transportation system performance and policy opportunities. For that, this program will be investigating user responses to different modal options by demography and geography. All research advances will also be peer reviewed. To assess the various ways in which transportation investments and system performance affect each other, including accessibility and mobility, this research program is taking and developing innovative approaches such as artificial intelligence, advanced mathematical and analytical models, and combining knowledge from traffic flow theory to network modeling and economic models which supports the Innovation strategic goal. Identifying specific input and output linkages between GEMS and other policy research activities and models, including HERS will be among accomplishments in this year. These activities will lead to more consistent and methodologically-sound application of investment impact analysis for policy decision-making which supports the Accountability strategic goal. It also supports the Infrastructure strategic goal by supporting the development and application of tools and techniques for evaluating the relative contributions of types of transportation investments, including multimodal applications.

Symposia, Strategic Planning and Policy Program Delivery. Key FY 2021 accomplishments for the Symposia, Strategic Planning and Policy Program Delivery research emphasis area include efforts supporting the Innovation strategic goal such as: 1) enabling FHWA/USDOT dialogue on transportation policy issues through a series of Transportation Policy Symposia; 2)ensuring policy research is high-quality, timely, and peer -reviewed; 3) assessing options for future federal roles and responsibilities in delivering or enabling elements of the nation's transportation system in light of future needs and opportunities; and, supporting the Accountability strategic goal, 4) leading FHWA Strategic Planning efforts, including FHWA contribution to DOT multi-year strategic plan and efforts to minimize corporate risk.

Global Benchmarking Program. In FY 2020, one of many mechanisms used to support these priorities has been the Global Benchmarking Program (GBP). The program focuses on acquiring and adopting proven foreign technologies and best practices that have the potential to significantly improve highway transportation in the U.S. International safety and innovation related activities include for example, FHWA is the in the implementation phase of the 2019 GBP study on *Electrically Isolated Tendons (EIT) in European Transportation Structures*. EIT is a new and innovative non-destructive evaluation technology that can validate the encapsulation integrity and remotely monitor long-term

tendon condition of post-tensioned (PT) bridge structures and enable improved long-term performance by providing the highest level of corrosion protection possible with current PT technologies. Information gathered from the study is being used supplement and assist multiple ongoing efforts to deploy EIT's in the U.S. Another outcome of this study has been the development of relationships with international experts that share interest in advancing the EIT technology, including a collaborative arrangement with Switzerland who is a world leader in EIT technology. Other planned and ongoing implementation efforts include the development of report on EIT State-of-the-Art, production of educational video(s), drafting EIT System Qualification Specifications for the U.S., and the conduct of EIT demonstration projects and workshops to educate designers, Contractors and owners about the technology.

Multinational Relations. In FY 2020, safety-related examples consist of supporting the development and dissemination of the Road Safety Manual for the World Road Association. International infrastructure-related activities include supporting the development and dissemination of World Road Association products in the form of reports, guidelines, and other information tools, and capturing the U.S. perspectives on topics of interest to the international community.

Binational Relations. Additional international safety-related activities in FY 2020 include collaboration with Japan and Korea on bridge safety, and bridge and road safety, respectively, and U.S.-Mexico Border States regarding incident management and first-responder operations. The U.S. and Korea will also be collaborating regarding pedestrian safety, as will the U.S. and Sweden. Infrastructure related activities include exchanges with Korea on bridges, geotechnical topics, inspection techniques, infrastructure resiliency, and pavements, and collaboration with Japan on Intelligent Transportation Systems and bridge issues. The U.S. and the Netherlands will continue to address cooperative automated driving and infrastructure resiliency. Innovation will be supported in all these areas, including exchanges regarding with Korea (and possibly Japan) on Nondestructive Evaluation techniques. Workplans with other countries are being developed in FY 2020 as well. These topics and the information learned have applicability to rural, suburban and urban settings.

Anticipated Program Activities:
In support of the objectives listed above, the Policy Analysis and Global Outreach Program will undertake the following activities in FY21:

Impact of Investment on Conditions and Performance: Develop the 25th C&P Report and maintain the associated data systems including HERS and NBIAS. Also develop a strategy for a web-based interactive report.

Economic Impact Analysis: Develop the USAGE-Hwy v1.2 with additional updates in macroeconomic structure and engineering and economic model parameters. Assess the intertemporal and spatial distribution of land value appreciation attributable to highway investment. Evaluate the role of transportation investment in sectoral and geographic changes in the economy by improved freight movement and trade

Benefit-Cost Analysis: Conduct economic analysis in support of FHWA proposed changes to regulations. Support the DOT application of benefit-cost analysis in reviewing discretionary grant applications. Conduct exploratory research to improve the ability of benefit-cost analysis methods to reflect infrastructure resiliency. Model the Benefits and Costs of Priced Managed Lanes.

Costs and Funding Options: Produce National Highway Construction Cost Index (NHCCI). Develop framing paper on modeling strategies for reflecting demand response to tolled and priced lanes. Explore Implementation Strategies, Costs, and Impacts of a Potential National Mileage-Based User Fee. Validate UPDAPS to support FHWA pavement performance prediction needs. Update and enhance the highway revenue forecasting model (HRFM) by including state and local government highway revenues. Enhance NHCCI estimates (prepare seasonally adjusted and unadjusted estimates). Review and validate construction costs per lane-mile methodology and estimates for C&P & other uses. Exploratory research on user marginal costs of infrastructure analysis.

Emerging Trends and Future Demand: Monitor and analyze the policy implication of emerging trends and intermodal transportation. Lead Safety Data Initiative Rural Non-motorist study. Develop the Annual Emerging Trends Report. Develop quantitative analyses of emerging transportation factors shaping travel demand.

Geo-Economics of Multi-Modal Systems: Develop GEMS geotypes, modal, and travel behavior modules, including: 1) Develop a set of geo-types to represent the categorization of regions across nation based on based on density and travel patterns; 2) Develop cost curves for different modal options in different regions; 3) Develop a multi-modal decision support model and tool to analyze impact of different transportation policies, such as right-of way allocation, on transportation system performance within each geo-type including behavior response on how people choose between different modes.

Symposia, Strategic Planning & Policy Program Delivery: Lead quadrennial FHWA strategic plan development. Ensure policy research is high-quality, timely, and peer-reviewed. Summarize MBUF and AV study results and implications for future program delivery. Host transportation symposia to provide a formalized information resource for FHWA to gain insight and perspectives on key transportation policy questions in the context of emerging trends.

Global Benchmarking Program: Conduct GBP studies on Unmanned Aerial Systems for Road Infrastructure and Reducing Pedestrian Fatalities with Systematic Safety Strategies on Arterial Networks and conduct related follow-on implementation; initiate two new GBP studies on priority topics identified by FHWA leadership and conduct related follow-on implementation activities; and continue activities to implementation findings and recommendations from 2019 GBP studies on Building Information Modeling for Infrastructure and Electrically Isolated Tendon Technology for Bridges.

Multinational Program: Engage with the World Road Association (WRA), the European Union/European Commission (EU/EC), the Forum of European National Highway Research Laboratories (FEHRL), and, the International Transport Forum (ITF) as well as strategically targeted collaborations, such as the EC-USDOT Transportation Research Project Twinning Initiative.

Binational Program: Continue FHWA's prioritized binational engagements which cover topics such as pedestrian safety, cooperative automated driving, innovative financing, freight, infrastructure resilience, safety, bridges, binational planning and coordination, and pavement, among others. Binational Current and developing binational partnerships currently include: Japan, Korea, the Netherlands, Australia, Canada, Mexico, Sweden, Switzerland, Brazil, and Israel. Examples of activities include workshops, webinars, site visits, peer-to-peer exchanges, and Twinning research projects.

Key FY21 FHWA Policy Analysis and Global Outreach Program R&T Program Activities.

Activity	Period of Performance
Impact of Investment on Conditions and Performance	2019-2025
Economic Impact Analysis	2020-2022
Benefit-Cost Analysis	2018-2024
Costs and Funding Options	2018-2024
Emerging Trends and Future Demand	2019–2024
Geo-Economics of Multi-Modal Systems	2018-2023
Symposia, Strategic Planning & Policy Program Delivery	2019-2024
Global Benchmarking Program	2019-2024
Multinational Program	2016-2022
Binational Program	2018-2022

Expected Program Outcomes:
Impact of Investment on Conditions and Performance FY2021 research efforts will culminate in the production of the next edition of the C&P report. Software enhancements to the HERS model incorporating in FY2020 to include updated vehicle operating cost equations and enhanced modeling of delay will be used to generate a range of budget and policy analyses. Efforts to provide an interactive, web-based report, and to modernize the investment analysis models used (HERS and NBIAS), will be ongoing. A web-based interactive C&P report, modernized software coding, and cloud-based database/software platforms will bring FHWA closer to providing more transparency and improved accessibility of our investment forecasts, and the associated investment analysis methodology.

Expected accomplishments under the Economic Impact Analysis emphasis area include the completion of an updated USAGE-Hwy v1.2 model, which will have the capacity to better reflect US economy with more details after improvement in data and model parameters. Policy simulation scenarios, developed based on ongoing discussion, will provide decision makers with evidence on different aspects of economic impact. Users can compare

potential impacts from the various highway investment funding options and inform policy making process. The evaluation of economic impact and distribution of highway investment on land values will produce a database on land value change and a visualization tool that improves understanding of wider economic impacts and highway investment. An analytical framework will be established to quantify the impact of highway investment on land value. The research activity on the linkage between transportation investment and sectoral development will enhance our understanding on how highways promotes freight movement and trade, and how geography affect industrial development.

Achieving the planned results in the Benefit-Cost Analysis emphasis area will lead to delivering more consistent and methodologically sound regulatory and deregulatory analysis, better and more efficient discretionary grant reviews, while responding timely to the needs of the FHWA Office of the Chief Counsel, program offices, and the OST office. In addition, including resiliency in benefit cost analysis will provide better methods for investment decision-making and planning responses to natural and man-made threats. Research in the Costs and Funding Options emphasis area will evaluate potential costs and impacts of Mileage-Based User fee (MBUF) implementation options, including distributional, economic, financial, logistic, organizational and administrative structures, travel behavior and other user impacts. Work in the Costs and Funding Options emphasis area will also produce a more accurate measure of highway construction inflation via seasonally adjusted and unadjusted National Highway Construction Cost Index (NHCCI) estimates, more accurate and reliable estimates of cost per lane-mile matrix used in HERS model that are crucial inputs for forecasting investment requirements, state of the art pavement performance prediction models, and an improved highway revenue forecasting model incorporating all levels of government (i.e., federal, state and local government).

The Emerging Trends and Future Demand research emphasis area addresses the potential value, costs, and system performance implications emerging trends for future travel behavior and associated future system needs and performance. The impacts of this work provide risk assessments, forecasts, and policy considerations to inform decision making and strategic planning. Building off of previous research on rural access, this research program also explores issues pertaining to pedestrian safety and system access, with a focus on underserved communities; in particular, rural communities.

Geo-economic Multi-modal Systems research activities will help us move beyond 'rural' and 'urban dichotomies by identifying a limited number of transportation 'geo-types' reflecting differences in the underlying economics of transportation modes based on density and travel patterns. They also help us identify cost-effective alternatives to adding new lane miles to enhance system performance by modeling the potential for technological/modal options utilizing existing rights-of-way across geotypes and travel patterns. These activities will support our effort in evaluating the extent to which emerging modes and technologies are economic to supply in different geo-types, and the impact of policy options on modal/technology viability.

Strategic planning not only serves as a roadmap for FHWA, but also works to mitigate corporate risk at a higher level. The Transportation Policy Symposia series provides a

formalized information resource for FHWA to gain insight and perspectives on key transportation policy questions. Each symposium gathers leading policy experts to inform FHWA leadership and staff on current transportation issues, and provides resources FHWA to gain information and perspectives from experts on key policy topics. Another outcome goal for this area is develop a suite of tools to streamline publication and outreach plans for HPTS research products. These tools will help ensure our stakeholders are aware of and using the outcomes of our research.

Three main international program elements, Global Benchmarking, Multinational Relations, and Binational Relations facilitate the exchange of innovative ideas, best practices and technologies that can have a direct and practical impact on improving the U.S. highway system.

- The Global Benchmarking Program (GBP) provides a dedicated mechanism for obtaining and adapting proven foreign innovations that can help FHWA respond to challenges facing the U.S. highway system. The program connects FHWA and U.S. technical experts with transportation advances around the world and thereby helps avoid duplicative research, reduce overall costs and accelerate improvements to our transportation system. In FY 2021, the GBP will continue its mission of seeking and adapting foreign innovations that directly support DOT strategic goals. Specifically, the GBP plans to schedule two new studies on priority topics that will be identified by FHWA's leadership. Additionally, activities to initiate implementation of findings and recommendations from FY 2020 GBP studies will be completed.

- The FHWA's involvement in Multinational Relations spans a wide range of program and research activities that cover Department and Agency priorities. These relationships include global and regional organizations, such as the World Road Association (WRA), the Forum of European National Highway Research Laboratories, the European Union/European Commission, and the International Transport Forum. For FY 2021, the Multinational Relations Program will continue to support the FHWA Executive Director in the Strategic Planning Commission, Executive Committee's working groups tasked with implementation of Terms of Reference for the Technical Committees and Task Forces to be launched in the 2020-2023 cycle. Additionally, domestic dissemination of the technical work produced by state and federal government U.S. representatives to the World Road Association technical committees and task forces will continue. The products in the form of reports, guidelines, and other information tools, will capture the U.S. perspectives and are invaluable tools for the professional roads community worldwide.

- The Binational Relations Program promotes knowledge exchange by leveraging partnerships, and establishing and managing cooperative arrangements with other government agencies worldwide. These efforts help provide direction for U.S. collaboration on highway research and practice and broaden the depth of knowledge in given priority areas. These exchanges address: areas of national

significance that deliver a clear public benefit to the U.S., current or emerging needs as well as gaps in research and priorities of FHWA and the U.S. transportation community. It is anticipated that in FY 2021, the Binational Relations Program will continue FHWA's prioritized binational engagements to facilitate knowledge exchange that supports Departmental and Agency strategic goals, and US foreign and trade policy. Anticipated topics include pedestrian safety, cooperative automated driving, innovative financing, freight, infrastructure resilience, safety, bridges, and binational planning and coordination, among others.

Collaboration Partners:
FHWA policy staff regularly engage with key stakeholders in both formal and informal settings to gather input concerning challenges and opportunities that might be addressed through the program, as well as information on work undertaken by other organizations both nationally and internationally.

A key tool for gathering stakeholder input for domestic research are future policy symposia, a dialogue series that facilitates discussion with external experts and practitioners to frame future policy considerations and options. The information gathered via the symposia helps to broaden the relevance of future policy research and to avoid duplication with research being conducted by other entities. Input received via this mechanism are documented in summary reports.

Research collaboration is also undertaken through evaluations of proposed modeling improvements and interim research results by technical experts. For example, FHWA facilitated discussion of potential improvements to its HERS model by external users of the model.

Global Benchmarking Program.
The Global Benchmarking Program (GBP) focuses on identifying, evaluating, and adapting innovative foreign technologies and practices that have the potential to significantly improve highway transportation in the U.S. The program focuses on innovations that are transferable to the U.S. context and that have a high level of interest among partners and stakeholders (states, local government, private sector, U.S. roadway users). Recognizing the vital role of State DOTs in getting innovative solutions into practice, studies include the participation of up to two State DOT technical representatives. These individuals are selected by the American Association of State and Highway Transportation Officials and their participation is funded through the National Cooperative Highway Research Program. State DOT representatives are involved in the GBP desk study process to determine which countries and foreign experts to engage, virtual exchanges and technical site visits, development of the study report, and importantly, assisting with the implementation of key study findings. The FHWA also coordinates with relevant DOT partners on GBP studies. For example, FHWA coordinated with the Federal Aviation Administration on the current GBP study on *Unmanned Aerial Systems for Road Infrastructure.* Non-government groups (private sector associations) are indirectly involved with the program.

Multinational Relations Program.

FHWA leads and coordinates U.S. participation in the World Road Association (WRA), providing the head of the U.S. delegation—the First Delegate—to PIARC. FHWA appoints U.S. delegates to Technical Committees (TCs) and Task Forces and representatives to the World Road Congresses and International Winter Road Congresses. Designation of FHWA representatives to the TCs is made along FHWA program priorities. Partnerships include The American Association of State Highway and Transportation Officials, which has served as the U.S. National Committee to the WRA since 2011, and shares responsibility with FHWA for disseminating WRA products, organizing local activities, and supporting delegates' participation. In addition, TRB supports activities designed to strengthen participation in the Association by providing support to U.S. representatives in the WRA's Technical Committees, and by disseminating products of interest to the U.S.;

- Other regional partners include the Forum of European National Highway Research Laboratories-Other Multinational Relations which provides access to a large multi-national pooled fund program, with 29 national research laboratories;

- European Union/European Commission (EU/EC) - Participation in the EC-US DOT Twinning expands the breadth of learning, optimizes the use of mutual resources, and improves transportation outcomes in both regions.

- International Transport Forum – As the only global body that covers all transport modes, participation in the International Transportation Forum provides access to a unique pooled-fund model in support of departmental priorities.

<u>Binational Relations Program.</u>
Binational programs derive from USDOT and FHWA priorities. To the extent that public and stakeholder input has impacted the development of those priorities, their input has been utilized in the program development. International programs are developed with direct input from FHWA Leadership and program offices regarding both the topic areas and the countries with which to work, and Leadership and those program offices account for public input in providing recommendations to the Office of International Programs;

- Program partners including the following:

    - DOT Internal: Office of the Secretary of Transportation (multiple offices), Federal Motor Carrier Safety Administration, Federal Transit Administration, FHWA (Administrator's Office, all of the headquarters program offices, FHWA - Turner Fairbank Highway Research Center, FHWA- Office of the Chief Counsel, FHWA- Acquisitions, various FHWA Division offices, and FHWA- Resource Centers);

    - External: U.S. Department of State (HQ and Embassies), U.S. Department of Commerce, U.S. Trade and Development Agency, State DOTs, American Association of State Highway and Transportation Officials, academic institutions, occasional private sector partners (limited due to authorization

restrictions and the need to avoid the appearance of favoritism), foreign national ministries of transport, foreign provincial/state ministries of transport, foreign ministries of foreign affairs/embassies, the World Bank, the Inter-American Development Bank;

- On occasion, nongovernmental groups are part of the program, most often through industry associations or when State DOTs request their participation for a specific instance, all while focusing on U.S. priorities and the objectives of the agency.

Benefits of Partnership and Partner Contributions to FHWA Policy Analysis and Global Outreach Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard / Goal Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding	Stakeholder Advice	Education and Awareness
FHWA HQ	X	X				X	X	X	X		
FHWA - Field		X			X		X	X			
FTA	X	X				X	X	X			
NHTSA						X					
FAA	X	X				X	X	X			
OST	X	X				X	X		X		
BTS	X					X	X	X			
BLS	X					X		X			
Census	X					X	X	X			
Commerce Dept.	X	X			X		X	X	X		
State Dept.					X			X	X		
USTDA		X			X		X		X		
DOE	X					X	X	X			
EPA	X							X			
Other Federal Agencies	X	X					X				
State and Local Agencies	X	X			X	X	X	X	X		
AASHTO	X	X			X	X	X	X	X		
TRB	X	X				X	X	X	X		
NCHRP		X				X	X	X	X		
Academia	X	X			X	X	X	X			
Policy and Research Organizations	X	X				X	X				
Private Sector Entities	X	X			X	X	X	X	X		
World Road Association	X	X			X	X	X	X	X		
FEHRL	X	X			X	X	X	X	X		
EU/EC	X	X			X	X	X	X	X		

Partner Organization	User Perspective on Needs	Industry Perspective	Standard / Goal Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding	Stakeholder Advice	Education and Awareness
Interamerican Development Bank							X	X	X		
Foreign Ministries and Embassies						X	X	X	X		

Highway Data and Information
$5,725,160

Program Description:
The Highway Data and Information (HDI) program is a set of initiatives to collect, process, analyze, model, visualize and disseminate data and information by working with State, local transportation agencies, private businesses, and research communities through an active and advanced RD&T program.

The HDI program offers a national perspective on the state of our highway transportation system through coverages on:

- State, local and federal highway financing information;
- Vehicles (# of vehicles by vehicles types);
- Drivers (# of licensed drivers by age and gender);
- Fuel consumption (both gasoline and diesel);
- Travel condition (vehicle type, # of vehicles, vehicle speed, truck weights on the road by the hour of the day, day of the week, and month of the year);
- Travel migration (both passenger and truck travel origins destinations by travel purpose);
- Infrastructure condition (pavement condition and overall congestion);
- Infrastructure inventory (length by various dimensions);
- Future travel demand (projection); and
- Travel behavior (why, how, and when people travel).

The RD&T effort under the HDI program enables an efficient, effective, nationally consistent, and affordable data program by developing and deploying new methods, new approaches, new analytics, and new models for Federal, State and local governmental agencies and private businesses to adopt and use.

The HDI program directly supports policy and program activities and decision-making across the FHWA and the U.S. DOT. The HDI program offers data and information that enable the U.S. DOT to carry out the RD&T strategic goals covering Safety, Infrastructure, Innovation, and Accountability. The HDI program provides the foundation for the entire transportation community, which includes public entities, private businesses, and researchers for data and information. The HDI program also provides support to data providers at State DOTs and MPOs through policy and technical guidance.

Specifically, the RD&T effort enables the HDI program in 8 key data and tool areas as listed below:

- FHWA 500 Series Data consists of data related to: (a) fuel consumption (gasoline and special fuel), (b) licensed drivers, (c) registered vehicles, and (d) highway financing, including local, State and Federal spending, revenue, tolls, and bonds. These data serve as input to the various analyses used to inform and enable the Federal-aid highway program delivery.
- Policy Information Data Portal (PIDP) is the FHWA's application for collecting form-based data and information from its State agency partners and stakeholders. The application currently supports the agency's Transportation Performance Management (TPM) and Emergency Relief (E.R.) programs; and is currently being enhanced to support the 500 Series data program. The application will be further enhanced to support other programs in the future.
- Highway Performance Management System (HPMS) collects and processes highway inventory, traffic, and condition data, serving as the foundation for all Federal-Aid highway programs. The HPMS is the only publically available dataset characterizing the nations' highway infrastructure.
- Integrated Transportation Information Platform (ITIP) serves as the agency's data warehouse and offers a mechanism for integrated data analysis throughout the FHWA. Specifically, the application supports some of the agency's Federal-aid system condition and performance monitoring initiatives and various TPM implementation objectives.
- Data Visualization Center (DVC) activities benefit the entire FHWA through its data analysis and visualization expertise and products.
- Traffic Monitoring performs advanced research on traffic data collection and processing methods and technologies aiming for efficiency improvement, collects and disseminates consistent traffic volume, class, and weigh data for both motorized and nonmotorized vehicles, and provides technical guidance for the transportation community.

  National Household Travel Survey (NHTS) provides the only national-level demographic, behavior, and origin/destination transportation data for the entire transportation community through an effective data method research and deployment program. NHTS enables future demand analysis and a wide range of projects, programs, and policy analysis and evaluation.
- National Performance Dataset (NPD) covers both the National Performance Management Research Dataset (NPMRDS) and the Performance Vehicle Occupancy data on an annual basis. The NPD delivers travel time data for all NHS highways as

well as vehicle (truck, bus and POV) occupancy data for all states and urban areas, enabling transportation performance management for accountability and transparency. The annual NPD program enables trending analysis, detects new issues, increases data quality, and lowers the cost and the data reporting burden.

The RD&T effort enables the HDI program through the following strategies:

- Develop and deploy effective policy and technical guidance and provide hands-on training and coaching to states and local MPOs on data acquisition and analysis.
- Develop and deploy effective I.T. technology to process data collected by states.
- Explore new alternative methods, approaches, and strategies to acquire needed data in a cost-effective, quality-driven, and timely manner.

Program Objectives:
The goal of FHWA's HDI program is to serve the needs of national surface transportation data both within and outside of the U.S. DOT with quality and timeliness and enable the delivery of the Federal-aid highway program to state and local governments.

The HDI program provides the transportation community, the U.S. DOT, the Administration, and Congress, with quality information in a timely manner for the development and implementation of programs, policies, and legislation.

The HDI's RD&T effort strives to improve the efficiency and effectiveness of data collection and analysis on travelers and the physical, operational, and financial conditions of our highway transportation system.

Specifically, the HDI offers insight into (a) Safety strategy development in areas of human factors and behavior, (b) Infrastructure strategy covering areas of accelerated project delivery, risk-based asset management, and system resilience, (c) Economic competitiveness in areas of performance-based infrastructure investments, innovative freight practices, Transportation Systems Management and Operations (TSMO), (d) Innovation in areas of new models for access and the needs of rural America, and (e) Accountability strategies covering technology transfer, technology deployment, and data.

In addition, the HDI provides national leadership on transportation data through the development of national specifications and guidance with ongoing support and training for State data providers as well as internal and external customers. The program's research addresses weaknesses and gaps in relevant technologies, knowledge, and analyses due to a lack of capabilities and/or interest from private entities. The focus has been on integrating public and private data, new data method development and deployment, and efficient data analytics.

Anticipated Program Activities:
In support of the objectives listed above, the HDI R&T Program will undertake the following activities in FY21:

500 Series Data: Perform operations & maintenance (O&M) support for Fuels & FASH v3.5. Provide training/technical assistance to State agency partners on the collection, analysis and reporting of 500 Series data. Transition from State reporting of aggregate motor vehicle registration and licensed driver data, to bulk reporting of unaggregated VIN and license driver data. Develop methodologies for automating and streamlining data quality analysis and post-processing procedures. Update existing program guidance, and develop new program guidance and web-based training program for all program areas. Update existing and develop new Desk Guide documentation for all program areas.

Policy Information Data Portal (PIDP): Perform O&M support and enhancements for the Performance Measures Forum (PMF). Migrate existing 500 Series forms and analytical procedures from Fuels & FASH v3.5 to PIDP. Design, develop, test, and deploy new automated data quality analysis tools and post-processing procedures.

Highway Performance Monitoring System (HPMS) v8.0: Collect, analyze and release highway inventory, annualized traffic data, and pavement data through HPMS V8.0. Deliver a full set of data for Apportionment, C&P Report, Freight, Congestion, and TPM usages. Carry out National Data Quality Initiative through D.A.T.

Highway Performance Monitoring System (HPMS) v9.0: Finalize all functional requirement and start the phased development of V 9.0. Test V9.0 with real data submittal and processing. Pilot V9.0 with States. Develop and deploy user friendly GUIs. Develop and deploy standard data outputs for ITIP and other applications.

Integrated Transportation Information Platform (ITIP): Maintain ITIP V 1.0 to ensure its continued operation. Develop functional requirements for V2 to take advantages of more robust data analytics (e.g., INFORMATICA). Deploy all new functionalities in V2. Develop and deploy effective GUIs to link all components efficiently, enabling effective analysis. Deliver trainings to all FHWA Division offices on its usage and application.

Data Visualization Center (DVC) 2.0: Continue the current services offered to the entire FHWA for effective data visualization and analysis.

National Performance Data: Improve data method and quality while reducing collection cost and reporting burden. Collect, process, analyze, and release the 2021 NPMRDS data covering all NHS roadways in partnership with all State DOTs and MPOs through improved and enhanced methods. Integrate the 2021 NPMRDS data with 2020 HPMS data, enabling integrated analysis. Deploy the big data analytical method to derive 2021 Performance Vehicle Occupancy Data for all States and urban areas enabling transportation performance management. Develop and deliver a monthly Traffic Speed Trend report.

Traffic Monitoring and Traffic Data: Deploy big data analytics based on passive data for AADT data computation pending final conclusions in the 4th quarter of FY20. Collect and process monthly traffic volume data and generate the monthly Traffic Volume Trend (TVT) report enabled by the continuous maintaining and updating the IT Travel Monitoring Analysis System (TMAS) system. Develop a submodule within TMAS to handle "live pull" data. Pilot a pool funded technology deployment initiative on the subject of corridor traffic monitoring and origin destination identification. Update NHI Traffic Monitoring Guide (TMG) training course. Develop a crosswalk linking the FHWA 13 vehicle types to vehicles based on body type, cab, and overall vehicle length.

National Household Travel Survey (NHTS): Collect and process passenger and truck origin-destination (O.D.) data. Deliver national core behavior data answering why, how, and when people travel. Collect and process NHTS core 2021 data. Provide technical assistance to State DOTs and MPOs on the usage of NHTS data for information extraction and modeling usages. Execute appropriate agreements with State DOTs and MPOs for data gathering and cost sharing. Compile State. local, and other data related to bicycle exposure.

Key FY21 FHWA HDI R&T Program Activities.

Activity	Period of Performance
500 Series Data	2019-2022
Policy Information Data Portal (PIDP)	2019-2022
Highway Performance Monitoring System (HPMS) v8.0	2019-2022
Highway Performance Monitoring System (HPMS) v9.0	2019-2023
Integrated Transportation Information Platform (ITIP)	2019-2023
Data Visualization Center (DVC) 2.0	2019–2023
National Performance Data	2018–2023
Traffic Monitoring and Traffic Data	2019-2023
National Household Travel Survey (NHTS)	2020-2024

Expected Program Outcomes:
Anticipated accomplishments in FY21 are listed below.

The 500 Series Data program research initiatives will enable better quality, consistency, and prompt submission of highway finance, motor fuel, licensed driver, and vehicle registration data through the: (1) development and implementation of new data collection tools and processes, (2) the automating and streamlining of data analysis, and post-processing procedures and workflows, (3) the development and dissemination of updated or new program guidance, and (4) the development and delivery of training and education to State and local agency partners on how their data are being used for safety, financial, economic, and research purposes, as well as impacts their agencies may experience in the attribution and allocation process due to poor quality and untimely data submission.

This initiative will also explore other ways the data can be used, and any additional licensed driver, finance and motor fuel, and vehicle data attributes needed to determine and trend safety concerns, emerging economic markets, and research needs.

The Policy Information Data Portal (PIDP) program research initiatives ensure that FHWA's application for collecting form-based data and information from its State and local agency partners and stakeholders continues to receive the required information technology (I.T.) application development and operations & maintenance (O&M) support. The application currently supports the agency's TPM and E.R. programs, and is currently being enhanced to support the 500 Series data program. The application will be further enhanced to support other programs in the future in the future. PIDP will continue to standardize data collection, post-processing, and review activities across programs areas, which will result in increased improvements and data timeliness, completeness, and quality.

The initial implementation of the PIDP focused solely on the deployment of the Performance Measures Forum (PMF) required for TPM implementation purposes. The successful deployment of the PMF validates the application's viability. In FY21, PIDP will begin developing and deploying a nexus sub-platform for the submittal of highway finance, motor fuel, licensed driver, and vehicle registration data by State and local agencies, which will result in reduced errors and duplications of effort in a more user-friendly environment. This effort will also provide contractual programmatic and analytic support to improve data quality, timeliness, and program efficiency.

The Highway Performance Monitoring System (HPMS) initiative will implement the results of the recent HPMS Reassessment effort. The HPMS Reassessment developed new approaches to decrease data provider burdens as related to data collection, submission, and management while providing more timely, complete, and accurate data for end-users.

This effort will (a) develop a system integration plan, (b) purchase needed commercial off the shelf (COTS) software, (c) deploy and configure existing and new software, and (d) enhance or improve the existing graphical user interface (GUI).

The Integrated Transportation Information Platform (ITIP) initiative will transform the existing server-based custom coded data warehouse into a cloud-based COTS solution with minimal custom coding. Initial testing determined this transformation to be cost-effective and likely to improve our ability to integrate, analyze, and disseminate data.

Additional software will supplement existing software and capabilities to ensure ITIP is positioned to serve FHWA's future data needs. This effort will also involve adding data linkages to other FHWA and U.S. DOT data systems and data sets.

The Data Visualization Center (DVC) will provide new visualization services using data from both the FHWA and others for effective communication. Future services will continue to be driven by user needs and are expected to include developing charts, maps, reports, dashboards, infographics, and timelines. The work on weekly FHWA and bi-weekly OST

Safety Data Initiative social media factoids will continue. Based on customer feedback, there continues to be a strong desire to use data to communicate effectively at FHWA.

The National Performance Dataset (NPD) program offers travel time and occupancy data to all state DOTs and MPOs, enabling performance-based infrastructure investments, innovative freight practices, and TSMO strategies. This program relies on private business in data gathering and compilation through big data analytics.

The program will deliver (a) 2021 NPMRDS data for all state agencies and MPOs for TPM usage b) year 2021 vehicle occupancy data for passenger, bus, and truck covering all states and urban areas, and c) national trends on travel reliability based on the NPMRDS data.

The Traffic Monitoring program performs research on methods to improve traffic data collection and integration to increase data quality, utilization, and timeliness. The program will focus on 1) piloting a corridor level vehicle tracing technology, enabling the identification of vehicle entry and exit zones such as states. The pilot will rely on a technology developed through the U.S. DOT Small Business Innovation Research program (SBIR) work. It is anticipated that a great number of states will participate in the research and deployment; 2) developing and deploying the vehicle weight computation tools where the public will have access to it; 3) continuing national speed performance analysis, VMT forecasting, and travel hour computation; 4) continuing TMAS operation ensuring timely production of the monthly national Traffic Volume Trend (TVT) and reports for each State; and 5) establishing a live data pool platform where traffic flow data can be pulled live from stations operated by States throughout the nation.

The National Household Travel Survey (NHTS) serves as the only source of national-level travel behavior data and is used extensively for demographic, behavior, and human factor analysis related to transportation program and project development. The NextGen NHTS's 2020 data cycle will deliver the first travel origin/destination data, enabling corridor, regional, and integrated national passenger and freight analysis. The FY21 will also focus on the core NHTS data on the behavior front. These core data will enable travel behavior trend change detection, the pro-active transportation program and project planning, and robust policy and program scenario analysis.

Collaboration Partners:

The HDI program staff regularly engage with key stakeholders in both formal and informal settings to gather input concerning challenges and opportunities that might be addressed through the program, as well as information on work undertaken by other organizations, both nationally and internationally.

Stakeholders include representatives of individual highway agencies (State DOTs), metropolitan planning organizations (MPOs), pertinent committees of the American Association of State Highway and Transportation Officials (AASHTO) and the Transportation Research Board (TRB), industry organizations, such as the American Trucking Associations, American Bus Association, and others, and private businesses, such

as GOOGLE, Inrix, Airsage, Streetlight, CitiLabs, Caliper, SAS, and Teralytics. The H&TD staff also partner with researchers from universities and other public and private entities.

Formal interactions with AASHTO, TRB, and industry organizations generally occur at regular intervals (at least annually, and as often as quarterly). Interactions with states and MPOs tend to be on a more frequent, but ad hoc, basis. Inputs obtained through these interactions are considered by program staff as they identify and formulate the research program and technology initiatives.
Program partners (both government and non-government), benefits derived from partnerships, and partner contributions are summarized in the table below.

500 Series Data – Licensed driver, finance and motor fuel, and vehicle data are currently collected and submitted by State and local public entities. The quality and timely submission are dependent on a strong partnership between FHWA and the States. The benefactors of this collaboration are the States themselves, the safety community, researchers, the insurance industry, and economic and policy decision-makers.

Policy Information Data Portal (PIDP) – The establishment of the PIDP is based on feedback from State agencies seeking a one-stop place for Federal data submittals. The portal development is led by the Policy Information office and supported by several other offices within FHWA. The eventual goal is to convert all data collection mechanisms to this platform.

HPMS 9.0 – Having completed the latest HPMS Reassessment, FHWA will develop HPMS 9.0 based on the Reassessment findings. The Reassessment effort involved a direct solicitation of stakeholder data needs and data collection and management capabilities, with the goal of achieving the highest quality data in a timely and complete manner without increasing the burden on the data providers.

ITIP 2.0 – ITIP 2.0's migration to the cloud will allow for increased data integration capabilities and better and more complete data analysis. It is envisioned that ITIP 2.0 will have a public-facing component making available integrated accepted data for use by the public. Currently, the public would need to make data requests from each of the system owners and find a way to combine the data on their own.

Historically, data has been collected and reported by State DOTs. In 2018, for the first time, private data was purchased for inclusion in HPMS. Purchasing the speed limit data on the NHS was not as straight forward or easy as anticipated, so future efforts are going to explore additional sources and methods for acquiring or collecting these data. This includes pursuing possible partnerships with the US Postal Service and federal agencies like the Census, U.S. Geological Survey, and the Federal Lands Management Agencies.

DVC 2.0 – The DVC 2.0 will provide new analytical and expanded visualization services to FHWA and others. Because of the DVC visualizations, FHWA has grown its capability and interest in analytical software. For example, the DVC just provided FHWA and others with

two days of hands-on training in Tableau. FHWA uses the DVC services to better communicate with stakeholders and the public through social media. State DOTs have been inspired by the DVC weekly social media output to create their visualization products to help them communicate with their stakeholders.

National Performance Data Program – All state highway agencies and MPOs are partners in improving data quality via different specifications. Interactions among partners are carried out through regularly scheduled quarterly webinars, where issues are addressed, and good practices are shared and promoted. In addition, the NPMRDS relies on knowledge and data that reside with private businesses. In this case, instead of collecting such data by FHWA or via state agencies, the FHWA gains such data from Inrix/The University of Maryland/Texas A&M Transportation Institute through a contract. Because of the engagement of private business and contract competition, the cost is reduced, data quality is improved, and data delivery is more timely.

Travel Monitoring Program – State highway agencies are great partners in the research development and deployment of travel monitoring. Virtually all traffic monitoring research and development projects receive State DOTs' financial support in addition to their technical expertise. Also, private equipment vendors and manufacturers have been eager to participate in FHWA's research program and share their products and technology to promote the traffic monitoring program.

National Household Travel Survey (NHTS) – The proposed NHTS core behavior data and origin-destination data method development and deployment program is an FHWA-led national data program. The following entities have committed to providing financial support to the Program: Metropolitan Washington COG, AAA Foundation for Traffic Safety, Arizona DOT, Georgia DOT, Michigan DOT, New York DOT, Ohio DOT, Oklahoma DOT, Oregon DOT, and Virginia DOT. The Atlanta Regional Council, Arkansas DOT, Rhode Island DOT, and Tennessee DOT have also expressed interest in joining the program.

Benefits of Partnership and Partner Contributions to FHWA HDI Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard / Goal Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding	Stakeholder Advice	Education and Awareness
Internal DOT Partners: NHTSA, FMCSA, FTA, BTS, Volpe, and OST	X		X		X		X		X		
Other Federal Partners: FMLAs, DOE, DOD, Census, and USGS	X		X		X		X		X		
Data-related AASHTO Committees	X		X		X						
State Departments of Revenue	X		X		X		X		X		
State Departments of Transportation	X		X		X		X		X		
State Motor Vehicle Administrations	X		X		X		X		X		
Metropolitan Planning Organizations	X		X		X						
National Laboratories		X	X				X				
Universities	X						X				
American Trucking Associations		X			X						
American Bus Association		X			X						
American Association of Retired Persons		X									
Association of Motor Vehicle Administrators		X									
Federation of Tax Administrators		X									
International Bridge, Tunnel and Turnpike Association		X									
Vendor Community		X					X				

Innovative Program Delivery

Every Day Counts

$5,778,500

Program Description:
The Every Day Counts (EDC) Program is a State- and Local-based program that identifies and rapidly deploys proven, yet underutilized innovations to enhance roadway safety, shorten the project delivery process, reduce roadway congestion, and integrate automation. In support of the four USDOT Strategic Goals, proven innovations promoted through EDC facilitate greater efficiency at the State and local levels saving lives and saving time, money, and resources that can be used to deliver more projects.

Program Objectives:
The objective of the program is for innovations that enhance safety, accelerate project delivery, improve mobility, and integrate automation to become incorporated into the State and local transportation agencies' business practices. The EDC program has made a significant positive impact in accelerating the deployment of innovations and in building a culture of innovation within the transportation community.

As FHWA engages with stakeholders to identify the innovations with the greatest potential to have transformative impact on transportation, the agency also targets the inclusion of innovations that support the USDOT R&DT Strategic Goals.

The current portfolio of innovations in EDC-5 directly support the strategic goals and the mission of the agency, and the four USDOT RD&T Strategic Goals. For example, the Safety Strategic Goal is reflected through the current Safe Transportation for Every Pedestrian (STEP) and Reducing Rural Roadway Departures initiatives; topics such as Unmanned Aerial Systems and Advanced Geotechnical Exploration Methods support the Infrastructure goals; while Project Bundling and Value Capture connect to the focus on Accountability.

Anticipated Program Activities:
The FY21 EDC Program will continue to support the deployment of EDC-5 innovations while supporting the roll-out of new EDC-6 initiatives. The Program will also continue to support education and awareness associated with EDC and continue to promote the program through communications and marketing.

Key FY21 EDC Program Activities.

Activity	Period of Performance
EDC-5 Innovation Deployment	Ongoing
Roll out of EDC-6 Initiatives	2021
EDC-6 Innovation Deployment	2021-2022
Development of educational aids to heighten awareness of EDC innovations to the emerging transportation workforce	Ongoing
Program Communications and Marketing	Ongoing

Expected Program Outcomes:
The EDC program essentially is an agency-wide T2 effort. The FHWA Center for Accelerating Innovation has program management responsibilities and facilitates the conversations with transportation leaders from across the country to discuss and identify opportunities implementing the innovations that best fit the needs of their respective State transportation program. FHWA Program Offices and the Resource Center provide subject matter expertise to support the implementation of the innovations (i.e., Deployment Teams).

Each of the Deployment Teams that support the innovations spotlighted in the EDC program develop implementation plans based on the desired level of adoption or implementation of each State. These plans include performance measures and metrics specific to each innovation. The EDC Coordinators within each FHWA Division Office monitor and track their respective states' progress in achieving their self-identified implementation goals, with this implementation being the primary program outcome.

For reference, the following table defines the innovation deployment stages referenced in the progress reports:

Innovation Implementation Stages

Not Implementing	The State is not using the innovation anywhere in the State and is not interested in pursuing the innovation.
Development Stage	The State is collecting guidance and best practices, building support with partners and stakeholders, and developing an implementation process.
Demonstration Stage	The State is testing and piloting the innovation.
Assessment Stage	The State is assessing the performance of and process for carrying out the innovation and making adjustments to prepare for full deployment.
Institutionalized	The State has adopted the innovation as a standard process or practice and uses it regularly on projects.

The State and local highway agencies who receive targeted technical assistance and training through the program are the primary beneficiaries of the EDC program. Other outputs include but aren't limited to supporting education materials, case studies, and other products developed through the other deployment programs which compliment EDC.

The EDC-5 Baseline Report summarizes each current innovation and documents the national implementation goals for each innovation, and a Progress Report covering the first six months of EDC-5 implementation activity is also available. These progress reports include short narratives describing accomplishments and achievements as reported by the States.

Collaboration Partners:
Every two years, FHWA issues a public Request for Information (RFI) to seek input and suggestions from State Transportation Departments, local governments, tribes, private industry and other stakeholders to identify a new collection of innovations to champion that merit accelerated deployment. FHWA refines the list of suggestions received to include the innovations with the greatest potential to have transformative impact on transportation, and engages with key transportation organizations to ensure the list of innovations is most reflective of stakeholder demand. After selecting the EDC innovations for each new round, FHWA convenes transportation leaders from across the country at regional summits to discuss and identify opportunities for implementing the innovations that best fit the needs of their respective State transportation programs. Following the summits, States and Locals finalize their selection of innovations, establish performance goals for the level of implementation and adoption over the upcoming two-year cycle, and begin to implement the innovations with the assistance of the technical teams established for each innovation.

Benefits of Partnership and Partner Contributions to FHWA EDC Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard / Goal Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding	Stakeholder Advice	Education and Awareness
American Association of State Highway Transportation Officials (AASHTO)	X	X		X	X					X	X
American Road & Transportation Builders Association (ARTBA)	X	X			X					X	X
American Society of Civil Engineers (ASCE)	X	X			X					X	X
American Public Works Association (APWA)	X	X		X	X					X	X
Associated General Contractors (AGC) of America	X	X			X					X	X
Association of Metropolitan Planning Organizations (AMPO)	X	X		X						X	X
National Association of County Engineers (NACE)	X	X		X	X					X	X
American Traffic Safety Services Association (ATSSA)	X	X		X	X					X	X
Institute of Transportation Engineers (ITE)	X	X			X					X	X
National LTAP Association (NLTAPA)	X	X		X	X					X	X
National Asphalt Pavement Association (NAPA)	X	X		X	X					X	X

Partner Organization	User Perspective on Needs	Industry Perspective	Standard / Goal Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding	Stakeholder Advice	Education and Awareness
The Portland Cement Association (PCA)	X	X		X	X					X	X
ITS America	X	X		X	X					X	X
Transportation Research Board (TRB)											X
Academic Institutions	X	X		X						X	X

State Transportation Innovation Council Incentive
$4,978,400

Program Description:
Key components to the success of innovation deployment programs such as EDC are the State- and Local-based approach and the State Transportation Innovation Council (STIC) concept. A STIC or other equivalent task force, committee or group brings together public and private transportation stakeholders to evaluate innovations and spearhead their deployment in each State. Each State operates its STIC based on its unique business needs and approaches to meeting those needs. The STIC puts the transportation community in each State in the driver's seat to comprehensively and strategically consider sources of innovation, select those innovations that best fit its unique program needs, and then quickly put those innovations into practice. A formalized council or group affirms a State's commitment to institutionalize innovations, ensuring innovation deployment will continue as a business practice for years to come—establishing a culture of innovation.

The FHWA STIC Incentive program provides resources to help foster a culture for innovation and make innovations standard practice in their States. Through the program, funding up to $100,000 per State per Federal fiscal year is made available to support or offset the costs of standardizing innovative practices in a State transportation agency or other public sector STIC stakeholder.

Program Objectives
The STIC Incentive Program provides resources to advance innovations into standard practices in a State transportation agency or other public-sector stakeholder and foster a culture of innovation. States with a strong culture of innovation leverage the resources of the transportation community within the state to get the appropriate innovations into practice quickly. The establishment of a well-organized STIC, defined processes and procedures, and engaged leadership serve as the foundation for fostering a culture of innovation within a state. The STIC structure is essential to ensure that innovation deployment remains a State-based initiative.

Each STIC has established a Charter to defines its mission, scope, membership, and administration (Template Charter available here).

To the extent that STICs pursue further adoption and standardization of EDC innovations previously identified, the STIC Incentive Program supports the USDOT Research Priorities through individual projects.

A summary of all STIC Incentive Projects to date is provided at:
https://www.fhwa.dot.gov/innovation/stic/incentive_project/

Anticipated Program Activities:
The FY21 STIC Incentive Program will continue to support project awards as well as Regional and National STIC network meetings and the STIC Excellence Awards Program.

Key FY21 STIC Program Activities.

Activity	Period of Performance
STIC Incentive project awards	Ongoing
Regional and National STIC Network Meeting(s)	2020-2021
2021 STIC Excellence Awards Program	2020-2021

Expected Program Outcomes:
Each STIC self-defines the outcome being sought through the implementation of the innovations and monitors performance to ensure those outcomes are met. By setting goals, the STIC communicates the expected outcome and results from innovation deployment and encourages successful implementation.

A summary of output (STIC Incentive Projects) is maintained on the Center for Accelerating Innovations public website: https://www.fhwa.dot.gov/innovation/stic/incentive_project/

The STIC Incentive program's outputs include but aren't limited to:

- Standards, specifications, operating procedures;
- Job aids and similar technical resources;
- Training and education materials (webinars, workshops, etc.); and
- Peer-to-peer information exchanges.

Collaboration Partners:
Each STIC is comprised of a diverse membership; the broader the diversity of the transportation industry represented on the STIC, the greater the opportunity to be comprehensive in performing the actions noted above. In particular, FHWA continues to encourage the participation of the academic/research community in the STIC to build linkages between transportation research and practice.

The STIC membership typically includes the following:

- State DOT
- Federal Highway Administration (FHWA)
- Local Technical Assistance Program (LTAP)
- Local Public Agencies (LPAs)
- Industry Associations (APWA, NACE, NACO, etc…)
- Tribal representation (if applicable)

- Research liaison or Research Advisory Committee (RAC)
- Metropolitan Planning Organizations (MPOs)
- Contractors
- Consultants
- Federal Resource Agency
- University Transportation Center (if applicable)

Benefits of Partnership and Partner Contributions to FHWA STIC Program.

Partner Organization	**User Perspective on Needs**	**Industry Perspective**	**Standard / Goal Setting**	**Field Trials**	**Deployment**	**Research Collaboration**	**Specialized Expertise or Capabilities**	**Donation of Material or Services**	**Funding**	**Stakeholder Advice**	**Education and Awareness**
State DOT	X					X					X
Federal Highway Administration (FHWA)	X										X
Local Technical Assistance Program (LTAP)	X					X					X
Local Public Agencies (LPAs)	X					X					
Industry Associations (APWA, NACE, NACO, etc…)	X					X					
Tribal representation (if applicable)	X					X					
Research liaison or Research Advisory Committee (RAC)	X					X					
Academic Institutions	X					X					
AASHTO Innovation Initiative											X

Accelerated Innovation Deployment
$5,778,500

Program Description:
The Accelerated Innovation Deployment (AID) Demonstration Program provides funding to State DOTs, federal land management agencies, tribal governments, metropolitan planning organizations, and local governments to offset the risks associated with the initial deployment of an innovation by that agency. Innovations funded by AID can come from EDC or other sources. Funds are available to cover the full cost of implementation of an innovation on a project, up to the maximum amount of $1 million per each individual award, in areas such as planning, financing, operations, pavements, structures, materials, environment, and construction.

The AID Demonstration Program provides funding to support the pilot/demonstration of innovations on projects by State DOT, federal land management agencies, tribal governments, metropolitan planning organizations, and local governments. Funding recipient reports on experiences and lessons learned from each innovation deployment are shared via the program web site to provide technology transfer.

Program Objectives:
The objective of the AID Demonstration program is to accelerate the deployment and adoption of proven innovative practices and technologies, and through enhanced technology transfer encourage a more widespread rate of adoption. FHWA established the AID Demonstration program to provide transportation agencies the resources to mitigate risks associated with first-time or early adoption of innovations on transportation projects. The AID Demonstration Program helps infrastructure owners overcome the conservative culture found within the transportation industry by offsetting some of the financial risks associated with first-time adoption of new technologies or practices.

The program supports and contributes to all DOT RD&T Critical Transportation Topics. The AID Demonstration Program contributes directly to highway safety, on a project-by-project basis, by providing resources to infrastructure owners to implement innovative safety projects that improve the safety of the traveling public. Numerous AID Demonstration grant awards have supported infrastructure related goals. These include projects incorporating Accelerated Bridge Construction technologies; the use of compacted concrete pavement, ultra-high-performance concrete, intelligent compaction, warm mix asphalt and e-Construction. The AID Demonstration Program directly contributes to the advancement of innovative technologies and practices by transportation agencies. AID Demonstration projects must pilot practices or technologies which the applicant has not yet used as conventional practice, but intends to implement and adopt as a significant improvement. Finally, a number of AID Demonstration Program awards have supported the advancement of greater efficiency and effectiveness within transportation programs, including the implementation of Business Process Management systems and "Practical Solutions" strategies.

A summary of all AID Demonstration projects to date is provided at: https://www.fhwa.dot.gov/innovation/grants/projects/

Anticipated Program Activities:
The FY21 AID Demonstration Program will issue a new Notice of Funding Opportunity (NOFO) while closing out the activities associated with the FY20 NOFO. The program will make awards based on the proposals received through the NOFO process.

Key FY21 AID Demonstration Program Activities.

Activity	Period of Performance
Issue a new Notice of Funding Opportunity (NOFO) to enable continuation of program in FY 2021; current NOFO runs through the end of FY 2020	2021
Award the maximum number of grants commensurate with the available funding	Ongoing

Expected Program Outcomes:
The key output and performance indicator of the AID Demonstration program is the award of project grants. FHWA constantly monitors the progress towards awarding grants in accordance with the funding available. This information is available at https://www.fhwa.dot.gov/innovation/grants/projects/ Trend data such as the rate of grant awards over the life of the program is also available at this site.

The target for the AID Demonstration Program for FY 2021 will be to award the maximum number of grants commensurate with the available funding. The key outcome goal of the program is a completed project report (See above link) which documents the impact the innovation had on the delivery of the overall transportation project. Other program outputs include but aren't limited to:

- Completed project reports, required as part of the grant award;
- Performance metrics for the innovation implemented on awarded projects;
- Proposed standard operating procedures based on successful project completion and lessons learned;
- Proposed standards and specifications (or proposed revisions to existing standards and specifications) for consideration by AASHTO and/or other standard setting organizations;
- New and/or updated technical guidance;
- Product/project demonstration showcases;
- Training and education materials (webinars, workshops, etc.); and

- Marketing materials.

Collaboration Partners:
State DOTs, federal land management agencies, tribal governments, metropolitan planning organizations, and local governments submit applications for funding to support deployment of innovations on projects of their choosing. Depending on the nature of the individual AID Demonstration projects, consultants and contractors are engaged through their services provided (e.g., design, construction, inspection, operations, etc.).

Benefits of Partnership and Partner Contributions to FHWA Aid Demonstration Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard / Goal Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding	Stakeholder Advice	Education and Awareness
State DOT				X	X	X					
Federal Land Management Agencies				X	X	X					
Tribal Governments				X	X	X					
Metropolitan Planning Organizations				X	X	X					
Local governments				X	X	X					

Accelerating Market Readiness
$2,222,500

Program Description:
The Accelerating Market Readiness (AMR) program supports promising innovations that have the potential to be considered for accelerated deployment. The AMR program provides resources for the rapid, national assessment of emerging innovations and for the development of objective, written documentation of these assessments. The AMR Program is intended to help advance the innovations to a more complete market-ready status, which in turn should accelerate the adoption of the innovations by transportation agencies under the EDC Program or by other initiatives.

The AMR Program is intended to address longstanding challenges that exist in the transportation industry that impede the integration of new innovations into widespread practice. The initial "hand off" of innovative products from the research community to implementers, and the subsequent adoption of these products into practice, can take many years. Once in the domain of the implementers, the products may be piloted, and the results of the pilot documented, but the benefit data compiled is often limited at best and the dissemination of the findings has not traditionally occurred in a fashion that encourages wider piloting (and later adoption) of a product in the transportation community.

Program Objectives:
The AMR program is intended to stimulate and spur the advancement of emerging and transformative innovations in the transportation industry by matching these innovations to the transportation organizations interested in testing and evaluating them. The innovations to be supported by AMR program resources are those that:

- Significantly advance conventional practice;
- Address knowledge and technology gaps;
- Significantly advance the state-of-the-art; or
- Constitute a sea change in the development and delivery of transportation projects and programs.

The AMR Program supports the Department's Safety, Infrastructure and Innovation Strategic Goals, and contributes to all DOT RD&T Critical Transportation Topics. Examples of recent initiatives (from within FHWA) supported through AMR include the development of an in-situ scour testing device and the "Mobile Solution for Assessment and Reporting" (MSAR) app to support survey and inspection activities required with the FHWA Emergency Relief (ER) and Emergency Relief for Federally Owned Roads (ERFO) programs. FHWA prepared the first BAA for the AMR program to enable awards to support key U.S. Department of Transportation and FHWA goals in safety, accelerating project delivery, and infrastructure performance, and expects future BAAs to enable award to other topics that support departmental and agency level goals.

Anticipated Program Activities:
In FY21, the AMR Program will make project awards for the selected proposals from the first AMR Broad Agency Announcement (BAA). Additionally, a new BAA will be released for the next round of project selections.

Key FY21 AMR Program Activities.

Activity	Period of Performance
Initiate projects awarded under first AMR program Broad Agency Announcement	Ongoing
Issuance of Broad Agency Announcement for 2nd AMR project solicitation	2021

Expected Program Outcomes:
The key output and performance indicator of the AMR program is the award of project grants. FHWA constantly monitors the progress towards awarding grants in accordance with the funding available. This information is available at https://www.fhwa.dot.gov/innovation/grants/projects/

The key outcome goal of the program is a completed project report which objectively documents the performance of the emerging innovation or technology in a real-world transportation context. Other program outputs include but aren't limited to:

- New and/or updated technical guidance such as standard operating procedures or implementation aids to foster more market ready status for the innovation
- Product/project demonstration showcases;
- Training and education materials (webinars, workshops, etc.); and
- Marketing materials.

Collaboration Partners:
FHWA has used considerable stakeholder input in the development of the AMR Program as one that sources topics from the transportation community. The regional stakeholder summits held as part of the launch of the fourth cycle of the Every Day Counts Program featured a town hall session, where transportation leaders ---including representatives from the AASHTO Innovation Initiative (AII) and the National STIC Network---discussed how they made innovation part of the everyday operation of their organizations. To address the feedback received during the round table discussions, FHWA committed to working with its transportation partners to enhance ways for emerging innovations to be fairly evaluated and more rapidly accelerated into use in transportation programs and projects.

Benefits of Partnership and Partner Contributions for the FY21 AMR Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard / Goal Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding	Stakeholder Advice	Education and Awareness
AASHTO Innovation Initiative	X					X				X	
State Departments of Transportation	X			X		X				X	
Local and Tribal Transportation Agencies	X			X		X					
Institutions of Higher Education	X	X		X		X					
Transportation Industry/Private Sector	X	X		X		X					
National STIC Network	X	X				X				X	
FHWA Program Offices/Resource Center/TFHRC				X		X					

Innovative Program Delivery
$791,210

Program Description:
Innovative Program Delivery (IPD) provides tools, training and technical assistance that support the transportation community's use of cutting-edge financial and procurement strategies to deliver critical infrastructure projects. FHWA's efforts in this area are primarily led by the Center for Innovative Finance Support (CIFS), whose products are often marketed and delivered in coordination with the Secretary's Build America Bureau. These research and technology deployment efforts focus on revenue generation (tolling and value capture), procurement (public-private partnerships and other alternative contracting methods), and innovative finance (Federal project finance tools such as GARVEE Bonds and State Infrastructure Banks). Support for our partners include (1) technical resources, guidebooks and analytical tools, (2) capacity building and outreach, and (3) technical assistance for project implementation.

Program Objectives:
The IPD program begins with the recognition that public infrastructure resources at all levels of government are continually under stress, and thus demand effective project finance and delivery practices. These practices, in turn, must constantly evolve to exploit the opportunities of a dynamic economy. Given the sprawling number of public agencies in the United States, a potential "market failure" exists each time a project sponsor fails to look beyond its local environs for beneficial new practices. Federally-sponsored research and technology (R&T) deployment can open State and local jurisdictions to opportunities tested elsewhere by their peers. Specific objectives that require R&T support include:

- To increase consideration of innovative finance project revenue options, such as user fees and value capture, via research, training and technical assistance.
- To increase consideration of the P3 delivery option for major projects by providing the U.S. transportation community with the most complete, up-to-date body of knowledge on P3s.
- To support the accrual of P3 knowledge by industry practitioners and advisors in the areas of planning/evaluation, procurement, and monitoring/oversight.

Anticipated Program Activities:
- **State DOT P3 Program Offices**. Public policy research into potential organizational structures for newly-established P3 offices within State DOTs. This research would address the opportunity in section 133(b) of title 23, United States Code, which makes Surface Transportation Block Grant Program dollars available to fund a P3 office and pay stipends to private bidders seeking long-term concessions.
- **P3 Training**. Intensive training for public project sponsors on critical aspects of public-private partnerships (P3s), including life-cycle cost comparisons between alternative delivery methods (Value for Money analysis), model contract provisions

for long-term concession agreements, and best practices for competitive procurements. Delivered under auspices of the National Highway Institute (NHI), each course is based on material developed by the CIFS with R&T funding.

- **Value Capture Training**. Intensive training for public project sponsors on critical aspects of "value capture" techniques to help finance transportation projects via the incremental property value generated by the project itself. Value capture enables new local funding sources that, in turn, can attract new public or private investment.
- **Project Finance Training.** Training for state and local partners on the appropriate use of Federal project finance tools, with an emphasis on their early consideration during regional planning exercises.
- **Rural Projects/SIBs.** Project-specific assistance to public sponsors seeking access to TIFIA credit assistance for rural infrastructure projects. The CIFS will work with the Build America Bureau to prepare State Infrastructure Banks (SIBs) to identify, underwrite and service rural project loans capitalized with TIFIA loan proceeds.
- **Project Delivery Benchmarking.** This analysis, which the FAST Act requires the Build America Bureau to perform, will rely extensively on a database of major highway projects created under a CIFS initiative supported by R&T funds.
- **Center for Excellence in Project Finance (CEPF).** Financial and organizational support for a cooperative agreement to be awarded per a new competitive solicitation. The current CEPF, the BATIC Institute: An AASHTO Center for Excellence, offers a program of training, sharing of best practices, and technical assistance to all State Departments of Transportation and local partner agencies.

Key FY21 IPD Program Activities.

Activity	Period of Performance
State DOT P3 Program Offices	2021
P3 Training	2021
Value Capture Training	2021
Project Finance Training	2021
Rural Projects/SIBs	2021
Project Delivery Benchmarking	2021-2022
Center for Excellence in Project Finance (CEPF)	2021-2022

Expected Program Outcomes:
With its emphasis on applied research and ongoing deployment, the CIFS measures its program impact by monitoring innovative finance activities across the States. As one of its critical Performance Metrics, the FHWA has adopted the goal of seeing 20 States employ at one innovative finance tool during Fiscal Year 2021.

Collaboration Partners:
The relevance of the IPD program is a direct function of engagement with its stakeholders, the State and local public sponsors seeking the needed technical resources, capacity and information to deliver critical infrastructure. Whether in response to structured CIFS inquiries or via informal but frequent dialogue with FHWA, these practitioners largely shape the research and deployment agenda. This engagement is often facilitated by the network of FHWA Division Offices, which interact daily with public sponsors throughout the nation. The IPD program partners provide regular communication channels, again both formally and informally:

Benefits of Partnership and Partner Contributions to FHWA IPD Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard / Goal Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding	Stakeholder Advice	Education and Awareness
Office of the Secretary of Transportation: Build America Bureau					X	X	X				
Transportation Research Board (TRB), Revenue and Finance Committee	X	X				X	X				
American Association of State Highway & Transpo. Officials (AASHTO)	X				X	X	X				
American Road and Transportation Builders, P3 Division		X					X				
Association for the Improvement of American Infrastructure (AIAI-Infra)		X					X				
National Governors Association (NGA)	X				X		X				
National Council of State Legislatures (NCSL)	X				X		X				
Association of Metropolitan Planning Organizations (AMPO)	X				X		X				

Corporate

Research Infrastructure, Technology Transfer and Partnerships
$12,446,000

Program Description:
The FHWA Research Infrastructure, Technology Transfer, and Partnerships Program supports the goals of the USDOT Strategic Plan by supporting strategic investment in transportation infrastructure, safety, operations, planning, policy, and innovation development and deployment. The program monitors legislative developments, helps to coordinate the R&T budget allocation, maintains the Turner Fairbank Highway Research Center, organizes strategic Research and Technology (R&T) investment, and provides marketing and outreach. This Program's overarching role is to coordinate all elements that support and promote the USDOT Strategic Plan to ensure the FHWA R&T program invests in innovations that will result in fewer transportation-related deaths and serious injuries; infrastructure that supports mobility and economic competitiveness; innovation development and deployment; and reduced regulatory burden and greater efficiency. This FHWA R&T investment portfolio is stakeholder driven, with partners engaged throughout the entire innovation lifecycle process, from agenda setting and planning, through the research, technology development, and innovation deployment phases, to the implementation and assessment stages. The Research Infrastructure, Technology Transfer, and Partnerships Program supports these coordinated efforts across all other programs.

The Research Infrastructure, Technology Transfer, and Partnerships Program also coordinates activities and expenditures related to administration and facilities costs for the FHWA R&T Program (Administration and Facilities funds are shown as a separate funding line in the tables in Chapter 1). FHWA's Office of Research, Development, and Technology is located at the Turner Fairbank Highway Research Center (TFHRC), a federally owned and operated national research facility in McLean, Virginia. At the TFHRC, staff administers the majority of FHWA's research and development activities in the areas of infrastructure, operations, and safety. Research in areas of Intelligent Transportation Systems (ITS), policy, innovative finance, planning, and the environment is conducted or administered by FHWA offices located at USDOT Headquarters.

In addition to supporting R&T development and deployment activities, the Research Infrastructure, Technology Transfer, and Partnerships Program promotes communication, coordination, and collaboration with FHWA's partners, which are crucial to conducting the right research, doing it well, and delivering solutions when and where they are needed. Communication strategies address the needs of internal and external audiences and cover the depth and breadth of the federal effort for highway research and technology, displaying prudent use of government resources, advancing the state of the practice, and building a case for continued and future funding.

Finally, the Research Infrastructure, Technology Transfer, and Partnerships Program supports the FHWA Office of Technical Resources and the FHWA Resource Center's technology transfer activities. Through these programs, FHWA helps State and local agencies address technical and partnership hurdles by providing personalized technical assistance, customized training and ongoing support. FHWA develops and delivers training, technical assistance and technology deployment for transportation partners through the Research Infrastructure, Technology Transfer, and Partnerships Program.

Program Objectives:
The primary role of the Research Infrastructure, Technology Transfer, and Partnerships Program is to provide leadership, coordination, and support in the administration of the FHWA R&T program in support of the USDOT Strategic Goals. To accomplish this the Program will continue to foster and promote enhanced coordination of highway research among all stakeholders; communicate, publish, market, and disseminate research results to appropriate audiences; coordinate strategic resource allocation; and conduct R&T Program Evaluations.

Additionally, the Research Infrastructure, Technology Transfer, and Partnerships Program will maintain and support the operation of the TFHRC. The highway research and development relating to emerging highway technology that occurs at TFHRC is focused on addressing research gaps not addressed by FHWA's partners. TFHRC specifically focuses on long-term, high-risk research to improve the materials used in highway infrastructure; the development of tools and techniques that provide solutions to complex technical problems; and the development of innovative highway products and practices.

The Research Infrastructure, Technology Transfer, and Partnerships Program provides the following services to the overall R&T program:

- R&T Program Support and Administration:
    - Develop and execute the R&T program strategic direction, policies, and budget to further USDOT and FHWA initiatives.
    - Provide technical support to Congress and staff in the development and analysis of legislations and regulatory requirements impacting national research initiatives.
    - Identify and deliver communication and outreach strategies to engage transportation stakeholders in technology transfer and innovation delivery.
    - Manage the Transportation Pooled Fund Program which allows interested States, FHWA and other organizations to partner when interest is shown in solving transportation–related problems.

- Communications, Publishing, and Marketing:
    - The FHWA Research Library located at TFHRC preserves and maintains knowledge to support the research program.
        - Provides comprehensive topical searches to identify relevant literature, experts, and institutions, and to obtain bibliographic and electronic resources and materials to help inform the direction of research.

        - Helps employees find facts, statistics, and other specific information.
        - Provides detailed research and scanning to keep FHWA experts and managers current with the latest knowledge from various sources, including patent and prior art searches, and tracking new spin offs from a specific topic.

    - Promote marketing and communication activities for the TFHRC including participation in STEM Symposiums and FHWA's exhibition presence at the Transportation Research Board Annual Meeting.

- Publications, periodicals, and technical reports: Plans, edits, and prepares technical reports and documents for publishing in print or on the web, and publishes the award-winning Public Roads magazine, R&T Now newsletter, and other newsletters.

    - Develops outreach and social media materials and campaigns to communicate research results to State DOTs and other stakeholders.
    - Develops, manages, and maintains the TFHRC website, which provides public access to program policy, ongoing and completed research, laboratory information, and connects users to experts as well as invites visitors to tour the facility and laboratories.

- TFHRC Laboratory Capacity Building: Supports the technical and scientific needs of researchers, such as installing special hardware or software, maintaining scientific laboratory instruments, repair or replacement of research equipment resulting from failure or replacement of obsolete or end-of-service-life equipment, enhanced capabilities for existing laboratories.

- R&T Evaluation Program: The R&T Evaluation Program has been designed to further FHWA's transparency, accessibility, and responsiveness of R&T for stakeholders. The program conducts retrospective and program evaluations of selected FHWA research programs and projects. The impacts of deployed research and innovations are assessed, which then inform research planning and resource allocations

- Support domestic and international partnerships: The FHWA R&T Program works with State DOTs to identify and conduct critical research; coordinates with National highway research organizations on priorities and objectives; collaborates with international organizations by sharing best practices and research results that are transferable or adaptable to the American highway system.

- Knowledge Management: Supports more than 20 research and collaboration websites to address critical business topics by conducting day-to-day business and sharing knowledge within FHWA and with external partners including State DOTs and private organizations.

Anticipated Program Activities:
In FY21, the Research Infrastructure, Technology Transfer, and Partnerships Program will undertake a number of activities. These activities primarily focus on supporting technology transfer across the entirety of the FHWA R&T program; conducting program evaluations; providing marketing, communication, and publication services; maintaining critical corporate partnerships; and supporting the Tuner-Fairbank Highway Research Center.

Key FY21 Research Infrastructure, Technology Transfer, and Partnerships Program Activities.

Activity	Period of Performance
Support Technology Transfer of R&T Innovations	2018-2022
Invest in laboratory and research infrastructure improvements and maintenance	On-going
Conduct R&T Program Performance Evaluation	On-going
Provide Administrative support services for the R&T program	On-going
Provide marketing, promotional, social media, and strategic planning support.	On-going
Develop newsletters and periodicals and manage distribution	On-going
Develop technical communications, writing, and printing	On-going
Develop websites and provide maintenance	On-going
Support technical symposia and meetings (e.g. TRB Annual Meeting)	On-going
Provide library staffing and maintenance	On-going
Facilitate the Research and Technology Coordinating Committee (RTCC)	2019-2022
Manage TRB Core Program Services for a Highway Research, Development, and Technology Program	2020-2025
Conduct Site Visits with State DOTs and FHWA Division Offices to Identify Emerging Issues and to Promote New Innovations	On-going
Conduct Instructional Webinars and Participate in Peer Exchanges	On-going
Update FHWA R&T Agenda	2020-2021
Provide IT services and improvements	On-Going
Develop and deliver training, technical assistance and technology deployment for transportation partners	On-Going

Expected Program Outcomes:
The FHWA Research Infrastructure, Technology Transfer and Partnerships Program aims to deliver a variety of products and services that benefit the entirety of the FHWA RD&T program and advance the mission and goals of FHWA and USDOT. This program will facilitate information sharing with critical research partners by providing access to critical research publications, supporting marketing and communication efforts, and maintaining research databases that provide access to legacy materials and new research products. Additionally, this program will provide the necessary technical support and access to facilities for the FHWA RD&T staff to ensure that strategic and innovative solutions are being developed and deployed to the network of transportation partners. This includes

investing in core research infrastructure at the TFHRC to ensure that critical experimental and analytical tools are available to successfully achieve the objectives of the FHWA RD&T program. Development of new research capabilities allows FHWA to investigate and develop emerging technologies to the benefit of the nation's highway transportation system. Additionally, this program operates and maintains the FHWA Research Library, which provides technical research and publication resources to FHWA researchers. Finally, this program ensures that all research efforts are coordinated and communicated with FHWA's research partners, creating a market of research ideas that reduces duplication and strategically invests FHWA's research funds where they are needed most. This is accomplished by maintaining the strong legacy of research partnerships, including a cooperative agreement with the National Academy of Sciences' Transportation Research Board for technical services and support of the AASHTO's National Cooperative Highway Research Program (NCHRP). Additionally, this program manages the FHWA Transportation Pooled Fund program, which facilitates research investments across multiple State DOTs with common research goals.

Collaboration Partners:

Benefits of Partnership and Partner Contributions to FHWA Research Infrastructure, Technology Transfer and Partnerships Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard / Goal Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding	Stakeholder Advice	Education and Awareness
USDOT			X			X			X		
TRB	X	X	X		X	X	X				
AASHTO	X		X	X	X	X	X				
State DOTs	X			X	X	X	X		X		
University Transportation Centers				X		X	X				
FEHRL				X	X	X	X				

Small Business Innovation Research

Small Business Innovation Research
$1,778,000

Program Description:
The SBIR program is a highly competitive, awards-based program that encourages domestic small businesses to engage in research and development addressing high priority research areas within USDOT. The SBIR program favors research that has the potential for commercialization through products and applications sold to the private sector transportation industry, State DOTs, USDOT, or other federal agencies.

The program is administered by the Volpe Transportation Center. The SBIR Program Office publishes one or two solicitations each fiscal year for proposals on specific research topics of interest to USDOT operating administrations, including the FHWA.

Program Objectives:
To encourage small businesses to engage in research and development (R&D) that has the potential for commercialization and meets federal R&D objectives. The SBIR program is uniquely positioned to support both the interests of FHWA as well as the small business. In this respect, the SBIR programs aims to provide essential funding to small businesses with aim toward commercialization of products that align with FHWA and Departmental Strategic goals. Given that the SBIR program is available to all FHWA RD&T programs, all USDOT Strategic goals are supported as a result.

The SBIR program offers unique services to the small businesses to aid in their technical and commercial development. Specifically, the SBIR program offers a Commercialization Assistance Program to provide consulting services to the SBIR participants to help conduct market research, commercialization plans, and other services. In addition, in FY21 the FHWA SBIR program will continue with a Technology Readiness Level (TRL) assessment program to help the Small Businesses conduct an independent assessment of the technological status of the innovations developed through the SBIR program.

Anticipated Program Activities:
In FY21, the Small Business Innovation Research program will participate in the annual solicitation of topics and support current Phase I, II, and IIB projects. Additionally, the FHWA SBIR program will continue with the Technology Readiness Level (TRL) Assessments at the end of Phase II.

Key FY20 FHWA SBIR Program Activities

Activity	Period of Performance
Technology Readiness Level (TRL) Assessments	2021
Annual Solicitation of Topics	2021

Expected Program Outcomes:
FHWA aims to advance technologies and make problem-solving innovations available to the end user. FHWA will accomplish this by identifying the most promising new innovations, advancing Phase I and Phase II projects that have a clear path to commercialization, and focusing on market-driven needs. This creates a win-win-win opportunity for the Federal Government, the small business, and the traveling public. The Federal Government advances their strategic goals by investing in promising innovations; the small businesses benefit from the ability to pursue a good idea through Federal seed-funding and, if successful, the sale of their innovative products and solutions; and the public benefits from new innovations in the marketplace that enhance the travel experience.

Collaboration Partners:
The FHWA SBIR program is coordinated internally within USDOT and methods and practices are shared with other modes through the Volpe center, which administers the SBIR programs for USDOT.

Benefits of Partnership and Partner Contributions to FHWA SBIR Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard / Goal Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding	Stakeholder Advice	Education and Awareness
USDOT				X	X	X					

Exploratory Advanced Research

Exploratory Advanced Research
$4,213,860

Program Description:
The EAR Program is the only funding specifically addressing the need for longer-term, higher-risk research in highway transportation. Funding of exploratory advanced research has a direct impact on the supply of potential technologies and processes necessary for continued industry innovation to meet the challenges of improving the safety, operation, and resilience of the U.S. highway system for years to come. The EAR Program applies proven deliberative and open processes to engage experts within and outside the Department to identify potential research topics among new discoveries in science and technology that may address current and emerging needs of the highway transportation industry.

Program Objectives:
The EAR Program is scouting topics for possible FY 2021 investment across multiple areas of focus that support the Departmental RD&T Strategic Goal of innovation.
In the area of "connected systems," the EAR Program anticipates building on interagency coordination, for example with the NSF AI Institutes Program, to align and transition advances in fundamental science and engineering towards highway transportation practices.

In the areas of "material science" and "new technology for assessing performance," the EAR Program anticipates investment in machine learning approaches that can increase the performance of new pavements and extend the life of existing pavements and structures.
In the area of "human behavior," the EAR Program expects to continue investments in computer vision as a tool for safety and operations researchers and practitioners to exploit the growing amount of image data while preserving privacy. The EAR Program also is scouting new national scale modeling and forecasting methods to improve the efficiency and resilience of moving goods.

Anticipated Program Activities:
In FY21 the EAR Program will initiate new research efforts resulting from the broad agency announcement. Additionally, topics for the next broad agency announcement will be considered. The program will also continue to support the National Research Council (NRC) Research Associate program and engage with other Federal agencies through interagency agreements to collaborate on exploratory research topics.

Key FY21 EAR Program Activities.

Activity	Period of Performance
New research project starts acquired through a broad agency announcement	2021-2024
Supporting novel intramural research through placement of NRC Research Associates in FHWA	2021
Leveraging broader federal investments through interagency agreements	2021

Expected Program Outcomes:
The Exploratory Advanced Research Program transitions fundamental advances in science and engineering toward applications in highway transportation necessary for persistent or emerging needs. The Program conducts regular portfolio assessments to identify the most promising investments then provides supplemental support to transition the results within FHWA or to partners. Possible 2021 transition results include connected simulation as a new safe and cost-effective method for testing vehicle-pedestrian interactions and scaling of connected vehicle technologies.

Collaboration Partners:
The EAR Program regularly works with technical experts within the Department from BTS, FMCSA, FAA, FTA, ITS JPO, and NHTSA, from other government agencies, and the private sector. Activities include scoping activities, such as stakeholder workshops and scanning trips to meet with experts. In support of the Program portfolio activities include serving on technical review panels and technical working groups reviewing milestone achievements for ongoing EAR Program-funded research. As part of the transitioning results, activities include Technology Readiness Level assessment panels and demonstration workshops where stakeholders can gain a firsthand understanding. Coordination across modes enhances the opportunity for EAR Program-funded results to benefit multiple modes.

The EAR Program works with other government agencies. For example, the EAR Program and the NSF Cyber Physical Systems program signed a MOU in 2019 to coordinate on research such as artificial intelligence applications for surface transportation The EAR Program also has and anticipates continued coordination with Defense, Energy, NIST, and NASA laboratories in individual research projects of joint benefit through Interagency Agreements. Work with NSF has more than doubled the research funding focused on critical agency research priorities such as mobility. Work with other laboratories has leveraged expertise, research facilities, and funding for FHWA research priorities. The EAR Program also works with the private sector, which frequently provides resources – such as materials, salary costs, equipment, etc. – through cooperative agreements.

Benefits of Partnership and Partner Contributions to FHWA EAR Program

Partner Organization	User Perspective on Needs	Industry Perspective	Standard / Goal Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding	Stakeholder Advice	Education and Awareness
FMCSA, FTA, ITS JPO, NHTSA				X		X			X		
Defense Department						X					
Energy Department				X		X					
National Science Foundation						X			X		
National Institute of Standards and Technology, Commerce Department				X		X					
State Departments of Transportation				X		X					
Industry				X					X		

Advanced Transportation and Congestion Management Technologies Deployment
$34,671,000

Program Description:
The ATCMTD is statutorily required in the FAST Act Section 6004, 23 U.S.C. 503(c)(4). The ATCMTD grants are managed by FHWA and the ITS JPO contributes a mandated percentage of funding through FHWA to annually satisfy the requirement.

The language provided here duplicates the language provided in the ITS JPO AMRP for consistency.

The Advanced Transportation and Congestion Management Technologies Deployment Initiative (ATCMTD) Program is intended to provide funding for eligible entities to develop model deployment sites for large scale implementation and operation of a diverse set of technologies in various geographic regions. As the program is aimed at the rapid deployment of advanced technologies, limited expenditures for infrastructure construction is anticipated in grant application. The stated purpose is to reduce costs and increase return on investments; deliver environmental benefits through increased mobility; enhance transportation system operations; improve safety; improve collection and dissemination of real-time information; monitor transportation assets; deliver economic benefits; and accelerate deployment of connected and autonomous vehicle technologies. Successful proposals will contain quantifiable system performance objectives, use innovative technologies and strategies, and a plan for long term operation and maintenance of the deployed technologies. The U.S. Department of Transportation (DOT) encourages partnering among the private sector, public agencies, research institutions, technology leaders, and other transportation stakeholders.

Program Objectives:
The DOT's vision for the ATCMTD initiative is the deployment of advanced technologies and related strategies to address issues and challenges in safety, mobility, sustainability, economic vitality, and air quality that are confronted by transportation systems owners and operators. The advanced technologies are integrated into the routine functions of the location or jurisdiction, and play a critical role in helping agencies and the public address their challenges. Management systems within transportation and across other sectors (e.g., human services, energy, and logistics) share information and data to communicate among agencies and with the public. These management systems provide benefits by maximizing efficiencies based on the intelligent management of assets and the sharing of information using integrated technology solutions. USDOT shares the advanced technology solutions and the lessons learned from their deployment with other locations, scaled in scope and size, to increase successful deployments and provide widespread benefits to the public and agencies.

Anticipated Program Activities:
In FY21, the ATCMTD program will request proposals for new grant awards, complete the awards under the previous solicitation, and manage the existing grant awards. Additionally, the program will publish first ATCMTD annual report as mandated by the FAST Act.

Key FY21 ATCTMTD Program Activities.

Activity	Period of Performance
Selection of FY20 grant awards and timely implementation of projects.	2021
Continue award of FY19 grants and manage FY16-18 projects.	On-Going
Publish first ATCMTD annual report as mandated by the FAST Act.	On-Going

Expected Program Outcomes:
The ATCMTD Initiative will develop model deployment sites for large scale installation and operation of advanced transportation technologies to improve safety, efficiency, system performance, and infrastructure return on investment. Each ATCMTD project will consist of model technology deployments to help demonstrate how emerging transportation technologies, data, and their applications can be effectively deployed and integrated with existing systems to provide access to essential services and other destinations. This also includes efforts to increase connectivity to employment, education, services and other opportunities; support workforce development; or contribute to increased mobility, particularly for persons with visible and hidden disabilities and elderly individuals.

Collaboration Partners:
ATCMTD is not a research program, rather it is a discretionary grant program established in the FAST Act, however, public and stakeholder input is considered in the development of the annual Notice of Funding Opportunity (NOFO).

To be selected for an ATCMTD award, an applicant must be an eligible applicant. Eligible applicants are State or local governments, transit agencies, metropolitan planning organizations (MPO) representing a population of over 200,000, or other political subdivisions of a State or local government (such as publicly owned toll or port authorities), or a multijurisdictional group or consortia of research institutions or academic institutions. Partnership with the private sector or public agencies, including multimodal and multijurisdictional entities, research institutions, organizations representing transportation and technology leaders, or other transportation stakeholders, is encouraged.

Typically, a consortium is a meaningful arrangement with all members involved in planning the overall direction of the group's activities and participating in most aspects of the group; the consortium is a long-term relationship intended to last the full life of the

grant. Any application submitted by a sole research or academic institution and that is not part of a consortium will not be considered for selection.

DOT encourages partnerships with the private sector or public agencies, including multimodal and multijurisdictional entities, research institutions, organizations representing transportation and technology leaders, or other transportation stakeholders. Numerous ATCMTD awardees include non-governmental partners that traditionally have provided non-Federal matching funds in the form of technical services, hardware, and software.

Program partners (both government and non-government), benefits derived from partnerships, and partner contributions are summarized in in the table below.

Benefits of Partnership and Partner Contributions to FHWA ATCMTD Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard / Goal Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding	Stakeholder Advice	Education and Awareness
ATCMTD partners are the individual grant recipients (benefits of partnerships are identified in FAST Act Section 6004 and 23 U.S.C. 503(c)(4)). Benefits of partnership and partner contributions will be detailed in FAST Act-mandated Secretary's report, which is due May 2020.					X				X		

Surface Transportation System Funding Alternatives
$17,780,000

Program Description:
Fixing America's Surface Transportation (FAST) Act of 2015, Pub. L. No. 114-94, H.R. 22, § 6020, H.R. 22, 114th Cong. (2015) authorized the Secretary of Transportation to establish the Surface Transportation System Funding Alternatives (STSFA) program. The purpose of the STSFA program is to provide grants to States to demonstrate user-based alternative revenue mechanisms that utilize a user fee structure to maintain the long-term solvency of the Federal Highway Trust Fund. The FAST Act provides that $15 million in Fiscal Year (FY) 2016 and $20 million annually from FY 2017 through FY 2020 will be made available from the Highway Research and Development Program for grants for STSFA demonstration projects.[7] These grants shall make up no more than 50 percent of total proposed project costs, with the remainder coming from non-Federal sources. Other Federal funds using their appropriate matching share may be leveraged for the deployment but cannot be considered as part of the STSFA matching funds, which must come from non-Federal sources unless otherwise supported by statute. On August 1 of each year, if there are insufficient grant applications that meet program requirements, any excess funds must be transferred back to the Federal Highway Administration (FHWA) Highway Research and Development program.

The grants are only available to States; however, groups of States can form partnerships for regional or national proposals.[8] Section 6020 of the FAST Act authorizes the DOT to enter into agreements with State authorities to demonstrate user-based alternative revenue mechanisms. However, this solicitation requires that a State department of transportation (State DOT) serve as the lead agency for administering the program funding through the Federal-aid highway program. Another State agency or a State agency in a different State (if the project involves a group of States) may be responsible for providing day-to-day project oversight. It is expected that all relevant State agencies (e.g., Department of Motor Vehicles, Department of Revenue) needed to initiate a full-scale deployment of the proposed revenue mechanism will be actively involved in the planning and operation of the demonstration.

Program Objectives:
The program seeks to fund activities that meet the following goals:

- To test the design, acceptance, and implementation of user-based alternative revenue mechanisms.

[7] STSFA funds are subject to the overall Federal-aid obligation limitation. Therefore, the actual amount of STSFA funds available for grants in a fiscal year is reduced ("lopped off") based on the imposition of the limitation on obligations.
[8] Except where specifically indicated, the term "States" as used in this Notice will apply to both individual States and groups of States submitting a common proposal.

- To improve the functionality of such user-based alternative revenue mechanisms.
- To conduct outreach to increase public awareness regarding the need for alternative funding sources for surface transportation programs and to provide information on possible approaches.
- To provide recommendations regarding adoption and implementation of user-based alternative revenue mechanisms.
- To minimize the administrative cost of any potential user-based alternative revenue mechanisms.
- Minimize the administrative costs associated with the collection of fees.

The major focus of the program is in funding larger scale demonstrations projects, rather than smaller scale demonstration projects, and in awarding funds to both single State and multistate demonstrations.

Anticipated Program Activities:
In FY21, the STSFA program will continue to administer the grant program by releasing a new solicitation for proposals, finalizing awards under the previous solicitation, and continue to manage the existing awards. Furthermore, the program will explore the needs to conduct a national pilot of STSFA strategies and develop a framework that could be used for a pilot.

Key FY21 STSFA Program Activities.

Activity	Period of Performance
Administer and support the delivery of the STSFA grant program, evaluate program outcomes, and conduct outreach and technology transfer.	2021-2021
Conduct outreach to educate and inform State legislators about tools available to States interested in advancing STSFA strategies designed to provide alternate funding mechanisms to the gas tax for financing transportation infrastructure improvements.	2020-2021
Explore what would be needed to conduct a national pilot of STSFA strategies and develop a framework that could be used for a pilot.	2020-2021

Expected Program Outcomes:
This statutory program provides user perspective and experience with implementing an array of approaches to alternatively fund surface transportation infrastructure. Participating States serve as laboratories for lessons learned from which others across the nation can learn.

Collaboration Partners:
HOP staff works closely with FHWA Division Offices to provide technical support to States deploying STSFA demonstration projects. State transportation and revenue agencies are the program's primary stakeholders, so they are the target audience for most activities. FHWA staff from headquarters and the field offices work with partner organizations in a variety of ways, such as supporting the execution of demonstration projects, conducting webinars, workshops and roundtable discussions; developing written resources, providing technical assistance and support to assist with deployments. The Program office sponsored an in-person stakeholder meeting during the Transportation Research Board (TRB) Annual Meeting in January 2020. All of the project partners participated in the meeting and shared lessons learned from their pilots and identified challenges experienced in the process of implementing individual pilots. In the fall 2019, the FHWA STSFA Program Manager participated in Road User Charge (RUC) West technical meeting/Hawaii RUC Workshop where they kicked off the soft launch of their statewide pilot. Attendance included State representatives from Hawaii and a half dozen RUC pilot States
The STSFA Program Office sponsored an independent evaluation of State implemented pilots. So far six phases, one pilots have been evaluated and reports have been drafted. Additionally, the contractor prepared a cross cutting report that identifies commonalities across the project sites and lessons learned that could support a national pilot.

The Mileage Based User Fee Alliance (MBUFA) was formed in 2010. It is a national non-profit organization that brings together government, business, academic, and transportation policy leaders to conduct education and outreach on the potential for mileage-based user fees as an alternative for future funding and improved performance of the U.S. transportation system. MBUFA educates key federal policy-makers and the community at large on the importance of a sustainable funding mechanism for surface transportation through regular meetings and outreach by MBUFA members. Each pilot has a public outreach process. Some of the States that deployed pilots recruited State and local government officials as pilot participants. FHWA entered into a contract with MBUFA to have them conduct research on the public involvement approaches each State has launched. The final product will include a webinar to allow for information exchange between the State partners as well as a lesson learned guide that includes cross cutting issues that will provide guidance regarding the best approach to supporting a national outreach effort. The final report is currently under review.

The Office of Operations is collaborating with the Office of Policy to explore implementation strategies, costs and impacts of a potential national MBUF. It is seeking a team of experts to assist in executing this work in 2020-2022.

FHWA would like to collaborate with National Conference of State Legislatures staff to disseminate information about the pilots to increase awareness and understanding about road user charges.

Benefits of Partnership and Partner Contributions to FHWA STSFA Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard / Goal Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding	Stakeholder Advice	Education and Awareness
Transportation Research Board	X	X								X	
Industry Groups	X	X		X		X				X	

Chapter 3 – FY 2022 RD&T Programs

Infrastructure

Accelerated Implementation and Deployment of Pavement Technologies

Program Description:
In 2022, FHWA will continue to conduct an Accelerated Implementation and Deployment of Pavement Technologies (AIDPT) program that is closely coordinated with the Pavement & Materials R&D program. The program will continue to focus on demonstrating new technologies directly to States, highlighting the benefits to the user. Advancing tools to increase overall pavement durability and performance and reducing overall risk to owners will be a key goal. Providing education resources and training on fundamentals for pavement quality will also be addressed. FHWA will be focused on implementing best practices and tools for topics such as conducting life cycle assessments and implementing strategic preservation techniques and protocols for evaluating pavement foundation condition and designing inverted pavements. Exploration and deployment of best practices for pavement resiliency will also be a key activity in 2022.

Program Objectives:
In 2022, the AIDPT program will continue to directly support the strategic goals relating to Infrastructure and Innovation contained in the FY18-22 DOT Strategic plan. Specific contributions to the strategic goals and the key program objective to optimize pavement performance are as follows.

Infrastructure: The AIDPT Program supports the Life Cycle and Preventive Maintenance objective through continued efforts to accelerate implementation of pavement preservation and pavement management practices through implementation of new training courses, updated roadmaps, and demonstration projects. Additionally, the program will continue to advance material and design innovations to improve pavement durability. These efforts will provide increased education and awareness, technical assistance, and demonstration project opportunities to States Tangible outcomes are expected in 2022 and beyond.

Innovation: The AIDPT Program supports the Department's Innovation Goal by accelerating the deployment of innovative pavement technologies. Furthermore, by advancing performance-related specifications, the program opens the door to further innovation on the part of the construction contracting community. Other entities such as NCHRP, the National Center for Asphalt Testing, and several universities are conducting supporting research in this area. These efforts will provide National standards published for procedures, tests, and equipment as well as technical assistance to States. Anticipated activities and deliverables to further deploy targeted solutions for both asphalt and

concrete pavement overlays is planned to further improve and maintain the nation's pavement assets. Tangible outcomes are expected in 2022 and beyond.

Anticipated Program Activities:
In 2022, FHWA will continue to conduct an AIDPT program that is closely coordinated with the Pavement & Materials R&D program. It will continue to drive implementation of innovative pavement technologies, with a focus on improving pavement performance. It is anticipated that the program will focus on more demonstration initiatives, providing funds to States to advance key FHWA technologies under the AIDPT program.

Construction and Project Management

Program Description:
FHWA's Construction and Project Management R&T Program seeks to strategically advance innovative technologies and best practices to accelerate construction and improve quality and durability of as-constructed infrastructure. The program is aligned with and supports achievement of the Department's Infrastructure and Accountability Strategic Goals. The program's mission is to transform infrastructure project delivery to minimize the impact of construction on the public. In support of the Infrastructure Goal, the program contributes to improving the nation's infrastructure by improving system performance in support of the Nation's economy, as well as speeding up project delivery. It facilitates expanded infrastructure development, modernization, and construction in both rural and urban communities by fostering more efficient and collaborative advanced construction techniques and supports Economic Competitiveness by increasing foreign market access and opportunities for American businesses and services by engagement on international standards.

Program Objectives:
FHWA's Construction and Project Management R&T Program seeks to strategically advance innovative technologies and best practices to accelerate construction and improve quality and durability of as-constructed infrastructure. The program is aligned with and supports achievement of the Department's Infrastructure and Accountability Strategic Goals. In support of the Infrastructure Goal, the program contributes to improving the nation's infrastructure by improving system performance in support of the Nation's economy, as well as speeding up project delivery. It facilitates expanded infrastructure development, modernization, and construction in both rural and urban communities by fostering more efficient and collaborative advanced construction techniques and supports Economic Competitiveness by increasing foreign market access and opportunities for American businesses and services by engagement on international standards.

Anticipated Program Activities:
Key activities will be to advance digital project management and construction techniques to increase the efficiency of highway construction. By working with owner agency partners, FHWA's Construction and Project Management R&T Program will advance the integration of data throughout a project's life cycle from design to construction to operations and asset management. It will help foster the increased use of technology such as UAS that can enable greater efficiencies in the program while ensuring that federally supported programs are effectively managed.

Geotechnical and Hydraulics

Program Description:
The Geotechnical and Hydraulics Research and Technology (R&T) Program provides a coordinated and cohesive approach to research, development and technology activities to improve the geotechnical and hydraulic performance (safety, efficiency, durability, resiliency and cost-effectiveness) of the highway and transportation system.

Program Objectives:
The Program aligns with and supports the Department's Safety, Infrastructure, Innovation, and Accountability Strategic Goals. We anticipate that FY 2022 will continue to support such goals; for example, the Department's Innovation Goal through research and development in technologies and tools that provide more reliable and cost-effective project designs, and follow-on technology deployment initiatives to see that the resulting innovations are put into practice. However, the Program's forward thinking and flexible nature allows us to readily incorporate changing and additional research needs and directions.

Anticipated Program Activities:
In FY 2022, the FHWA Geotechnical and Hydraulics R&T Program anticipates continuing work in several areas, including development of design specifications and guidance addressing hydraulic issues such as highway drainage, hydroplaning risk assessment models using AI concepts, changes in rainfall and flood frequency, flow modeling for bridges and culverts, coastal highways impacted by extreme events, use of geosynthetics in pavements, assessment of corrosion for buried metallic foundations and elements, design and construction of mechanically stabilized earth walls, and geotechnical asset management. Deployment efforts will focus on implementing research and development results in these areas. New areas of investigation planned for pursuit in 2022 include development of real-time 3-dimensional automated scour simulation and prediction tools to monitor bridge scour during storm events, evaluation of the use of NDE technologies to assess the condition of in-service pavement foundations, and findings on the durability and strength-deformation characteristics of virgin and recycled backfills for retaining walls and pavement base courses.

Long-Term Infrastructure Performance

Program Description:
The Long-Term Infrastructure Performance (LTIP) Programs include the Long-Term Pavement Performance (LTPP) Program and the Long-Term Bridge Performance (LTBP) Program. These programs, conducted in close collaboration with the State DOT infrastructure owners, provide for characterization and monitoring of in-service highway pavement test sections (LTPP) and bridges (LTBP) to assemble the data needed to improve infrastructure design and advance the understanding of highway infrastructure performance required to effectively manage transportation assets. The collected data are disseminated to the public through web-based portals. FHWA's investment in obtaining and disseminating the data is leveraged by both public and private sector research organizations that apply the data to address a variety of infrastructure performance needs of local, State, regional, and national interest.

Program Objectives:
FHWA's LTIP Programs seek to advance understanding of how and why highway pavements and bridges perform as they do, knowledge that will enable the improved durability and extended infrastructure life as called for in the FAST Act. The LTIP research is central to FHWA's work to advance Risk-Based Asset Management within the State of Good Repair Topic under the Department's Infrastructure Goal.

Anticipated Program Activities:
In 2022 the LTIP programs will continue collection, processing and analysis of pavement and bridge data required to achieve Program objectives. The LTPP InfoPave and LTBP InfoBridge web portals will be updated with additional data to more fully document the long-term performance of the infrastructure under study. New analysis projects will be undertaken to develop bridge performance models and address to-be-selected objectives identified in an updated LTPP Data Analysis Plan.

Pavement and Materials

Program Description:
FHWA's Pavement and Materials RD&T Program provides a coordinated program to research, development and technology activities to improve the performance, sustainability, and assessment of the highway system. This is aligned with the Advanced Materials, Designs and Technologies objective within the State of Good Repair Topic Area.

Program Objectives:
The FY21 Pavement and Materials Research and Technology Program aligns and supports the USDOT RD&T Strategic Goals through the conduct of innovative research in pavement materials, design, evaluation, and management practices to enhance the performance for longer lasting, durable, and innovative pavements while shifting some of the risk and rewards for performance.

Anticipated Program Activities:
The FY2022 FHWA Pavement and Materials RD&T Program builds in part on previous achievements which enable more rapid and accurate testing of materials. The Program anticipates continuing work in several areas, including the application of artificial intelligence concepts as part of the overall development of specifications and guidance for material selection and mixture design of asphalt and concrete mixtures; the development of guidance for the use of local materials, and the development of methods to assess pavement structural capacity. New areas of investigation for FY2022 include the investigation of the use of premium and sustainable materials to enhance the life of overlays and preservation treatments, the application of NDE tools to assess pavement surface characteristics and underlying damage, the development of models for evaluating the impact of connected and autonomous vehicles on pavements, assessing pavement structural capacity, and evaluating material effects on concrete curling and warping.

Structures

Program Description:
The Structures Research and Technology (R&T) Program is a coordinated and cohesive program of research, development and technology activities focused on providing tools, technologies and guidance, and supporting updated policies, to improve the safety, structural integrity, longevity, construction processes and cost-effectiveness of highway bridges, tunnels and other structures. Consistent with the Department' State of Good Repair strategy, FHWA's FY 2022 Structures R&T Program will include work addressing Advanced Materials, Designs, and Technologies; Risk-Based Asset Management; Infrastructure System Resilience; Advanced Inspection Tools; and Effective Application of Best Practices.

Program Objectives:
FHWA's 2022 Structures R & T Program will continue to support the Department's Safety, Infrastructure and Innovation Strategic Goals. It will contribute directly to highway safety by providing tools, technologies, guidance and training to support infrastructure owners in ensuring that highway bridges, tunnels and other structures are designed, constructed, inspected, evaluated, and maintained to safely carry traffic loads and withstand the forces of nature. It will support the Life Cycle and Preventative Maintenance Objective by providing test methods, and guidance to support infrastructure owners in effective design, construction and management of highway bridges, tunnels and other structures. The program addresses the Department's Economic Competitiveness and Workforce objective through training to ensure that personnel responsible for bridge and tunnel inspection have the knowledge and skills required to effectively and efficiently carry out this vitally important responsibility. The Structures R&T Program contributes to Development of Innovation by undertaking research and to develop innovative solutions to highway structural engineering challenges. Ultimately, the resulting innovations will improve the state of the practice and result in resilient and adaptable systems to mitigate the impact of hurricanes, floods, and other extreme events on bridges and other structures. Additionally, the Program contributes to Deployment of Innovation through training and technology transfer initiatives.

Anticipated Program Activities:
In 2022, FHWA's structures R&D program will complete several projects initiated in 2021 and will initiate additional projects consistent with the Department's State of Good Repair strategy. Advancement in the use of robotics for bridge inspection will be facilitated. Refined prestressed girder shapes will be designed, geared toward the optimized use of ultra-high performance concrete in combination with large diameter pre-stressing strands. Novel bridge repair and rehabilitation solutions will be packaged for use by bridge maintenance teams across the country. Anticipated new starts in 2022 include development of detailing and construction guidance for stainless steel bridges, investigation of best practices for tunnel mechanical systems, and an assessment of bridge preservation treatment effectiveness through bridge condition rating analysis.

Transportation Performance Management and Asset Management

Program Description:
In 2022, FHWA's TPM and TAM R&T Program will continue as a coordinated and cohesive program of research, development and technology deployment activities focused on providing tools, innovations, technologies and on developing guidance and policies to advance the effective management of highway infrastructure and system performance.

Research development and deployment activities will include:

- Identification
- and advancement of specific strategies to enhance TPM and TAM;
- The
- improvement of management of the NHS for its whole life; and
- The
- development and deployment of TPM and AM training, technology transfer and support initiatives.

Program Objectives:
FHWA's TPM & AM R & T Program supports the efficient investment of Federal transportation funds across each of the four national transportation goals by:

- Ensuring
- that highway infrastructure condition supports achievement of safety performance targets;
- Ensuring
- that transportation agencies use sound asset management principles to optimize the condition of the highway system based on the resources invested, this is especially important as most, if not all States, will be submitting their second complete asset management plans in 2022;
- Providing
- tools and resources to further advance and support innovative techniques to manage infrastructure conditions; and
- Advancing
- new regulations that hold State's accountable to the achievement of performance targets while limiting federal oversight of program requirements.

This research plan aims to address gaps that exist today in the capability of highway agencies to use strategies that will increase their impact of their highway investments in providing for improved condition of their highway system over a life cycle. The development of addition technical resources, training, and sharing of best practices are intended to bridge this gap.

It is critical to invest in this research today as States are more and more challenged to acquire the funding needed to address their backlog of infrastructure condition investment

needs. They need tools and resources today to more effectively invest the limited funding they have for the greatest return possible.

FHWA is working in partnership with AASHTO in meeting research needs which have been documented in a research road map. Through this partnership FHWA has identified where it is most effective to conduct research at the federal level vs. other efforts primarily funded through TRB or through State SPR funds.

FHWA has made previous investments in TPM & AM related activities. These investments have made an impact in the advancement of sound practices to improve infrastructure management. Although previous investments have been made, this is a new and evolving aspect of the federal-aid highway program that is just becoming fully implemented. It will take several more years to understand and address gaps that need to be addressed at a federal level to improve infrastructure management.

The program is and will continue to produce tangible outcomes as implementation continues that address improved accountability and innovation to improve the condition and performance of our Nation's infrastructure and improved safety. For example, data quality has improving steadily over the past 3 years as a result of investments made to develop new tools, issue training, and advance best practices. It is expected that investment decision-making, performance modeling, and infrastructure conditions will improve as the products from these investments are fully realized.

Anticipated Program Activities:

It is anticipated that the 2022 TPM & AM R&T Program will be focused on supporting the development of next generation performance measures; the advancement of benefit cost and trade off analysis tools and methodologies; more comprehensive asset life-cycle planning and risk analysis with a greater focus on system resilience; data collection, management, analysis and integration best practices; identifying and using leading and lagging indicators to better predict and forecast condition and performance, and advancing state of the art data visualizing tools and methods to better communicate the national performance story.

Safety

Safety Program Delivery

Program Description:
The FHWA Office of Safety, Office of Safety Research and Development, and the Resource Center Safety and Design Technical Service Teams work alongside the safety specialists in the Division offices to provide national leadership on roadway safety. In particular, FHWA is working with States to help them design, operate, and maintain roadways that fully integrate a safe system approach.

A safe system aims to eliminate fatal and serious injuries for all road users. It is based on the principle that not a single death or serious injury is acceptable. It is human-centered, takes human fallibility and vulnerability into account, and relies on layers of protection being built into our roadway system, so if one layer fails another takes over.
This approach focuses our resources on activities that address the Nation's most critical safety challenges, and emphasizes our shared responsibility in meeting these challenges. Rather than aiming to just reduce the number of crashes, a safe system prioritizes addressing crashes that result in serious injuries or loss of life. Three critical areas are:

- Roadway departure
- Intersection crashes
- Pedestrian/bicycle crashes

Program Objective:
In 2022, FHWA will continue to conduct a coordinated Safety Program Delivery Program focused on providing guidance, policies, tools and technical assistance to improve safety. Through the HSIP and other efforts, FHWA will continue to encourage a data-driven, performance-based approach to save lives. Efforts in 2022 will build upon the 2021 activities and ensure alignment with the DOT and FHWA's strategic plans. The main goal of Safety Program Delivery Program is to reduce the number of motor vehicle fatalities and serious injuries on our nation's roads.

Anticipated Program Activities:
To achieve its objectives in FY 2022, FHWA's Safety Program Delivery will continue its focus on reducing highway-related fatalities and serious injuries on the Nation's roadways by continuing to:

- Implement FHWA Safety Programs' legislative requirements. Communicate the laws, regulations and funding eligibility for the HSIP (23 USC 148 and 23 CFR 924). Ensure oversight and stewardship for the HSIP. Work alongside modal partners to communicate the laws, regulations, policy guidance and funding eligibility and

provides stewardship for the statutory programs. Implement the safety-related planning regulations.

- Strengthen States' abilities to implement a safety program that is data driven by sharing information, training, and assistance, and provide national leadership to States and agencies as they design, operate, and maintain roadways that fully integrate Safe System principles. Provide technical assistance to stakeholders on data driven investments and the safe system approach. Assess 2020 State safety performance targets to determine which States met or made significant progress toward their safety targets. Support and educate the State Departments of Transportation, Metropolitan Planning Organizations, and other safety stakeholders on national safety goals, policies, and strategic plans.

- Advance the safety capacity building program to improve the technical capacity of transportation safety professionals at all levels of government. Support State and local agencies with the implementation of the HSIP by coordinating State or regional safety peer exchanges to ensure safety practitioners have current technical expertise. Provide technical assistance to help State and local agencies effectively manage and administer the HSIP, Strategic Highway Safety Plans (SHSPs), Safety Performance Management, High-Risk Rural Roads Program (HRRRP), and Railway-Highway Grade Crossing Safety Improvement Program (RHGCP), among others. Conduct marketing and outreach for capacity building products, trainings and other resources for practitioners and academia. Deliver capacity building programs for FHWA practitioners.

- Evaluate the results of FHWA Safety Program Delivery implementation efforts. Perform program assessments, prepare annual reports, evaluate safety products and tools to identify gaps in existing safety efforts and opportunities for enhancement. Identify enhancements to the HSIP online reporting tool to address user needs and requirements, ultimately yielding annual outputs and outcomes on the HSIP program. Develop the 2020 HSIP National Summary Report to determine the aggregate number and type of projects funded under the HSIP.

Safety Design and Operations

Program Description:
The Safety Design and Operations program encompasses core safety engineering work that overlaps traffic engineering, geometric roadway design, transportation planning, and system management and operations, and aims to help stakeholders reduce fatalities and serious injuries on all public roadways. The program focuses on three critical areas identified as providing the greatest potential to reduce highway fatalities using infrastructure-oriented improvements, as follows:

- Roadway departure
- Intersection crashes
- Pedestrian/bicycle crashes

Program Objective:
In 2022, FHWA will continue to research how to improve infrastructure to reduce fatalities and serious injuries and will continue to build our knowledge base of safety improvements and fill information gaps. Efforts in 2022 will build upon the 2021 activities and ensure alignment with the DOT and FHWA's strategic plans.

Anticipated Program Activities:
The Safety Design and Operations program is leading and collaborating a number of activities in the areas of traffic engineering, geometric roadway design, transportation planning, system management and operations, vulnerable road user safety, speed management, data driven safety analysis, and connected and automated vehicles. The program provides national leadership to agencies as they design and operate roadways in order to fully integrate the needs of all users, accommodate human error, and minimize injury severity. Activities under this program include the promotion of certain infrastructure-oriented safety treatments and strategies, chosen based on proven effectiveness and benefits, to encourage widespread implementation by State, tribal, and local transportation agencies to reduce serious injuries and fatalities on American highways.

Safety Data and Analysis

Program Description:
The Safety Data and Analysis program area focuses on the use of safety data to inform highway investment decision making through a systemic safety approach based on crash experience, crash potential, crash rate, or other data-supported means. The scope of the program includes research, development, and technology (RD&T) to improve State and local safety data systems commonly record crash, roadway inventory, and traffic volume data. The program enhances our State and local partners' capability to use safety data systems for analysis and evaluation supporting highway investment decision making to help ensure efficient and timely detection of critical safety hazards. The program also includes analyses supporting FHWA safety policy decision making, providing a foundation for systemic, performance-based approaches to improving safety.

Program Objectives:
Data-driven technologies and decision making is a key theme for all FHWA programs. This is especially true for Safety. The Safety Data and Analysis Program reflects this priority for supporting highway infrastructure investment decision making. The main goal of the program is to discover new ways to use data and analysis tools to save lives and improve the ability of road owners and operators to make science-based safety decisions. Efforts in 2022 will build upon the 2021 activities and ensure alignment with the DOT and FHWA's strategic plans.

Anticipated Program Activities:
It is anticipated that the program activities for 2022 will continue the five areas from 2021: *Research and develop new methodologies and tools***:** The Phase 1 proof of concept studies in the areas of safety, planning, and operations using the SHRP2 Safety data that proved feasible will conduct full-scale studies that will yield implementable results. Data collection sites and agreements will be in place to begin field implementation of the motorcycle countermeasures identified from the Motorcycle Crash Causation Study data analysis. STAC will continue to manage development of video analytics tools that can de-identify personally identifiable information (PII) and extract data elements from video. The program will continue to explore new analysis methodologies such as interrupted time series and novel data sets such as synthetic data like the realistic artificial data (RAD)

Increase the utilization of proven methodologies and tools: FHWA will conclude the IHSDM software development and the tool's future deployment plan. FHWA will initiate the transition of IHSDM ownership.

Broaden the integration of safety data and analysis into all processes: HSIS plans to initiate an evolution from traditional data tools to emerging tools that will leverage existing open-source tools and Web-based geospatial tools to allow users to interact with HSIS linked data, as well as disparate data sets.

Improve understanding of the benefits of safety data-driven decision making: Low-cost evaluations of countermeasures will focus on pedestrian and bicycle improvements at

intersections and other improvements based on the direction of our State and local partners

Advance safety data and evaluation as a means of supporting Transportation Performance Management: FHWA will begin fullscale alignment mapping of state collected roadway inventories to MIRE. FHWA will monitor the products of the USDOT Safety Data Initiative and assess items that can be further developed for use by State DOTs to evaluate their HSIP safety countermeasure effectiveness. Through training and technical assistance, States and local agencies will improve their roadway inventory and traffic volume data and its integration with crash data and other safety data system components.

Improve data collection: The data systems developed by States to collect, store and manage their roadway data are unique to each State. Creating a standardized data procedure for both collection and reporting will assist FHWA in creating a single nationwide geospatial dataset. Improved safety data collection will assist with advancing problem identification and program evaluation efforts.

Human Factors Analytics

Program Description/Activities/Objectives:
The purpose of the Human Factors Analytics program is to better understand human behavior and the relationship between roadway users, infrastructure, and vehicles. This program is responsive to the DOT Research, Development, and Technology deployment strategies for safety. Specifically, this program supports accelerating technology integration by studying the safe integration of people with emerging automated driving systems technology. This program also develops strategies for influencing driving behavior by studying driver interpretations of roadways.

Human Factor Analytics encompasses human factors research and related activities. Human factors studies consider how drivers, pedestrians, and special users' needs can be met through improved roadway designs, countermeasures, and technological innovations. HF research looks at how people respond to highly visible, easy to read signs, improved pavement markings, vehicle automation technology, innovative operational changes, and safer streets with improved walkability.

US crash report data identifies human error as a factor in approximately 94% of vehicle crashes (1). Human factors research is a cross-cutting field that routinely conducts both applied and more fundamental investigations for projects in areas such as traffic control device effectiveness, novel intersection designs, and pedestrian & bicyclist safety, to help reduce vehicle crashes resulting from human behavior and error. The Human Factors Analytics program includes the Highway Driving Simulator (HDS), two Field Research Vehicles, the Highway Sign Design and Research Lab (also known as the Sign Lab), the MiniSim™ driving simulator, and the Virtual Reality Lab, which includes a pedestrian and bike VR simulator.

Some key focus areas for the Human Factors Analytics Program are the following:

- Connected and Automated Vehicles (CAV)
- Traffic Control Devices
- Roadway User Behavior (including traveler information research)
- Roadway Design Evaluation (including alternative intersection and interchange evaluation research)
- Pedestrian, Bike, and Vulnerable Road User Research

Program Objectives:
The Human Factors Analytics program produces valuable research that promotes and improves the safety of our transportation system by gaining a better understanding of road users behavior. The program identifies the following objectives:

- Improve the effectiveness of safety countermeasures as well as tools that promote operational efficiency.

- Understand how connected and automated vehicles can be safety integrated into the Nation's roadway systems by evaluating the human behaviors related to the deployment of cooperative automation.
- Improve roadway designs that meet the needs of drivers, pedestrians and vulnerable users.
- Understand how people respond to the roadway environment, including signs and markings, emerging vehicle and roadway technology, innovative operational changes, safer streets with improved walkability, and other new roadside innovations.
- Identify how human factors for safety may guide safety programs and enable innovative approaches to improving safety.

The Human Factors Analytics program provides a range of research products and guidance that includes guidelines, experimental studies, and visualizations, that result in informed decision-making to help improve roadway design, evaluate safety countermeasures, and provide technology assessments to improve safety. Human Factors staff work regularly with other offices within FHWA, including the Office of Safety, the ITS Joint Program Office, the Office of Operations, and Operations R&D. As part of our research on connected and automated vehicles, we collaborate and receive funding from the ITS JPO to do a variety of human factors research to assess the safety and acceptability of automated vehicles. We collaborate with HRDO, on several truck platooning research efforts, including driving simulator-based and field-based research into the human factors issues related to truck platooning and its potential impacts on other road users. Other activities that we collaborate on include the development of Human Factors training, including a course based on the Human Factors Guidelines for Roadway Systems (NCHRP Report 600), as well as a condensed set of guidelines for rural users. The Human Factors Team also collaborates on a multi-year research effort that will inform the development of a guidelines document for the traffic management centers. The Human Factors Program also coordinates closely with the DOT Human Factors Coordinating Committee, a cross-agency working group, on a systematic view of human factors interactions with vehicle factors and roadway factors to deliver continued improvement to safer roadway design. In addition, the Human Factors staff participates in international coordination efforts on critical human factors vehicle automation issues, including EU Twinning activities, and with the US EU Japan Trilateral Human Factors Working Group.

Anticipated Program Activities:
The anticipated program activities for FY 2022 will be similar to the activities in FY 2021. The Human Factors Program will continue to lead a number of activities and collaborate in the areas of connected and automated vehicles, traffic control device design and evaluation, pedestrian and vulnerable road user safety, and enhancing and upgrading Human Factors Lab capabilities. Many of these activities focus on empirical research using human participants, that participate in studies in the Highway Driving Simulator, field research vehicles (FRVs), and sign laboratory. These studies provide valuable quantitative human

performance data, that provide a sound basis for developing safety and human factors guidelines and design recommendations for our different stakeholders. The work with help to promote better and safer TCDs and signing, increase pedestrian and bicyclist safety, and facilitate and accelerate the safe integration of emerging automated driving systems technology into our roadway system, in a manner that is safe and acceptable for all roadway users.

As part of our research on connected and automated vehicles and our collaboration with HRDO, the current driving simulator-based research into the human factors issues related to truck platooning and its potential impacts on other road users will be further studied using data from USDOT's Phase 2 Truck Platooning Early Deployment Assessment Field Operational Test. These additional analyses will investigate both the safety and operational impacts of truck platoons on other road users as well as safety impacts related to any changes in behavior of the truck drivers operating the platoons.

Operations

Transportation Systems Management and Operations

Program Description:
The U.S. has invested billions of dollars in building our existing transportation infrastructure. When these facilities are congested, the efficient movement of people and goods is disrupted, causing impacts to the economy and quality of life. Facilities need to be operated well so that we use them efficiently and effectively to maximize the value of these investments. The TSMO R&T Program helps State and local agencies, and other partners, do that.

Because of the need for alternatives to capacity projects -- due to limited resources, growing customer expectations, emergence of real-time decision support systems and on-demand mobility applications, and an emphasis on performance-based programs -- there is an increasing focus on TSMO in U.S. urban and rural areas. The need continues to grow for a transportation system that provides travel options for the effective movement of people and goods that will mitigate as congestion impacts on urban areas and allow for increasing freight transportation, especially with a growing awareness of the needs of underserved communities. As consumer technologies (smart phones, apps, GPS, etc.) progress, the traveling public expects that transportation agencies will find creative ways to apply these advances to improve their travel experience.

TSMO provides a range of strategies that can leverage technology, strategically address the unique issues of an area in a cost-effective manner, and optimize the use of existing and future infrastructure. TSMO has the potential to make significant improvements in safety, reduce congestion and fuel consumption, enable better management of the road network, expand mobility services to underserved communities, improve the convenience of travel, and stimulate the economy through improved freight movement. The activities proposed in this TSMO R&T Program continue critical research and deployment support to help State and local agency partners realize the true potential of TSMO by building a strong foundation for successful operations; applying data-driven operations decision-making; and effectively implementing operations strategies.

Program Objectives:
The TSMO R&T Program primarily supports the USDOT RD&T Strategic Goals of Infrastructure and Innovation by enabling efficient movement of people and goods across the transportation system using operational strategies and technologies. Many of these strategies and technologies are innovative and leverage emerging technologies, data sources, and public and private services. These efforts also support safety by smoothing traffic flow, mitigating disruptions, consistent motorist guidance and information about current conditions. This program also supports the innovation goal by exploring alternate funding mechanisms for transportation.
The objectives of the TSMO R&T Program are to:

- Equip State and Local transportation agencies to effectively manage and operate the transportation system to gain the most from their existing infrastructure and technology investments and enhance safety and mobility.
- Increase understanding of current system performance and the strategies that are available to address performance issues.
- Support agencies in their use of performance-based planning and programming, and analysis, modeling, and simulation tools, to use data-driven decision-making find the best solutions for their unique transportation problems.
- Support the development of strong agency organizational and workforce capabilities to plan for, deploy, and manage TSMO technologies and operational strategies and strengthen the key institutional underpinnings and linkages that are needed for effective TSMO.
- Provide mechanisms to assess and programmatically address emerging trends including multi-modal, mobility on demand, mobility as a service, and shared use mobility services and leverage emerging technologies and data.
- Ensure that the MUTCD is maintained and is updated in a timely manner to reflect current and forthcoming needs of practitioners and road users, and that it accommodates automated driving systems.
- The STSFA Program to develop and pilot test alternate funding mechanisms to the. gas tax for financing transportation infrastructure improvements

Anticipated Program Activities:

Foundation for Successful Operations

Continue the development of outreach and training materials and conduct targeted outreach and technology transfer to advance the state-of-the-practice and improve the capabilities of agencies for developing and delivering TSMO programs. Continue the implementation of the US DOT Mobility Data Business Plan by conducting bi-weekly workgroup meetings and quarterly stakeholder meetings, facilitating the development of regional mobility data business plans for states and local jurisdictions, and working with the FHWA Governance Group as an advisor to facilitate communications between the Business Plan and the Governance Group. Continue to support the advancement of TSMO through initiatives with the NOCoE and AASHTO on TSMO workforce development, strategy deployment, and preparing for emerging trends and technologies. Develop and convert workshops with stable content in mature TSMO program areas to long-term, self-sustaining online training courses.

Surface Transportation System Funding Alternatives (STSFA) Program

Continuation of previous outreach efforts including broad dissemination of State pilot implantation results.

Data-Driven Operations Decision-Making

Follow on to Influence of Operations Strategy on PM3 Measures to cover non-recurring strategies and implement outreach activities. Continue the enhancement of tools and decision support systems for operational/tactical and executive/organizational TSMO decisions by adding functionality for emerging technologies. Continue the development and dissemination of resources to enable holistic analyses of operational improvement benefits at system, network, and facility levels. Continue Providing technical assistance to advance the practice on data analytics/business intelligence.

Implementing Operations Strategies

Continue the development of a coordinated and collaboration plan and provide knowledge and technology transfer, consistent messaging, team playbook, and briefing decks for the Innovative Operations Strategies Team. Continue support and manage the High Occupancy Vehicle (HOV)/Managed Lane and TMC Pooled Fund Studies to advance the state-of-the-practice. Continue the development of capabilities, tools, and guidance to enable more proactive, dynamic, integrated and performance-driven management and operations. Continue research and document best practices and conduct targeted outreach and technology transfer to share early deployment lessons learned and to proactively advance the adoption of ATDM and ICM solutions and strategies.

Manual on Uniform Traffic Control Devices (MUTCD)

Continue development of Staff Reference Handbook; develop procedures and guidance to FHWA Divisions on reviewing and approving State MUTCDs, Supplements, and supplemental documents. Continue development of Transfigured MUTCD or Supplement for CAV. Complete closeout of official experiments that are no longer active, update and maintain the official rulings database.

Automation and Connectivity

Program Description:
The FHWA, in collaboration with the ITS Joint Program Office, other USDOT modes, State and local public agencies, Academia, industry, and other surface transportation stakeholders, will continue to conduct an Automation and Connectivity research program to address the challenges of integrating vehicles with Automated Driving Systems (ADS) with the road infrastructure system, and to take advantage of connectivity to improve the safety, efficiency, and equity of the highway transportation system.

Program Objectives:
Research in FY 2022 will build on prior year work to: develop capabilities and practices that support stakeholders move toward safe and effective operational readiness for ADS-Roadway integration; advance Analysis, Modeling, and Simulation (AMS) tools that are applicable to the operations of ADS-equipped vehicles in traffic; develop and test Cooperative Driving Automation (CDA) functions that support shared maneuvers by AVs in response to Transportation Systems Management and Operations (TSMO) use cases; and assess opportunities to revolutionize Traffic Management Systems (TMSs) through advances in computing (including but not limited to Artificial Intelligence (AI) and Machine Learning (ML)), communications, and automation. These efforts support USDOT RD&T Strategic Goals for Safety and Innovation through collaborative public/private efforts to stimulate and rapidly deploy innovation while ensuring that automation brings significant safety benefits.

Anticipated Program Activities:
ADS-Roadway Integration activities will include development of procedures and methodologies to measure and assess integrations readiness; study linkages between ADS-Roadway integration and new mobility alternative; facilitate incorporation of new operational paradigms into integration strategies, and develop procedures that will address how integration interoperability is obtained across different operational domains. Advance AMS capabilities through improved AV and CDA operations models and make them available to the modeling and microsimulation software development community. Facilitate incorporation of these models into commercial software to allow IOOs to make better decisions related to AV and CDA operations on their highways. Conduct modeling case studies of CDA operations on real road networks to communicate potential benefits to IOOs. Test and evaluate a subset of CARMA TSMO use cases using new CARMA HIL capabilities at the Turner-Fairbank Highway Research Center. Encourage the use of this open source HIL testing capability by the broader research community. Initiate development of further AMS HIL capabilities, as documented in the HIL roadmap. Introduce CDA to industry and begin to build a user community to develop innovative solutions using open source software (OSS). Support stakeholders through technology transfer and work force development activities. Demonstrate CDA through proof-of-concept testing of work zone, traffic incident management, weather and basic travel features, to include arterial and freeway use cases. Encourage user community to develop

and share results to accelerate adoption of CDA features aimed at system wide performance.

The Next Generation TMS activity will continue development of materials to create a "toolbox" for IOOs to plan for and manage the upgrade of TMSs to take advantage of new technologies and new sources of data. Initiate development of TMS-based algorithms that work in conjunction with CDA to improve traffic management strategies.

Managing Disruptions to Operations

Program Description:
In FY2022, several activities from FY2021 will continue and will need more funds to complete research, development, and deployment.

There will be continued engagement of stakeholders, training, and other outreach activities to better manage disruptions to operations and advance state-of-the-practice in the areas of work zone management (WZM), traffic and emergency management (TI&EM), and road weather management (RWM).

Road Weather Management: In FY2021, FHWA will continue to conduct a coordinated and cohesive Research and Technology Program focused on advancing RWM strategies, technologies and practices to minimize any adverse weather-related impacts on highway infrastructure and performance. This program will build on FY2020 activates by continuing to develop tools, guidelines and strategies that enable weather-responsive decision-making, analyze and use of weather data and connected vehicle (CV) technologies, develop effective messaging based on better understanding of traveler behavior, and apply performance management strategies based on consideration of resilience and large range changes in weather patterns. Ongoing maintenance and further development of the Weather Data Exchange will advance that platform as a foundational proof of concept for related activities under the Data Supporting Operations for Non-Recurring Events activity.

Traffic Incident & Event Management: In FY2021, FHWA will continue to conduct a coordinated and cohesive Research and Technology Program focused on advancing TI&EM strategies, safety, technologies and practices to minimize any adverse traffic incident and special events related impacts on highway infrastructure and performance. This program will build on FY2020 activates by continuing to enhance the capability and training of responders, develop tools and strategies based on better use of incident/crash data and other performance measures, benefit-cost analysis, and CV and integrated Computer Aided Dispatch, Unmanned Aircraft Systems and other technologies to enhance efficient incident mitigation and safety of responder and road users.

TI&EM program plans to start new activities to promote use of integrated sources in a big data approach to advance traffic incident management.

Work Zone Management: In FY2022, FHWA will continue to conduct a coordinated and cohesive Research and Technology Program focused on advancing WZM strategies, technologies and practices to minimize any adverse work zone related impacts on highway infrastructure and performance. This program will build on FY2020/21 activates by continuing to develop tools and strategies based on work zone safety and activity data, performance measures, safety countermeasures including use of positive protection, and planning/implementation of ITS and other CAV technologies.

Data Supporting Operations for Non-Recurring Events: In FY2022, FHWA will continue to integrate program-focused research initiatives from across the Office of Transportation Operations into a comprehensive strategy to address data management for non-recurring events. This effort will serve ongoing development and deployment of a national digital infrastructure that extends capabilities for transportation management leveraging emerging technologies and the results from recent research initiatives to address current and emerging use cases, and will inform broader TSMO efforts in providing a necessary specialized focus on non-recurring events.

Program Objectives:

- Understanding the operational impacts of these disruptions enables the development of predictive and real-time decision support systems that facilitate proactive operations and maintenance.
- Comprehending the opportunities that connected and automated vehicles present to better manage disruptive events (e.g., using connected vehicle data to track vehicles through work zones or using automated vehicle data to feed into block-level road weather forecasting), as well as to inform system owners of the actions they need to take to enable these vehicles to navigate through these difficult environments.
- Ensuring coordination across all the agencies that play a part in roadway safety and mobility (DOTs, law enforcement, fire, emergency medical services (EMS), etc.)
- Building the capability and capacity of operating agencies to optimize safety and system performance through the implementation of the capability maturity models for disruptive events.
- Be aware of the most effective messages to disseminate to the traveling public to educate and ultimately change driver behavior under these disruptive events.
- Provide necessary specialized expertise in Work Zone Management, Road Weather Management, Traffic and Incident Event Management to ensure proper integration of non-recurring events in digital infrastructure supporting advanced transportation management functions as well as Connected and Automated Vehicles (Safety/Automation, Innovation/Enabling Technologies, Accountability/Deployment, Accountability/Data)
- In cooperation with IOOs and other national partners, establish consensus for national requirements and framework for Data Supporting Operations for Non-Recurring Events to encourage private sector innovation and development of technology within the scope of that framework (Infrastructure/Economic Competitiveness)

Anticipated Program Activities:

- The Managing Disruptions on Operations Program will promote performance based approach to improving safety of non-recurring events (incidents, work zones, adverse weather conditions). Research will be conducted in areas of crash causation, analytical techniques, and mitigating strategies.
- The Managing Disruptions on Operations Program will address asset recycling in the Data Supporting Operations for Non-Recurring Events activity through integration of I2x technologies that register the presence of crucial infrastructure assets such as sensors, traffic control devices, or integrated mobile data collection units as resources that may be repurposed for multiple related applications, such the temporary utilization of a work zone Portable Changeable Message Sign by first responders to convey traffic control information during incidents near highway construction zones.
- The Managing Disruptions on Operations Program will address freight mobility by promoting the development of information resources that feed freight management functions including dispatch and routing that are reliant on current or predictive information on road conditions, such as informing on the presence of incidents/work zones or anticipated weather events that affect freight mobility.
- The Managing Disruptions on Operations Program will address cybersecurity concerns in deploying data resources and communication of data across various platforms through promotion of a framework that emphasizes the role of IOOs as system gatekeepers to ensure that data communicated through traveler information, I2V and V2V functions passes necessary quality checks and represents authoritative information on road conditions.

Freight Management and Operations

Program Description:
In 2022, FHWA will continue to conduct a coordinated and cohesive Freight Management and Operations Research, Development, and Technology (RD&T) Program to improve the physical components of the highway system that support goods movement, including roads, bridges, pavement, parking facilities, and other components. These objectives seek to better understand how freight movement impacts—and is impacted by—this infrastructure.

Planned 2022 Freight Management and Operations RD&T Program activities seek assess the condition and performance of key freight infrastructure, and to provide guidance that permits States and other stakeholders to incorporate freight infrastructure improvement projects into transportation program delivery. Overall, this Program aims to ensure safe, durable, and high performing infrastructure, identify solutions to mitigate or address the negative impacts of freight transportation, and research the resiliency of the freight transportation system.

As in 2021, activities will include developing data-driven tools that States/other stakeholders can use to better assess the operating condition, capacity, performance, and use of the freight transportation system. These activities will also address the need to develop strategies that assess the impact of freight movement, while helping stakeholders more effectively incorporate freight infrastructure considerations into transportation planning/project development, such as truck parking needs.

Program Objectives:
The Freight Management and Operations RD&T Program supports FAST Act NHFP-related goals and requirements and national policy on National Multimodal Freight Network condition, safety, security, efficiency, productivity, resiliency, and reliability. In addition, the Freight Management and Operations RD&T Program supports the following USDOT TD&T Strategic Goals.

Safety: The Freight Management and Operations RD&T Program seeks to improve the safety of the highway system that supports goods movement. These objectives seek to better understand safety issues of the highway system that support goods movement. The Freight Management and Operations RD&T Program will work with other USDOT modal agencies, such as MARAD, FRA, NHTSA, and FMCSA, and other stakeholders, such as the National Coalition on Truck Parking, and Transportation Research Board (TRB) to identify opportunities to investigate freight transportation safety. This program is particularly applicable to rural areas where the freight transportation network is more susceptible to weather or other disruptive events and alternate routes are less available to trucks.

Infrastructure: The Freight Management and Operations RD&T Program seeks to improve the physical components of the highway system that support goods movement, including roads, bridges, pavement, parking facilities, and other components. These objectives seek to better understand how freight movement impacts—and is impacted by—this infrastructure.

The Freight Management and Operations RD&T Program also seeks to assess the condition and performance of key freight infrastructure, and to provide resources that permits States and other stakeholders to incorporate freight infrastructure improvement projects into transportation program delivery. Objectives include ensuring safe, durable, and high performing infrastructure, as well as identify solutions to mitigate or address the impacts of freight transportation.

Innovation: The Freight Management and Operations RD&T Program seeks to improve the reliability of travel and freight movement on the Nation's transportation systems by working with State DOTs and other stakeholders to identify data sources and models to assess overall system reliability.

The Freight Management and Operations RD&T Program will also enhance freight data resources, such as the Freight Analysis Framework (FAF), which provide national level freight flows and projections critical to understanding the impact of freight movement on the transportation network.

Anticipated Program Activities:
The Freight Management and Operations RD&T Program seeks to improve the ability to measure current and future conditions and operation of the freight transportation network through the incorporation of more accurate, real-time, and localized freight data. These activities include improvements to:

- Data collection methodologies (e.g., data sharing collaboration with industry and dynamic freight data collection and analysis)
- Travel
- demand models (e.g., incorporating urban and rural freight movements and improvements to the accuracy and scale of the freight flows along the transportation network)
- Strategies
- to facilitate public-private sector data coordination and sharing (e.g., facilitating peer exchanges and stakeholder outreach)
- Freight
- -focused performance measures (e.g., incorporating reliability, economic impacts/costs, etc.)

The Freight Management and Operations RD&T Program seeks to improve the ability to measure current and future conditions and operation of the freight transportation network

through the incorporation of more accurate, real-time, and localized freight data. These activities include improvements to:

- Data collection methodologies (e.g., data sharing collaboration with industry and dynamic freight data collection and analysis)
- Travel demand models (e.g., incorporating urban and rural freight movements and improvements to the accuracy and scale of the freight flows along the transportation network)
- Strategies to facilitate public-private sector data coordination and sharing (e.g., facilitating peer exchanges and stakeholder outreach)
- Freight-focused performance measures (e.g., incorporating reliability, economic impacts/costs, etc.)

Other activities include:

- Coordinating and investigating truck parking issues
- Researching the resiliency of the freight transportation system through initiatives such as implementation of the recommendations of the USDOT Emergency Route Working Group.
- Coordinating with FHWA partners on safety and resiliency areas impacting freight, including FHWA Office of Transportation Operations Road Weather and Workzone Management Team, the FHWA Office of Infrastructure, the FHWA Office of Planning, and the FHWA Office of Safety.
- Communication and development of educational and professional development materials/events; noteworthy practices; and tools and technical assistance resources.

Truck Size and Weight

Program Description:
In 2022, FHWA will continue to conduct a coordinated and cohesive Truck Size and Weight Research, Development and Technology (RD&T) Program focused on providing other FHWA, other federal agencies, States and other stakeholders with information needed to create the safest and most efficient permitting and enforcement systems possible to ensure fluid freight movement across State borders. As in 2021, 2022 activities will include research on effective truck size and weight data use across States and supporting States in harmonizing oversize and overweight (OS/OW) permitting requirements. This Program will support FHWA's oversight efforts on State-enforced Federal size and weight truck/bus standards for travel on Interstate highways and the national network. TSW research will also examine the operations and safety of alternative truck configurations and oversize/overweight (OS/OW) vehicles.

FHWA 2022 activities will include implementing the highest priority elements of the CTSWL Research Plan. While these activities have not yet been determined, they would include research pertaining to the five topic areas identified in the 2016 Study. For example, activities could include development of enhanced bridge deterioration models that can account for impacts of alternative truck configurations; creation of more accurate models that States and others can use to identify impacts of heavy trucks on pavements; commodity analysis of truck types, and safety impact assessments.

Program Objectives:
Today, approximately 12 States require Pilot Car Certification. States use FHWA-developed guidelines, to support their certification requirements; however, these requirements vary from State to State. FHWA research in this program area will support harmonization among States on oversize/overweight State and local permits. The work outcome will improve safety on the national highways as well contribute to infrastructure preservation. Research activities will include research, review, and analysis of existing pilot/ escort vehicle operator (P/EVO) training materials and case studies and other information focused on the oversize loads movement.

There is a need for truck size and weight research specifically to assess raising weight limits or allowing longer combination trucks on national highways. Outside DOT, National Cooperative Highway Research Program (NCHRP) analyses have provided a foundation for this topic area. The Truck Size and Weight RD&T Program supports addressing these research and data gaps.

The Truck Size and Weight RD&T Program will provide States and other stakeholders with information needed to create the safest and most efficient permitting and enforcement systems possible to ensure fluid freight movement across State borders. Activities will include research on effective truck size and weight data use across States and supporting States in harmonizing OS/OW permitting requirements. Truck Size and Weight RD&T Program activities include producing resource on what information is needed for analysis

of freight vehicle size and weight and examining methods for inventorying and applying these data.

Truck Size and Weight RD&T Program efforts aim to better understand the impacts of alternative truck configurations on freight infrastructure, safety, and operations, through data collection and development of data-driven tools and analytical techniques. Additionally, there is an effort to identify key TSW-related research needs relating to pavement, bridge, mode shift, safety, and enforcement. The combination of these activities will lead to improved technical and implementation resources for stakeholder decision-making and analysis.

Anticipated Program Activities:
Key FY21 FHWA Truck Size and Weight RD&T Program Activities include those related to the Completion and Execution of FHWA Truck Size and Weight Research Implementation Plan and Analysis and Dissemination of Truck Size and Weight Data and Research.
A FHWA Truck Size and Weight Research Implementation Proposal is currently underway and expected to be completed in FY20. It is intended to aid in guiding specific resources towards TS&W research projects that are topically cross-cutting and impact multiple agencies and departments. The Truck Size and Weight RD&T Program seeks to implement the highest priority elements of this implementation proposal. While these activities have not yet been determined, they would include research pertaining to the topic areas identified in the 2018 TRB Truck Size and Weight Research Roadmap. For example, activities could include development of enhanced bridge deterioration models that can account for impacts of alternative truck configurations, development of more accurate models that States and others can use to identify impacts of heavy trucks on pavements, analysis of truck types, and safety impact assessments.

The Truck Size and Weight RD&T Program activities will include producing resources to determine needed information for freight vehicle size and weight analysis and examining methods for inventorying and applying these data. The Truck Size and Weight RD&T Program will work to provide States and other stakeholders with the knowledge needed to create the safest and most efficient systems possible to ensure fluid freight movement across State borders.

Environment and Planning

Accelerating Project Delivery

Program Description:
In FY22, the Accelerating Project Delivery research program will continue to help FHWA in expediting project delivery by improving environmental review and permitting processes to reduce regulatory timeframes and costs. This program will support improving the NEPA process and improve coordination and communication between Federal and State agencies, the public, and other stakeholders to create efficiencies in project review and development. This program supports accelerating project delivery through interagency collaboration, capacity building for environmental practitioners, integrating planning and environmental processes, and disseminating information about environmental program and process efficiencies.

Program Objectives:
The main objectives of the Accelerating Project Delivery program are to build tools and collaborate on studies to reduce regulatory burden and increase efficiencies in the environmental review process and real property acquisition process by innovating new ways to expedite project delivery. Examples of programs and tools that the Volpe Center will support in FY22 to accelerate project delivery include activities related to regulatory reform, rulemaking, guidance, PEL, programmatic approaches, NEPA assignment program support and audit support, "Eco-Logical: An Ecosystem Approach to Developing Infrastructure Projects," resource agency liaison program support, and the Environment Discipline Support System. Examples of tools FHWA will create through interagency agreements include programmatic approaches to expedite permitting and regulatory review times and policy and guidance development for stakeholder flexibilities. Examples for increasing the efficiency of the real property acquisition process include identifying opportunities to expedite real estate property acquisition by incorporating and leveraging big data.

The National Transportation Liaison Program has helped develop techniques that have expedited federally funded projects and permits, such as programmatic agreements, memorandum of agreement, and other tools that result in increased efficiencies throughout the project development and the environmental review processes. Additionally, the use of dedicated agency liaisons, such as the ones supported in this program, was identified as a best practice in the "Recommended Best Practices for Environmental Reviews and Authorizations for Infrastructure Projects for Fiscal Year 2018" by the Federal Permitting Improvement Council, to meet the objectives for federal permitting process improvement. This arrangement provides the support of liaisons in the federal permitting agencies who ensure the efficient application of those agencies' statutes and regulations. The research is conducted through continuous interaction between FHWA and the various liaisons.

In FY22, FHWA anticipates initiating several new activities to meet requirements under a re-authorization act for FHWA. The current Authorization for FHWA, Fixing America's Surface Transportation (FAST Act), will end in FY20. FHWA anticipates that the re-authorization will trigger a need for policy changes, rulemaking, guidance, and tools to meet requirements Congress will establish. As in past re-authorizations, FHWA will leverage the resources of its partner agencies to meet many of these needs, including but not limited to liaisons in other Federal departments, State agencies, and the Volpe Center in USDOT. Additionally, as appropriate, FHWA will contract for services in the private sector to accomplish tasks that are not inherently governmental.

Performance-Based Planning

Program Description:
The statutory planning requirements of 23 USC 134 and 135 and implementing regulation of 23 CFR 450 require the United States Department of Transportation (USDOT) to work with States and Metropolitan Planning Organizations (MPOs) and encourage a continued improvement/evolution of the metropolitan and statewide transportation planning through a performance-based planning and programming (PBPP) process. The USDOT is responsible for assisting States and MPOs to identify and meet performance measures and associated targets related to national highway and transit performance goals and provide risk-based oversight and stewardship on performance measures and targets.

FHWA will work with States and MPOs to provide a strategic, data-driven approach to decision-making that enables transportation agencies in implementing PBPP while efficiently allocating resources, maximizing the return on investments, and achieving desired performance goals while increasing accountability and transparency to the public. The PBPP supports the connection between performance measures and performance target levels that lead to data-driven, effective transportation solutions. These measures and targets are connected through transportation plans and programs developed at the statewide and metropolitan levels.

Program Objectives:
FHWA's mission is to improve mobility on our nation's highways through national leadership, innovation, and program delivery. PBPP will support this through the application of performance management within the planning and programming processes and work with States and MPOs to achieve desired performance outcomes for the multimodal transportation system. PBPP ensures that transportation investment decisions are made (both in long-term planning and short-term programming of projects) based on their ability to meet established targets. This research will support USDOTs strategic goals and promote more informed transportation decision-making that improves transportation planning, programming, operations, and coordination.

FHWA will conduct research to collect quality data; analysis; and information for FHWA Divisions, States, MPOs, transportation partners, and decision-makers to use in the planning decision-making. FHWA will continue to work with other Federal, State, and local agencies to develop methods and tools to analyze system performance to identify effective transportation solutions. This will create strategies and activities that will advance comprehensive international, interstate, state, metropolitan, rural, regional, multi-modal, and tribal planning processes. Other planning research initiatives that will support the performance-based planning process and links planning data to the National Environmental Policy Act (NEPA) process includes: environmental justice, public engagement, transportation safety planning, forecasting project benefits and impacts, exploratory modeling, scenario planning, and transportation land use.

Anticipated Program Activities:
In FY22, the Performance-Based Planning program expects to engage in the following activities:

- Partner with key agencies (domestic and international) to harmonize and market emerging products and technologies to meet planning research needs.
- Evaluate planning capacity needs in partnership with key stakeholders to identify risks and opportunities of existing procedures to support the 3-C planning process.
- Develop robust decision-making techniques to model and forecast the impact of emerging technologies on the transportation system and be proactive in performance, safety and mobility planning.
- Provide educational opportunities for peers to demonstrate new communication technologies and allow for virtual tools and strategies to enhance traditional public involvement techniques for all transportation users.
- Detect and deploy innovations for the efficient movement of people and goods in all areas of the state, including urban, rural, and tribal areas.
- Partner with key agencies to develop and deploy best practices, case studies, and other capacity building activities that support enhanced small, rural, and mid-sized communities and regions
- Continue delivery of customer service and technical support to key FHWA stakeholders through the development of trainings, peer reviews, peer exchanges, workshops, virtual forums, and other mediums that promote planning best practices.
- Apply state of the art analytical tools and data resources in the transportation planning decision-making process.
- Monitor the effectiveness of the implementation of PBPP in transportation planning and programing at the State and regional levels.
- Distribute State and MPO best practices for making investment decisions based on a data driven PBPP and estimate the economic benefits and other cost savings resulting from PBPP.
- Enhance coordination with States and MPOs to detect notable practices that prioritize multimodal projects to enhance accessibility and connectivity for all users.
- Coordinate with key stakeholders, to ensure consistent monitoring and documentation of performance measures, targets and decision-making in PBPP.
- Identify innovative visualization methods to effectively analyze, map, present, and report a wide range of information to transportation practitioners, elected officials, and the public.
- Enhance accountability by developing and streamlining efforts in the planning process to further reduce regulatory burdens.
- Assess the technology readiness of strategic planning models for performance based planning applications

Modeling and Analysis Tools

Program Description:
For FY2022, the "Modeling and Analysis Tools" research program will continue its focus on the development and deployment of new and refined analytical tools to reduce regulatory and analytical burdens and to support efficient delivery of highway projects. We will also continue the research on identifying new data sources to ensure necessary analyses can be done more efficiently and with improved accuracy.

Program Objectives:
The research goal is to identify, develop, and deploy technologies, tools, analysis methods, and performance management approaches to accelerate the environment review process, and to effectively and efficiently analyze the impacts of projects on the environment and communities so that transportation projects will be delivered more quickly and efficiently while maintaining a healthy environment, safeguarding our communities, and stimulating economic growth.

Anticipated Program Activities:
Develop and deploy state-of-the-art models, tools, data and methods to enhance air quality and noise analyses and to support the acceleration of highway project environmental review process. Research products such as analytical tools and models that are completed will be delivered to transportation stakeholders (State DOTs and MPOs) and the public in a variety of ways such as conferences, workshops, webinars, training courses, peer exchanges etc. Documents such as research reports, case studies, model sensitivity and validation analyses, and technical guidance will be posted on line and marketed at industry events.

Resiliency

Program Description:
The FY22 Resiliency research program will continue with the same main goals as the FY21 program, which is to focus on the development and deployment of tools, techniques, strategies and methodologies for assessing the resiliency, efficiency, and sustainability of transportation plans, projects and programs. However, it will build on it in important ways:

- Alternative fuels research and corridor designation activities will continue to shift focus to new technology that is becoming available, particularly higher level (faster) chargers, and on filling in the remaining gaps in the nationwide system of alternative fuel corridors. New areas of research examining the usage of alternative fuel stations and the fuel and energy impacts of CAVs will be continued.
- Resiliency efforts will continue to focus on improving resiliency in post-disaster decision making. Efforts to institutionalize hydraulic best practices in drainage manuals and other standard design manuals at State DOTs will be continued.

Program Objectives:
Consistent with the program objectives of this program in FY 2021, the objectives for FY 2022 include:

- Develop, deploy, identify and share tools, techniques, strategies, and methodologies, best practices, and training for assessing the resiliency and sustainability of transportation plans, projects, programs, and infrastructure (jointly with Infrastructure programs).
- Provide tools to help decision makers analyze economic, social, and environmental effects and considerations, smoothing interactions with stakeholders
- Reduce costs in highway construction by researching opportunities for increased material efficiency and material recycling.
- Increase energy security by creating opportunities for domestically sourced alternative fuels; conducting research on best practices, usage, behavior, stakeholder needs; designating alternative fuel corridors; and providing technical assistance and training to state DOTs and MPOs.
- Explore opportunities to use highway right-of-way to generate additional benefits that are consistent with operational and safety concerns, review restrictions on right-of way use, and address relevant technical analysis and data needs to inform decision making.

Anticipated Program Activities:
In FY22, the Resiliency Program expects to support the following activities:

- Build new and expanded partnerships with State DOTs and others to institutionalize hydraulic best practices in drainage manuals and other standard design manuals.
- Continue to improve processes, tools and methods through developmental and applied research and demonstration projects for incorporating resiliency and sustainability.
- Update and enhance technical assistance on resilience for all stages of highway planning, design, construction, operations and maintenance, and asset management.
- Support expansion of alternative fuels through designation of alternative fuel corridors, technical assistance, training, and research, continuing to shift focus to new and emerging technologies.
- Continue to explore opportunities and support deployment of alternative uses of the highway right-of-way.

Planning for Bicycle and Pedestrian Safety, Connectivity, and Multimodal Mobility, including for Underserved Communities

Program Description:
The goals of the FY22 program are to lower the number of pedestrian and bicyclist fatalities and serious injuries because of traffic crashes, and to improve the connectivity of the multimodal transportation system to allow travelers improved mobility options. The program will also support mobility innovation, active transportation, accessibility planning, context sensitive design solutions, and economic development to help ensure competitiveness of the U.S. economy. The program will help improve multimodal mobility options for all users of the transportation system, including underserved populations such as people with disabilities, older adults, low income individuals, and those in rural communities

Program Objectives:
The program will promote policy that supports multimodal transportation by assisting agencies to build capacity to support an integrated, safe, and convenient transportation system for all users, in urban, suburban, and rural areas. This program will support economic growth and the competitiveness of the U.S. economy by improving multimodal mobility options, including for lower income populations, persons with disabilities.

Anticipated Program Activities:
In FY22, the Planning for Bicycle and Pedestrian Safety, Connectivity, and Multimodal Mobility, including for Underserved Communities Program expects to support the following activities:

<u>Pedestrian Bicycle Information Center</u>
Operate a national pedestrian and bicycle information center (PBIC); conduct pedestrian and bicycle safety and connectivity research, and provide technology transfer and technical assistance. Address emerging technologies such as micromobility and automation and the impact of new transportation providers on the transportation system.

<u>Pedestrian and Bicycle Network Connectivity</u>
Research and implement the integration of pedestrian and bicycle network connectivity performance measurement and scalable risk analysis with transportation planning and project development.

<u>Innovative Technology Collaborative Evaluations for Road User Safety</u>
Research will support State DOT, railroad authorities, MPOS, and local governments Supports by identifying and promoting technologies that increase public awareness of safety hazards near railroad crossings to reduce fatalities and serious injuries.

Multimodal Innovation
This effort involves researching and deploying innovations in the financing and developing multimodal transportation projects to improve connectivity, accessibility, safety, and convenience for all users, including underserved communities.

Access and Mobility for All
This research will support implementation of USDOT's access and mobility for all initiatives, including the Compete Trip- ITS4US Deployment Program and accessibility strategic planning.

Assessment of Community Impacts and Context Sensitive Design Solutions
This research will help deploy innovations to support improved context sensitive design solutions, community impact assessment, and public engagement to accelerate project decision-making and improve mobility options for underserved communities.

Administration of the National Highway System Official Record and GIS Database
This effort will support State DOTs, MPOs, Rural planning agencies, Federal Land Management Agencies, and Department of Defense by establishing eligibility for Federal-aid funding; necessary for agencies to meet performance management requirements.

Evaluation of National Highway System (NHS) Intermodal Connector threshold criteria
This effort will evaluate the National Highway System (NHS) Intermodal Connector threshold criteria established in the 1990s to meet current NHS stakeholder needs.

State Economic Development and Transportation Research
This effort will support MPOs, Rural planning agencies, and Local governments by completing research on innovations in economic development and transportation planning and providing training materials and technology transfer reflecting those innovations. Innovative practices include value capture opportunities and curbspace management strategies.

Policy

Policy Analysis and Global Outreach

Program Description:
The domestic component of the Policy Analysis and Global Outreach program provides empirical assessments of the potential for national transportation strategies and policies to improve the overall value of transportation investments to the American people.
This research provides empirical analysis of potential for federal transportation policies and strategies to cost-effectively enhance transportation system performance in the United States. It uniquely integrates economic, public policy, geography, engineering, and statistics disciplines, to improve FHWA and U.S. DOT forecasting and policy analysis capabilities, with a focus on the role of highways within the context of changing – and somewhat uncertain -- transportation technologies, modes and travel behavior, and the economy.

Two broad lines of policy research address the supply and demand considerations essential to assessing the efficacy of national transportation policies and strategies in enhancing transportation access, system performance, and competitiveness:

- Transportation Investment
    - Impacts of Investment on Conditions and Performance
    - Economic Impact Analysis
    - Benefit-Cost Analysis

- Emerging Trends, Policy, and Strategy Analysis
    - Highway Costs and Funding Options
    - Emerging Trends and Future Demand
    - Geo-Economics of Multi-Modal Systems
    - Symposia, Strategic Planning and Policy Program Delivery

In FY 2022, the international component of the Policy Analysis and Global Outreach Program will continue to gather, promote and disseminate global policy, best practices, and technical innovations to ensure a safe and efficient U.S. Highway transportation infrastructure. Three main international program elements, Global Benchmarking, Multinational, and Binational, will facilitate the exchange of innovative ideas, best practices and technologies that can have a direct and practical impact on improving the high system.

Program Objectives:
Key anticipated FY 2022 accomplishments in the Impact of Investment on Conditions and Performance emphasis area include preparation of the 26th edition of the C&P report and the deployment of an interactive C&P website using data and exhibits published in the 25th edition. This document provides critical information documenting the state of the nation's infrastructure and projecting prioritized long-term infrastructure investment needs, which

in turn supports informed performance-based decisions regarding future infrastructure investment levels in support of FHWA's mission and strategic goal of infrastructure investment. Development of the Next Generation HERS model incorporating modern and innovative analyses of investment needs in support of the USDOT strategic goals of Infrastructure, Accountability and Innovation. Deployment of an NBIAS cloud-based database and the creation of a cloud-based software platform allowing for ease of software accessibility, efficiency and effectiveness, in support of FHWA's strategic goal of Accountability. Both HERS and NBIAS are critical in providing projected and prioritized infrastructure investment needs, which are documented in the C&P report.

Accomplishments under the Economic Impact Analysis emphasis area will include the completion of an enhanced USAGE-Hwy v1.2 model and its application in quantifying the macroeconomic impacts from highway investment. This new model will incorporate continuous improvements in the parameters of HERS and USAGE-Hwy models, update macroeconomic variables from other Federal agencies and BTS, and distinguish between rural and urban areas. Another accomplishment includes a new research activity to assess the potential how transportation investment enhances accessibility and mobility to employment across rural and urban settings, built on previous studies in this area and beyond. These products address the Department's strategic goal of Infrastructure by linking investment in infrastructure to economic growth and productivity and by informing decisions concerning the impacts of these investments on our broader national economy.

Planned FY 2022 accomplishments in the Benefit-Cost Analysis emphasis area include the completion of regulatory and deregulatory impact analyses as directed by FHWA's Office of the Chief Counsel, in cooperation with program offices, as well as support for the FHWA application of benefit-cost analysis in discretionary grant reviews. These activities support the USDOT goal of Accountability by ensuring more consistent and methodologically-sound application of benefit cost analysis, lifecycle-cost and related economic-impact analysis for policy, strategic, programmatic, and project decision-making. In addition, research to include infrastructure resiliency in benefit-cost analysis and other decision methods and applications will be conducted. This research will support the USDOT Infrastructure goal by including resilience in the investment decision-making and planning response to natural and man-made threats.

In FY 2022, research in the Costs and Funding Options emphasis area will continue to focus on evaluating the potential costs and impacts of Mileage-Based User fee (MBUF), developing prototype and validating the Unified Pavement Distress Analysis and Prediction Systems (UPDAPS) to support different FHWA pavement performance predictions needs, reviewing and validating the construction cost per lane-mile estimates for HERS, and continue exploring methods and data to estimate user marginal costs of highway infrastructure. Additional research will be pursued to implement modeling strategies for reflecting demand response to tolled and priced lanes based on the framing paper that will be completed in FY 2020/21, enhance and update the existing FHWA Interstate Tolling Analysis Tool, and prepare forecasts of construction cost per lane-mile estimates for different types of improvements used in the HERS model. Anticipated work in this research

emphasis area will contribute to achieving the Accountability and Innovation strategic goals of the Department.

Planned FY 2022 accomplishments for the Emerging Trends and Future Demand emphasis area continue to support the Innovation and Safety Strategic Goals. This includes the continuation of the annual Emerging Trends and Transportation Report, which documents key demographic, geographic, and technological trends impacting system supply, demand, and performance. Planned accomplishments include the improvement of access and mobility measures to support the multimodal analysis of demand in urban, suburban, and rural areas as well as improved methods for forecasting transportation demand in the context of demographic, technological, and geographic trends. This work improves our ability to analyze and predict user needs and performance gaps. In addition, several topical policy briefs and summary reports in the areas of Innovation and Safety will also be developed to synthesize cross-cutting issues and communicate technical research findings and policy alternatives to leadership and stakeholders.

The key FY 2022 accomplishment in the Geo-Economics of Transportation area will be developing an analytical spatial-typology model and a simple prototype interface to pilot GEMS for selected policy analyses. All research advances will also be peer reviewed. This research emphasis area focuses on taking and developing innovative approaches such as artificial intelligence, advanced mathematical and analytical models, and combining knowledge from traffic flow theory to network modeling and economic models which supports the Innovation strategic goal. Also by developing a user-friendly interface tool for this model, this program will enable the opportunity of running different scenarios to investigate infrastructure investment policy impacts and contributions on system performance which supports both the Accountability and Infrastructure goals.

Planned FY 2022 accomplishments for the Symposia, Strategic Planning & Policy Program Delivery research area that support the Innovation strategic goal include: 1) continuing the Transportation Policy Symposium series to identify and learn about critical transportation policy topics; and 2) assessing the impacts of new technologies, including AVs and potential mileage-based user fees. Accomplishments that support the Accountability strategic goal include an increased focus on identifying and mitigating corporate risk, including identifying internal and external factors that may affect DOT and FHWA. Another accomplishment includes supporting leadership discussions in defining strategic risks and objectives, and identifying performance targets for policy making.

The Global Benchmarking Program (GBP) will continue its mission of obtaining and adapting foreign innovations that directly support DOT strategic goals and critical RD&T areas. The GBP will also facilitate the acquisition and adoption of technologies and best practices already available and used abroad.

In FY 2022, Multinational Relations Program will continue to support domestic dissemination of the technical work produced by state and federal government U.S. representatives to the World Road Association technical committees and task forces. The products in the form of reports, guidelines, and other information tools, capture the U.S.

perspectives and are invaluable tools for the professional roads community worldwide. State DOTs are leading the effort of promoting and disseminating these products beyond the federal sphere including counties, local, and rural communities. In addition, several projects undertaken under the European Commission-USDOT Twinning Initiative will share findings on research performed in priority areas such as automated and connected vehicle applications.

In FY 2022, the Office of International Programs through the Binational Relations Program, will continue its work with FHWA Leadership, FHWA Program Offices, and the Office of the Secretary of Transportation to ensure that international topics and activities are geared to the DOT Strategic Goals. In FY 2022, the specific areas addressed by each binational relationship will depend on the expertise of the country involved and the interests of our partners, both internal and international. Two current examples are Japan, with whom FHWA has a long-standing collaboration on bridge and seismic issues, and Korea, with whom FHWA has worked on long-span and other bridges, pavements, road safety, and infrastructure resilience.

Anticipated Program Activities:
The main focuses of the Impact of Investment on Conditions and Performance (C&P) emphasis area in FY 2022 will be continuing work on new model enhancements to support the 26th C&P report. This will include development of the Next Generation HERS model, which will build upon the recent FORTRAN re-coding into Python by improving the optimization algorithms, unified modeling of demand and interface between other benefit-cost analysis software. Similarly, research efforts in cloud-based database and software platforms initiated in FY2021 for NBIAS will be implemented. In addition, an interactive C&P website will be deployed, providing an opportunity to display a large amount of investment trends analyses on FHWA website, potentially reducing the length of the printed report, which typically averages 500 pages.

Research in the Economic Impact Analysis emphasis area will include development work on USAGE-Hwy 1.2, building on USAGE-Hwy v 1.1 completed in 2020. This will include enhancements to the macroeconomic modeling structure, as well as updates to the engineering and economic model parameters. Work will continue on activities initiated in 2020, including a study on the distribution of land value appreciation from highway investment. A new research activity will be introduced to evaluate the role of transportation investment in sectoral and geographic changes in the economy by supporting freight movement and trades.

Within the Benefit-Cost Analysis emphasis area, work will continue to support FHWA's regulatory impact analysis needs, economic analysis of the discretionary grant programs applications, research to improve the ability of benefit-cost analysis methods to reflect infrastructure resiliency, and the impact of regulatory impact analysis on project outcomes.

FY 2022 work in the Highway Costs and Funding Options emphasis area will primarily build on prior years' work on pavement distress analysis and prediction modeling, reviewing and validating construction cost per lane-mile estimates, and modeling

strategies for reflecting demand response to tolled and priced lanes. Research will be pursued to enhance and update the Interstate Tolling Analysis Tool, and prepare forecasts of construction cost per lane-mile estimates for different types of improvements used in the HERS model.

FY 2022 work in the Emerging Trends and Future Performance emphasis area will build upon prior work to: 1) Analyze emerging trends and travel demand to inform policy questions; 2) advance understanding of the user impacts and interactions of emerging modes including automated vehicles, micromobility, on demand and shared transportation; 3) advance understanding of impacts of socioeconomic and demographic changes to transportation; 4) apply methods, indicators, and measures to evaluate the safety, accessibility, and mobility of roads; and 5) communicate actionable policy information and alternatives to support decision-making and strategic planning.

The Geo-economics of Multi-Modal Systems emphasis area will build upon prior years' work to develop geo-typologies and a multimodal analysis tool that will allow the transportation research community to quantify and understand how policy decisions impact performance measures, such as mobility and accessibility, and how economic factors influence the use and performance of the transportation network. This will specifically include developing an analytical spatial model and a simple prototype interface to pilot GEMS for selected policy analyses. All research advances will also be peer reviewed.

The Symposia, Strategic Planning & Policy Program research emphasis area will continue collaboratively exploring transportation policy topics, supporting agency and department efforts to identify and mitigate corporate risk, and enhancing and ensuring the quality production or peer-reviewed innovative research.

For the Global Benchmarking Program, FY 2022 work will focus on coordinating two new studies as determined by FHWA leadership, as well as, follow up implementation activities related to the FY 2019 and 2020 studies.

For the Multinational Relations Program, the FHWA will focus on the launching of technical committees and task forces for the 2020-2023 work cycle. As in the past, the expectation is that the U.S. will continue to influence the technical work produced by the Association's technical committees and task forces with the support of U.S. representatives. Special emphasis will be placed on products related to safety, infrastructure, and innovation. The products in the form of reports, guidelines, and other information tools, will capture the U.S. perspective. In addition, the quadrennial Winter World Road Congress will be held in FY 2022, preparations for the event will take place during FY 2020 and FY 2021.

For the Binational Relations Program, a U.S.-Korea Roads Workshop is scheduled for FY 2022. Furthermore, professional exchanges are anticipated in FY 2022 as well. Additionally, the next U.S. – Japan Bridge Workshop is scheduled during FY 2022. Other types of exchanges will also take place in relation to bridges and other topics. This includes the first Twinning research efforts, which are being coordinated now. Exchanges with Sweden on pedestrian safety will continue, cooperation with the Netherlands on new work

plan topics will take place, and exchanges with Switzerland on bridges will continue as well. Webinars on high-priority topics (e.g., freight) will continue with Australia and other countries.

Highway Data and Information

Program Description:
The Highway Data and Information (HDI) program is a set of initiatives to collect, process, analyze, model, visualize and disseminate data and information by working with State, local transportation agencies, private businesses, and research communities through an active and advanced RD&T program.

The HDI program offers a national perspective on the State of our highway transportation system through coverage on:

- State, local and federal highway financing information
- Vehicles (# of vehicles by vehicles types)
- Drivers (# of licensed drivers by age and gender),
- Fuel consumption (both gasoline and diesel),
- Travel condition (vehicle type, # of vehicles, vehicle speed, truck weights on the road by hour of the day, day of the week, and month of the year),
- Travel migration (both passenger and truck travel origins destinations by travel purpose),
- Infrastructure condition (pavement condition and overall congestion),
- Infrastructure inventory (length by various dimensions), and
- Future travel demand (projection).

The RD&T effort under the HDI program enables an efficient, effective, nationally consistent, and affordable data program by developing and deploying new methods, new approaches, new analytics, and new models for Federal, State and local governmental agencies and private businesses to adopt and use. The RD&T effort enables the HDI program in 8 key data and tool areas as listed below:

- FHWA 500 Series Data consists of data related to: (a) fuel consumption (gasoline and special fuel), (b) licensed drivers, (c) registered vehicles, and (d) highway financing, including local, state and federal spending, revenue, tolls, and bonds. These data serve as input to the various analysis used to inform and enable the Federal-aid highway program.

- Policy Information Data Portal (PIDP) is the FHWA's application for collecting form-based data and information from its State agency partners and stakeholders. The PIDP will continue to support agency-wide data collection efforts, offering state and local agency a single stop for data submittal.

- Highway Performance Management System (HPMS) provides the foundation for all Federal-Aid highway programs.

- Integrated Transportation Information Platform (ITIP) offers a mechanism for integrated data analysis throughout the FHWA.
- Data Visualization Center (DVC) activities benefit the entire FHWA through its data analysis and visualization expertise and products.
- Traffic Monitoring performs advanced research on traffic data collection and processing methods and technologies aiming for efficiency improvement, collects and disseminates consistent traffic volume, class, and weigh data for both motorized and nonmotorized vehicles, and provides technical guidance for the transportation community.
- National Household Travel Survey (NHTS) provides the only national-level demographic, behavior, and origin/destination transportation data for the entire transportation community through an effective data method research and deployment program. NHTS enables future demand analysis and a wide range of projects, programs, and policy analysis and evaluation.
- National Performance Dataset (NPD) covers both the National Performance Management Research Dataset (NPMRDS) and the Performance Vehicle Occupancy data on an annual basis. The annual NPD program enables trending analysis, detects new issues, increases data quality, and lowers the cost and the data reporting burden to State and local agencies.

Program Objectives:
The goal of FHWA's HDI program is to serve the needs on national surface transportation data both within and outside of the U.S. DOT. It provides the U.S. DOT, Congress, and the transportation community with quality information in a timely manner for the development and implementation of programs, policies, and legislation. The HDI's RD&T effort strives to improve the efficiency and effectiveness of data collection and analysis on travelers and the physical, operational, and financial conditions of our highway transportation system.

Specifically, the HDI offers insight into (a) Safety strategy development in areas of human factors and behavior, (b) Infrastructure strategy covering areas of accelerated project delivery, risk-based asset management, and system resilience, (c)Economic competitiveness in areas of performance-based infrastructure investments, innovative freight practices, Transportation Systems Management and Operations (TSMO), (d) Innovation in areas of new models for access and the needs of rural America, and (e) Accountability strategies covering technology transfer, technology deployment, and data.

In addition, the HDI provides national leadership on transportation data through the development of national specifications and guidance with ongoing support and training for State data providers as well as internal and external customers. The program's research addresses weaknesses and gaps in relevant technologies, knowledge, and analyses due to a lack of capabilities and/or interest from private entities. The focus has been on integrating

public and private data, new data method development and deployment, and efficient data analytics.

Anticipated Program Activities:

- FHWA 500 Series Data - The 500 Series Data activity will continue to advance program and process improvement efforts by further automating data collection and data quality control processes, developing and disseminating guidance, developing formal trainings and delivering technical assistance, and initiating/overseeing research studies.
- Policy Information Data Portal (PIDP) - The PIDP program will continue the deployment of forms, and design, development, testing and deployment of analytical procedures used in the collection, analysis, and reporting of State-reported 500 Series data. Additionally, application operations and maintenance (O&M) support will continued to be performed on the existing Performance Measures Forum (PMF) module.
- Highway Performance Management System (HPMS) - The HPMS program will test and deploy its V9.0 software, where states can submit data with reliability and speed needs. In addition, the HPMS program will develop and deliver the training to State on the usage of the HPMS v9 system.
- Integrated Transportation Information Platform (ITIP) - The ITI program will be deployed to FHWA division offices, enabling on0demand data analysis. The program will also deploy productive visualization capacities with its ITIP 2+ software platform. Data Visualization Center (DVC) - The DVC will explore more efficient and effective ways to provide agency-wide service on data visualization. Such exploration will include the development of a push-button type platform supported with advanced statistical and geospatial enabled analytics.
- Traffic Monitoring - The traffic monitoring program will deliver the newly created NHI TMG training to States and local MPOs; deploy the new vehicle signature technology with States for effective traffic monitoring. Also, the traffic monitoring program will attempt to develop an integrated mechanism on the various vehicle classification systems, enabling comprehensive analysis of safety, reliability, size and weight, and environmental impact analysis.
- National Household Travel Survey (NHTS) - The NHTS program will deliver the 2020 core data and 2021 origin-destination data during the 1st quarter of FY22 for trend analysis. The NHTS program also will provide the new big data analytics to States and MPOs on travel origin-destination data computation and analysis. The research focus will be on how to gather various travel mode data through passive data without any costly survey activity.

- National Performance Dataset (NPD) - The NPD program will seek to gather and disseminate quality travel time data to support the Transportation Performance Management needs. Data including both travel time and vehicle occupancy are needed on time at an affordable price. Partnership with private businesses and industries will be explored to achieve the data goal. Research activities will be focused on big data and big data analytics to derive such data vs. traditional data collection methods, which are through installing sensors on the highway.

Innovative Program Delivery

Every Day Counts

Program Description:
The Every Day Counts (EDC) Program is a State- and Local-based program that identifies and rapidly deploys proven, yet underutilized innovations to enhance roadway safety, shorten the project delivery process, reduce roadway congestion, and integrate automation. Proven innovations promoted through EDC facilitate greater efficiency at the State and local levels, saving time, money, and resources that can be used to deliver more projects.

Program Objectives:
As deployment of the EDC-6 initiatives continues in FY 2022, support of the strategic goals and the mission of the agency, and the four USDOT RD&T Strategic Goals will also continue.

Anticipated Program Activities:
Key FY22 program activities include the continued deployment of the EDC-6 innovations through December 2022, and determining the programmatic approach to continue strategic innovation deployment beyond the sixth cycle of EDC.

State Transportation Innovation Council Incentive

Program Description:
The FHWA STIC Incentive program provides resources to help foster a culture for innovation and make innovations standard practice in their States. Through the program, funding up to $100,000 per State per Federal fiscal year is made available to support or offset the costs of standardizing innovative practices in a State transportation agency or other public sector STIC stakeholder

Program Objectives:
The STIC Incentive Program provides resources to advance innovations into standard practices in a State transportation agency or other public-sector stakeholder and foster a culture of innovation. States with a strong culture of innovation leverage the resources of the transportation community within the state to get the appropriate innovations into practice quickly. FHWA intends to continue the STIC Incentive program in FY 2022 and continue to support a nationwide culture of innovation through the National STIC Network.

Anticipated Program Activities:
Key FY22 program activities for the STIC Incentive program include awarding projects commensurate with the funding available for the program; continued national-level outreach and stakeholder engagement with the National STIC Network thru no fewer than two virtual meetings (typically Fall and Spring during the FY); and conduct of the 2022 STIC Excellence Awards Program in partnership with the AASHTO Innovation Initiative.

Accelerated Innovation Deployment Demonstration

Program Description:
The AID Demonstration Program provides funding to State DOTs, federal land management agencies, tribal governments, metropolitan planning organizations, and local governments to offset the risks associated with the initial deployment of an innovation by that agency. Innovations funded by AID can come from EDC or other sources.

The AID Demonstration Program provides funding to support the pilot/demonstration of innovations on projects by State DOT, federal land management agencies, tribal governments, metropolitan planning organizations, and local governments. Funding recipient reports on experiences and lessons learned from each innovation deployment are shared via the program web site to provide technology transfer.

Program Objectives:
FHWA intends to continue the AID Demonstration program in FY 2022. This program impacts and is of benefit to transportation agencies throughout the nation. It is anticipated that the program will continue to support the Department's Safety, Infrastructure, Innovation and Accountability Strategic Goals, and contribute to all DOT RD&T Strategic Goals as previously described.

Anticipated Program Activities:
The key FY22 program activity is the continued award of grants based on the AID Demonstration program applications received and commensurate with the funding available for the program.

Accelerating Market Readiness

Program Description:
The Accelerating Market Readiness (AMR) program supports promising innovations that have the potential to be considered for accelerated deployment. The AMR program provides resources for the rapid, national assessment of emerging innovations and for the development of objective, written documentation of these assessments. The AMR Program is intended to help advance the innovations to a more complete market-ready status, which in turn should accelerate the adoption of the innovations by transportation agencies under the EDC Program or by other initiatives.

Program Objectives:
The AMR program is intended to stimulate and spur the advancement of emerging and transformative innovations in the transportation industry by matching these innovations to the transportation organizations interested in testing and evaluating them. The innovations to be supported by AMR program resources are those that:

- Significantly advance conventional practice;
- Address knowledge and technology gaps;
- Significantly advance the state-of-the-art; or
- Constitute a sea change in the development and delivery of transportation projects and programs.

It is anticipated that AMR Program will continue to support the Department's Safety, Infrastructure and Innovation Strategic Goals, and contribute to all DOT RD&T Strategic Goals.

Anticipated Program Activities:
The key FY22 program activity is the continued award of grants based on the AMR program applications received through BAAs and commensurate with the funding available for the program. FY22 also will be the timetable when final results from first BAA awards will be documented, so another key activity will be sharing these findings and lessons learned with the greater transportation community.

Innovative Program Delivery

Program Description:
Innovative Program Delivery (IPD) provides tools, training and technical assistance that support the transportation community's use of cutting-edge financial and procurement strategies to deliver critical infrastructure projects. FHWA's efforts in this area are primarily led by the Center for Innovative Finance Support (CIFS), whose products are often marketed and delivered in coordination with the Secretary's Build America Bureau. These research and technology deployment efforts focus on revenue generation (tolling and value capture), procurement (public-private partnerships and other alternative contracting methods), and innovative finance (Federal project finance tools such as GARVEE Bonds and State Infrastructure Banks). Support for our partners include (1) technical resources, guidebooks and analytical tools, (2) capacity building and outreach, and (3) technical assistance for project implementation.

Program Objectives:
The IPD program begins with the recognition that public infrastructure resources at all levels of government are continually under stress, and thus demand effective project finance and delivery practices. These practices, in turn, must constantly evolve to exploit the opportunities of a dynamic economy. Given the sprawling number of public agencies in the United States, a potential "market failure" exists each time a project sponsor fails to look beyond its local environs for beneficial new practices. Federally-sponsored research and technology (R&T) deployment can open State and local jurisdictions to opportunities tested elsewhere by their peers. Specific objectives that require R&T support include:

- To increase consideration of innovative finance project revenue options, such as user fees and value capture, via research, training and technical assistance.
- To increase consideration of the P3 delivery option for major projects by providing the U.S. transportation community with the most complete, up-to-date body of knowledge on P3s.
- To support the accrual of P3 knowledge by industry practitioners and advisors in the areas of planning/evaluation, procurement, and monitoring/oversight.

Anticipated Program Activities:
In FY22, Innovative Program Delivery Program expects to support the following activities:

- **P3 Training**. Intensive training for public project sponsors on critical aspects of public-private partnerships (P3s), including life-cycle cost comparisons between alternative delivery methods (Value for Money analysis), model contract provisions for long-term concession agreements, and best practices for competitive procurements. Delivered under auspices of the National Highway Institute (NHI), each course is based on material developed by the CIFS with R&T funding.
- **Value Capture Training.** Intensive training for public project sponsors on critical aspects of "value capture" techniques to help finance transportation projects via the

incremental property value generated by the project itself. Value capture enables new local funding sources that, in turn, can attract new public or private investment.

- **Project Finance Training.** Training for state and local partners on the appropriate use of Federal project finance tools, with an emphasis on their early consideration during regional planning exercises.
- **Rural Projects/SIBs.** Project-specific assistance to public sponsors seeking access to TIFIA credit assistance for rural infrastructure projects. The CIFS will work with the Build America Bureau to prepare State Infrastructure Banks (SIBs) to identify, underwrite and service rural project loans capitalized with TIFIA loan proceeds.
- **Center for Excellence in Project Finance (CEPF).** Financial and organizational support for a cooperative agreement awarded in FY 2021. The current CEPF, the BATIC Institute: An AASHTO Center for Excellence, offers a program of training, sharing of best practices, and technical assistance to all State Departments of Transportation and local partner agencies.

Corporate

Research Infrastructure, Technology Transfer, and Partnerships

Program Description:
The FHWA Research Infrastructure Program supports the goals of the USDOT Strategic Plan to invest strategically in transportation infrastructure, promote safe and secure transportation, support the development and deployment of infrastructure innovations, and promote greater accountability. The program monitors legislative developments, helps to coordinate the R&T budget allocation, administers the R&T program, maintains the Turner Fairbank Highway Research Center, organizes strategic Research and Technology (R&T) investment, and provides marketing and outreach. The overarching role is to coordinate all elements that support and promote the highway R&T portfolio to ensure the FHWA R&T program addresses national needs, meets future demands, and maximizes the strengths of all research entities. This R&T program is stakeholder driven, with partners engaged throughout the entire innovation lifecycle process, from agenda setting and planning, through the research, technology development, and innovation deployment phases, to the implementation and assessment stages. The Research Infrastructure, Technology Transfer, and Partnerships Program supports these coordinated efforts across all other Programs.

In addition to supporting R&T development and deployment activities, the Research Infrastructure, Technology Transfer, and Partnerships Program promotes communication, coordination, and collaboration with FHWA's partners, which are crucial to conducting the right research, doing it well, and delivering solutions when and where they are needed. Communication strategies address the needs of internal and external audiences and cover the depth and breadth of the federal effort for highway research and technology, displaying prudent use of government resources, advancing the state of the practice, and building a case for continued and future funding.

The Research Infrastructure, Technology Transfer, and Partnerships Program will build upon the activities in FY21 on multiple fronts. There will be continued work to identify opportunities to enhance communication, outreach, and sharing of information with our State, local, national, and international partners. The program will focus on strengthening the feedback loops in the Innovation Lifecycle and offering new services that move early-stage innovations from the laboratory to the field.

Program Objectives:
The primary role of the Research Infrastructure, Technology Transfer, and Partnerships Program is to provide leadership, coordination, and support in the administration of the FHWA R&T program in support of the USDOT Strategic Goals. To accomplish this the Program will continue to foster and promote enhanced coordination of highway research among all stakeholders; communicate, publish, market, and disseminate research results to

appropriate audiences; coordinate strategic resource allocation; and conduct R&T Program Evaluations.

Additionally, the Research Infrastructure, Technology Transfer, and Partnerships Program will maintain and support the operation of the TFHRC. The highway research and development relating to emerging highway technology that occurs at TFHRC is focused on addressing research gaps not addressed by FHWA's partners. TFHRC specifically focuses on long-term, high-risk research to improve the materials used in highway infrastructure; the development of tools and techniques that provide solutions to complex technical problems; and the development of innovative highway products and practices.

Anticipated Program Activities:

The Research Infrastructure, Technology Transfer, and Partnerships Program will continue to provide services to the overall R&T program. These include R&T Program support and administration to develop and execute the R&T program strategic direction, policies, and budget to further USDOT and FHWA initiatives; communications, publishing, and marketing services; development of publications, periodicals, and technical reports; administration of the TFHRC laboratory capacity building efforts; continue the R&T Evaluation Program; Transportation Pooled Fund Program; coordinate with domestic and international partnerships; and provide knowledge management for the FHWA RD&T program.

Small Business Innovation Research

Small Business Innovation Research

Program Description:
The SBIR program is a highly competitive, awards-based program that encourages domestic small businesses to engage in research and development addressing high priority research areas within USDOT. The SBIR program favors research that has the potential for commercialization through products and applications sold to the private sector transportation industry, State DOTs, USDOT, or other federal agencies.

The program is administered by the Volpe Transportation Center. The SBIR Program Office publishes one or two solicitations each fiscal year for proposals on specific research topics of interest to USDOT operating administrations, including the FHWA.

Program Objectives:
To encourage small businesses to engage in research and development (R&D) that has the potential for commercialization and meets federal R&D objectives. The SBIR program is uniquely positioned to support both the interests of FHWA as well as the small business. In this respect, the SBIR programs aims to provide essential funding to small businesses with aim toward commercialization of products that align with FHWA and Departmental Strategic goals. Given that the SBIR program is available to all FHWA RD&T programs, all USDOT Strategic goals are supported as a result.

The SBIR program offers unique services to the small businesses to aid in their technical and commercial development. Specifically, the SBIR program offers a Commercialization Assistance Program to provide consulting services to the SBIR participants to help conduct market research, commercialization plans, and other services. In addition, in FY22 the FHWA SBIR program will continue with a Technology Readiness Level (TRL) assessment program to help the Small Businesses conduct an independent assessment of the technological status of the innovations developed through the SBIR program.

Anticipated Program Activities:
FHWA will continue to support an annual solicitation of new Phase I topics and will support the most promising solutions through Phases II and IIB when a path to commercialization exists and if the impact of the innovation aligns with USDOT Strategic Goals. Additionally, FHWA will continue to utilize the TRL assessment process as a tool for determining next steps and technological maturity.

Exploratory Advanced Research

Exploratory Advanced Research

Program Description:
The FHWA Exploratory Advanced Research (EAR) Program is the only funding specifically addressing the need for longer-term, higher-risk research in highway transportation. Funding of exploratory advanced research has a direct impact on the supply of potential technologies and processes necessary for continued industry innovation to meet the challenges of improving the safety, operation, and resilience of the U.S. highway system for years to come. The EAR Program applies proven deliberative and open processes to engage experts within and outside the Department to identify potential research topics among new discoveries in science and technology that may address current and emerging needs of the highway transportation industry.

Program Objectives:
The EAR Program scouts new topics – around a dozen annually – as part of a continuous process engaging partners broadly from within and outside the highway transportation industry to seek, screen, and scope for emerging, unexplored advances in science and technology

Anticipated Program Activities:
The EAR Program seeks investments in new topics each year based on scouting and scoping activities and may return to a topic that continues to warrant additional exploratory research after a full cycle of investment. EAR Program investments support the Departmental RD&T Strategic Goal of innovation. The EAR Program actively manages and integrates research in new topics into the existing portfolio to provide a continued source of innovation into the highway research pipeline. Research projects generally span three years often with mid-point milestones to assess progress and revised objectives to pivot towards more impactful results based on finding from the initial phase of research and continued market research of external efforts. Accordingly, the EAR Program expects continued support for research started in FY 2020 and FY 2021, which includes innovative research on computer vision and realistic artificial data to improve traffic safety and on supplemental materials to improve the resilience and state of good repair of the nation's highways.

Designated Grant Programs

Advanced Transportation and Congestion Management Technologies Deployment

Program Description:
The ATCMTD is statutorily required in the FAST Act Section 6004, 23 U.S.C. 503(c)(4). The ATCMTD grants are managed by FHWA and the ITS JPO contributes a mandated percentage of funding through FHWA to annually satisfy the requirement.

The language provided here duplicates the language provided in the ITS JPO AMRP for consistency.

The Advanced Transportation and Congestion Management Technologies Deployment Initiative (ATCMTD) Program is intended to provide funding for eligible entities to develop model deployment sites for large scale implementation and operation of a diverse set of technologies in various geographic regions. As the program is aimed at the rapid deployment of advanced technologies, limited expenditures for infrastructure construction is anticipated in grant application. The stated purpose is to reduce costs and improve return on investments; deliver environmental benefits through increased mobility; enhance transportation system operations; increase safety; improve collection and dissemination of real-time information; monitor transportation assets; deliver economic benefits; and accelerate deployment of connected and autonomous vehicle technologies. Successful proposals will contain quantifiable system performance objectives, use innovative technologies and strategies, and a plan for long term operation and maintenance of the deployed technologies. DOT encourages partnering among the private sector, public agencies, research institutions, technology leaders, and other transportation stakeholders is encouraged.

Expected Program Outcomes:
The ATCMTD Initiative will develop model deployment sites for large scale installation and operation of advanced transportation technologies to improve safety, efficiency, system performance, and infrastructure return on investment. Each ATCMTD project will consist of model technology deployments to help demonstrate how emerging transportation technologies, data, and their applications can be effectively deployed and integrated with existing systems to provide access to essential services and other destinations. This also includes efforts to increase connectivity to employment, education, services and other opportunities; support workforce development; or contribute to increased mobility, particularly for persons with visible and hidden disabilities and elderly individuals.

Anticipated Program Activities:
Key FY22 FHWA ATCMTD R&T Program Activities include the selection and implementation of FY21 grant awards, the award of FY21 grants and management of

projects awarded for FY16-FY20, and the publication of the ATCMTD Annual reports. During FY22 FHWA will work with grantees to ensure that there is a timely implementation of grant awards after projects have been selected. In parallel to FY21 awards being selected and implemented, FHWA will continue to manage previous grant awards from FY16 though FY20 projects. In addition, as mandated by the FAST ACT, FHWA will work with grantees to ensure that individual annual project reports are submitted in a timely manner.

Surface Transportation System Funding Alternative Program

Program Description:
Fixing America's Surface Transportation (FAST) Act of 2015, Pub. L. No. 114-94, H.R. 22, § 6020, H.R. 22, 114th Cong. (2015) authorized the Secretary of Transportation to establish the Surface Transportation System Funding Alternatives (STSFA) program. The purpose of the STSFA program is to provide grants to States to demonstrate user-based alternative revenue mechanisms that utilize a user fee structure to maintain the long-term solvency of the Federal Highway Trust Fund. The FAST Act provides that $15 million in Fiscal Year (FY) 2016 and $20 million annually from FY 2017 through FY 2020 will be made available from the Highway Research and Development Program for grants for STSFA demonstration projects.[9] These grants shall make up no more than 50 percent of total proposed project costs, with the remainder coming from non-Federal sources. Other Federal funds using their appropriate matching share may be leveraged for the deployment but cannot be considered as part of the STSFA matching funds, which must come from non-Federal sources unless otherwise supported by statute. On August 1 of each year, if there are insufficient grant applications that meet program requirements, any excess funds must be transferred back to the Federal Highway Administration (FHWA) Highway Research and Development program.

The grants are only available to States; however, groups of States can form partnerships for regional or national proposals.[10] Section 6020 of the FAST Act authorizes the DOT to enter into agreements with State authorities to demonstrate user-based alternative revenue mechanisms. However, this solicitation requires that a State department of transportation (State DOT) serve as the lead agency for administering the program funding through the Federal-aid highway program. Another State agency or a State agency in a different State (if the project involves a group of States) may be responsible for providing day-to-day project oversight. It is expected that all relevant State agencies (e.g., Department of Motor Vehicles, Department of Revenue) needed to initiate a full-scale deployment of the proposed revenue mechanism will be actively involved in the planning and operation of the demonstration.

Program Objectives:
The program seeks to fund activities that meet the following goals:

- To test the design, acceptance, and implementation of user-based alternative revenue mechanisms.
- To improve the functionality of such user-based alternative revenue mechanisms.

[9] STSFA funds are subject to the overall Federal-aid obligation limitation. Therefore, the actual amount of STSFA funds available for grants in a fiscal year is reduced ("lopped off") based on the imposition of the limitation on obligations.
[10] Except where specifically indicated, the term "States" as used in this Notice will apply to both individual States and groups of States submitting a common proposal.

- To conduct outreach to increase public awareness regarding the need for alternative funding sources for surface transportation programs and to provide information on possible approaches.
- To provide recommendations regarding adoption and implementation of user-based alternative revenue mechanisms.
- To minimize the administrative cost of any potential user-based alternative revenue mechanisms.
- Minimize the administrative costs associated with the collection of fees.

The major focus of the program is in funding larger scale demonstrations projects, rather than smaller scale demonstration projects, and in awarding funds to both single State and multistate demonstrations.

Anticipated Program Activities:
In FY22, the STSFA program expects to support the following activities:

- Administer and support the delivery of the STSFA grant program, evaluate program outcomes, and conduct outreach and technology transfer.
- Post Biennial Report on FHWA website.
- Provide outreach on program results.

[END]