



# ANNUAL RESEARCH IMPLEMENTATION REPORT

OFFICE OF ORGANIZATIONAL PERFORMANCE MANAGEMENT  
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## INTRODUCTION

This report marks the Office of Organizational Performance Management's (OPM) fifth Annual Research Implementation Report to the Georgia Department of Transportation (GDOT) Research Advisory Committee (RAC). The report summarizes research implementation activities completed or in progress, since the last RAC meeting, under the GDOT Research and Development (R&D) program or the Transportation Pooled Fund (TPF) program. Contract research is normally funded with 80% federal State Planning and Research (SP&R) dollars and 20% state motor fuel dollars, while TPF projects are funded with 10=0% federal SP&R dollars. The report also highlights implementation activities associated with the Strategic Highway Research Program 2 (SHRP-2).

All research activities are intended to solve a particular problem or provide useful information. Each research project approved for conduct includes, as a specific objective, implementation of its findings (*GDOT Research and Development Manual, 2013*). R&D projects contain work elements to ensure this implementation as much as possible.

The project implementation summaries are organized according to the Research Technical Advisory Group (RTAG)—Asset Management, Mobility, Policy/Workforce, or Safety—that the research pertains to. The projects discussed herein demonstrate that both federal and state research dollars are being well leveraged to conduct and implement research with tangible benefits to GDOT and the traveling public. GDOT's R&D program is in direct alignment with its strategic goals, and the implementation products enhance operations in a cross-section of major GDOT divisions. This, in turn, supports GDOT's overall mission.

### Types of Research Implementation

This section provides brief descriptions of the types of implementation in GDOT's R&D program. Depending on the scope and deliverable(s) of each research project (RP), the implementation type may differ considerably from project to project. These types include:

- *Developmental* – In this most traditional type of implementation, the research produces a new or modified material, technology, policy, or process; and the product is implemented during and/or after the research project timeline (see page 3 for example). Progressive implementation of research products during the project timeline is encouraged as appropriate.
- *Response* – This research provides an answer to a question or concern from any of the various stakeholders of GDOT's R&D program (see page 11 for example).
- *Feasibility* – This type of implementation is guidance for GDOT on the feasibility of a new or modified material, technology, policy, or process. This type of research can be valuable in encouraging GDOT to move forward with further research and development on something or discouraging further study on it, eliminating further funding risks (see page 12 for example).

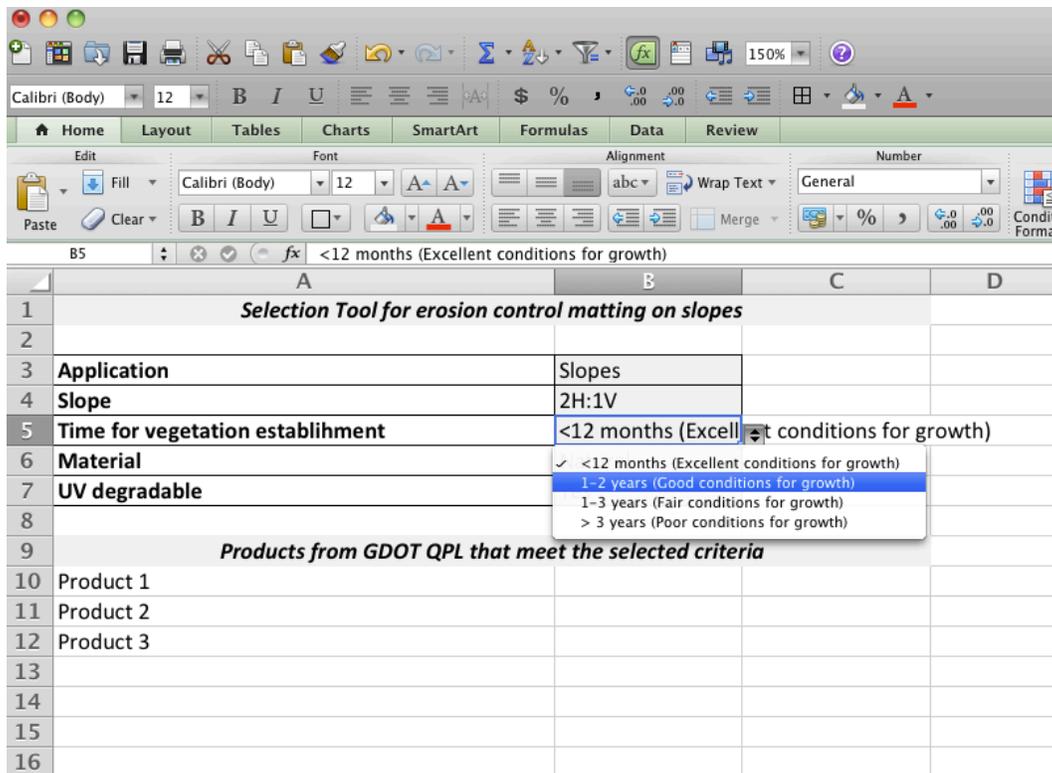
## HIGHLIGHTED IMPLEMENTATION ACTIVITIES

### ASSET MANAGEMENT

#### ***Categorization of Erosion Control Matting for Slope Applications [Research Project (RP) 11-22; Jon Griffith; Developmental]***

Erosion control is an important aspect of any GDOT construction project. Various erosion control products are available to reduce the transport of sediment loads or solids to receiving streams. For example, geotextiles made from natural or synthetic fibers, concrete, seed and sod, wood mulch, and soil binders are frequently used for erosion control. However, GDOT has only one category of slope matting material.

This research reviewed current practices in erosion control on slopes and performed a laboratory-based investigation of the erodibility of coarse-grained soils. The study provided designers with a tool for erosion control mat selection for the protection of slopes on GDOT rights-of-way, with primary emphasis on steepness of slope and considerations like materials type and vegetation-establishment timing (see Figure 1). GDOT’s Office of Design Policy and Support (ODPS) and Office of Materials and Testing (OMAT) are collaborating to implement the results by updating Qualified Products List 62 (Organic and Synthetic Material Fiber Blanket) with maximum slope and functional longevity data, i.e. supplemental specifications for slope mats.



**FIGURE 1** Screenshot from erosion control selection tool, with vegetative conditions known.

***Influence of Physical, Chemical and Biological Conditions on the Infiltration Rate of Highway Stormwater Runoff [RP 12-32; Jon Griffith; Developmental]***

The infiltration rate of soils in Georgia’s major physiographic regions (see Figure 2) is important to the proper design and sizing of stormwater infiltration structures such as infiltration trenches, which are an environmentally-friendly, low-impact construction practice. Overestimating the design infiltration rate results in non-conservative design and undersizing infiltration structures, with possible detention overflow and direct stormwater discharge to receiving streams. Underestimating infiltration rates results in oversizing infiltration structures and corresponding construction and maintenance cost increases. Consequently, accurate estimation of the design infiltration rate of any facility that receives stormwater is important. Infiltration is significant in reducing the amount of required stormwater runoff detention outlined in GDOT’s MS4 permit and *Manual on Drainage Design for Highways*.

This research recommended resources and tests for determination of infiltration and saturated hydraulic conductivity values through site feasibility screening processes and applicable field infiltration tests. GDOT ODPS is currently working to update these proposed procedures, soil survey guidance, and the infiltration rates in Piedmont soils into Appendix J of the *Manual on Drainage Design for Highways*.

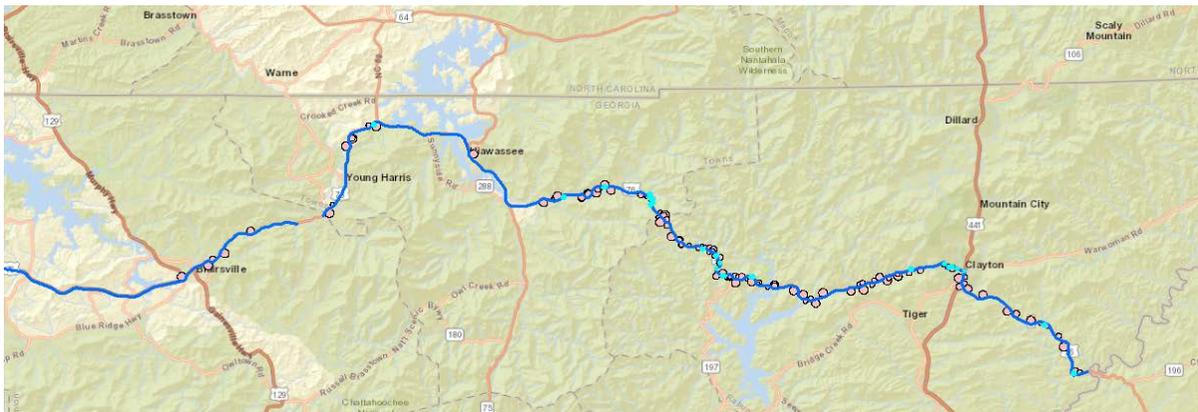


**FIGURE 2 Primary physiographic provinces in Georgia.**

***Curve Identification for High Friction Surface Treatment (HFST) Installation Recommendation [RP 15-05; Michael Turpeau; Developmental]***

According to FHWA’s Every Day Counts (EDC) initiative, more than 25 percent of fatal crashes in the U.S. occur on horizontal curves. GDOT has taken a proactive, preventative approach to improving the safety of curved roadways by investing in HFST programmatically to reduce the number of run-off-road (ROR) crashes on curved roadways. GDOT Office of Traffic Operations (OTO) and OMAT developed GDOT specifications for HFST and an “HFST corridor analysis” to identify locations that are prone to ROR crashes.

GDOT completed research delivering a smart curve information extraction (Smart-CIE) tool that can cost-effectively extract detailed curve information using widely available GPS and GIS data. The Smart-CIE tool has been implemented on State Route 2, whereon 31 miles of GPS data were analyzed for the HFST sites (see Figure 3) in a GDOT project (PI#00099993). The Smart-CIE method, as compared to the current manual procedure of determining the start and end points of the HFST installation, demonstrated its capability to provide an accurate and efficient means of extracting curve information at the network level, and it is promising for saving HFST construction costs. For this one project, estimated potential savings in construction costs was \$600,000. Approximately 25,000 sq. yd. of HFST materials were saved, and operational costs that would have been required by the manual determination of the start and end points of HFST installation were reduced.



**FIGURE 3 Overview of the roadway section with HFST sites plan on State Route 2.**

**MOBILITY**

***A Remote Sensing and GIS-Enabled Highway Asset Management System (RS-GAMS), Phase 2 [RP 12-10; Andy Doyle; Feasibility and Developmental]***

The USDOT Office of the Assistant Secretary for Research and Technology (OST-R) and GDOT co-sponsored this research project for validating the application of commercial remote sensing and spatial information (CRS&SI) technology on state agencies’ transportation operations using an intelligent RS-GAMS. This research validated the CRS&SI technologies, including 3D line laser

and mobile LiDAR, to enhance pavement, traffic sign, pavement marking, and roadway geometry data inventory, condition assessment, and management.

GDOT has successfully implemented the RS-GAMS research outcomes through several projects that enhance GDOT’s transportation assets, e.g. pavements, signs, roadway safety, data inventory, and condition assessment. Table 1 below lists some completed, ongoing, and proposed projects that involved various GDOT offices (Traffic Operations, OMAT, Maintenance) and the GDOT districts. Four of these projects are discussed in further detail following Table 1.

**TABLE 1 Completed, Ongoing, and Proposed Projects from RS-GAMS Research**

RP #	Title	Status
13-18	Development of an Asphalt Pavement Raveling Detection Algorithm Using Emerging 3D Laser Technology and Macrotecture Analysis	Completed
13-19	Enhancing GDOT’s Jointed Plain Concrete Pavement Rehabilitation Program Using Emerging 3D Sensing Technology and Historical Concrete Condition Survey Data	Completed
14-37	Next Generation Crack Sealing Planning Tool for Pavement Preservation	Completed
15-11	Implementation of Automatic Sign Inventory and Pavement Condition Evaluation on Georgia’s Interstate Highways	Completed
15-04	Developing Georgia’s HFST Program - HFST Site Characteristics Data Collection and Analysis	Ongoing
15-05	Curve Identification for HFST Installation Recommendation	Ongoing
Pending	Validating Change of Sign and Pavement Conditions and Evaluating Sign Retroreflectivity Condition Assessment on Georgia’s Interstate Highways using 3D Sensing Technology	Proposed

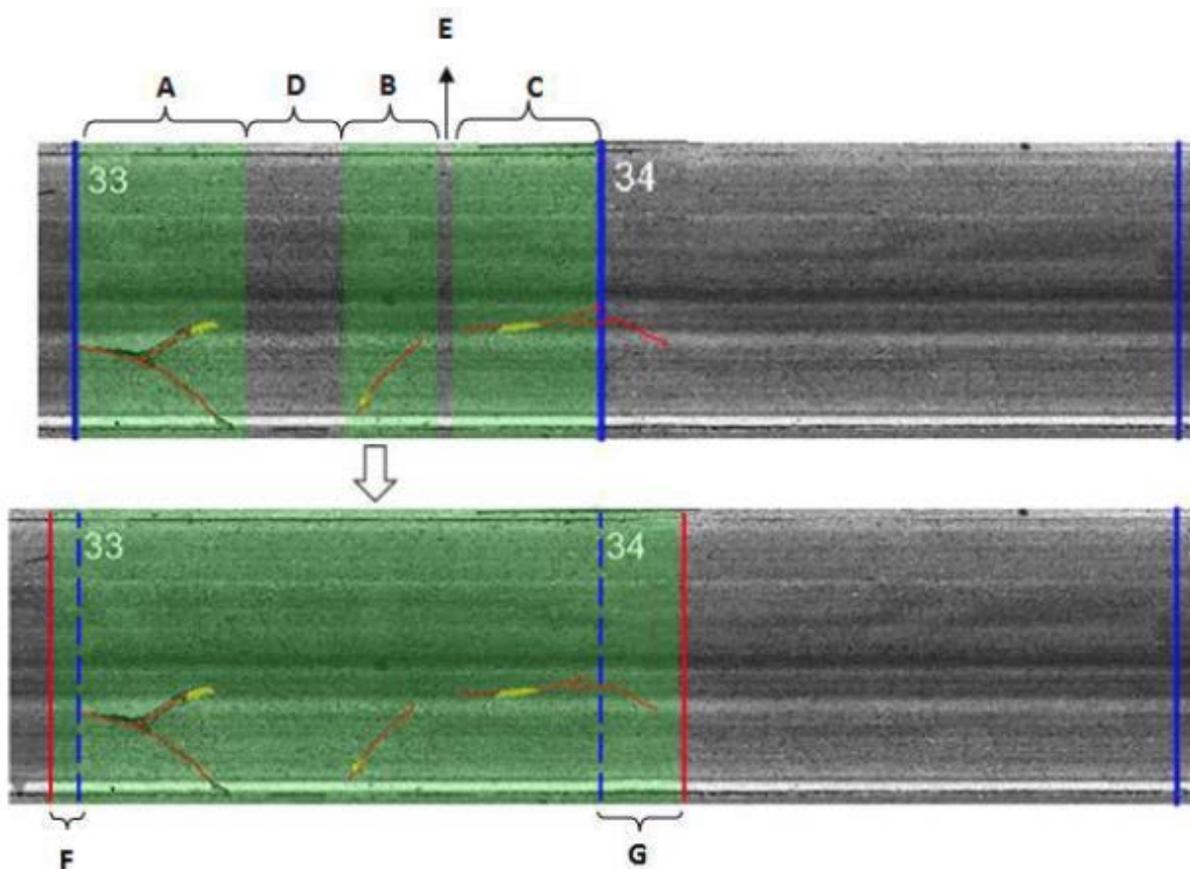
***Development of an Asphalt Pavement Raveling Detection Algorithm Using Emerging 3D Laser Technology and Macrotecture Analysis [RP 13-18 & RP 15-11; Ernay Robinson; Feasibility & Developmental]***

Raveling has become the most predominant distress for open graded friction course (OGFC) on Georgia interstate highways. It is critical to detect raveling in its earliest stage to apply inexpensive preventive maintenance methods such as fog sealing. However, GDOT’s current visual and manual methods make an accurate raveling survey difficult. RP 13-18 delivered a raveling condition survey protocol to GDOT. The protocol has been successfully implemented together with other pavement distress protocols developed from the RS-GAMS research (rutting measurement, crack detection, classification, and measurement) to provide a comprehensive and streamlined pavement condition evaluation for all asphalt-surfaced interstate highways in Georgia (**1,513 miles**, RP 15-11).

***Enhancing GDOT's Jointed Plain Concrete Pavement (JPCP) Rehabilitation Program Using Emerging 3D Sensing Technology and Historical Concrete Condition Survey Data [RP 13-19; Ernay Robinson; Developmental]***

This research project refined the JPCP distress protocol based on different levels of severity to support slab replacement prioritization. The tool aims to provide accurate estimates of the maintenance, rehabilitation, and reconstruction (MR&R) quantity to prevent project overruns. Thus, in effect, it enables better budget planning for future JPCP condition and MR&R needs.

An enhanced slab replacement quantity estimation method was developed and demonstrated a promising capability to effectively identify distresses and accurately estimate slab replacement quantities using 3D laser data (see Figure 4). Results show a significant improvement—approximately 26%—in the accuracy of slab replacement quantity estimation compared with the current windshield survey. The new method can simulate different slab replacement alternatives, e.g. replacing only severe distresses vs. all distressed slabs, and calculating corresponding costs. This allows the Office of Maintenance (OM) to analyze MR&R alternatives based on different treatment criteria and estimate corresponding costs.

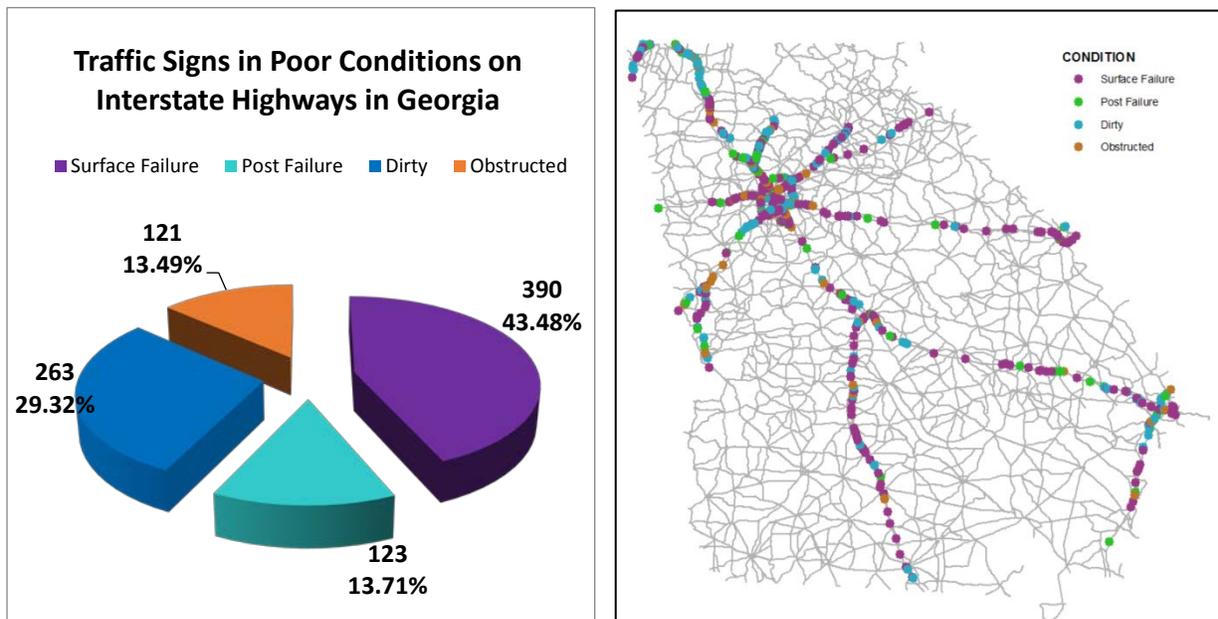


**FIGURE 4** Example of processing a slab replacement.

**Implementation of Automatic Sign Inventory and Pavement Condition Evaluation on Georgia's Interstate Highways [RP 15-11; Ernay Robinson; Developmental]**

FHWA requires all agencies having jurisdiction over roads to establish and implement a sign assessment or management method to maintain minimum levels of sign retroreflectivity. However, the number of signs on interstates, state routes, and secondary routes present a maintenance challenge for state DOT's. For GDOT, it is estimated that over 3 million traffic signs are to be inventoried, making a manual survey effort overwhelming.

RP 15-11 implemented efficient inventory methods on Georgia interstate highways not only for traffic sign inventory but also for pavement condition data collection using technology developed from the RS-GAMS research. A complete 22,344 sign data on Georgia's interstate highway system has been inventoried for the first time with MUTCD codes, classifications, overhead signs, and conditions using a streamlined procedure (see Figure 5). Also, a complete 1,513-mile survey of asphalt pavement condition (i.e. COPACES) data, based on GDOT pavement distress protocol and crack classification, has been collected with the detailed pavement distresses and ratings to support the Georgia Asset Management System in GDOT.



**FIGURE 5 GDOT sign inventory conditions category distribution.**

The successful implementation demonstrated that the streamlined procedures provide consistent, reliable, and cost-effective means for traffic sign inventory and pavement condition evaluation on interstate highways. More importantly, the developed methods eliminate the need for workers' exposure to roadway hazards and dramatically improve safety. This innovation can also be extended to other state DOTs and Public Works in local governments. Finally, this project's innovation received an **AASHTO High Value Research Award** from the AASHTO Research Advisory Committee. ***This award will be presented to the Commissioner at the AASHTO Annual Meeting.***

## POLICY/WORKFORCE

### ***Field Test Based Guidelines Development for the Integration of Unmanned Aerial Systems (UASs) in GDOT Operations [RP 16-09; Colette Edmisten; Developmental]***

Since 2013, Georgia Tech and GDOT have been researching the potential applications of UASs for GDOT operations. An earlier feasibility study (RP-12-38) introduced a variety of UAS applications in traffic management, transportation, and construction disciplines related to state DOTs, integrating aerial data into GDOT drawing software programs, and dealing with safety and restricted or complicated access issues.

The objectives of ongoing RP 16-09 are to (1) determine the technological feasibility and understand the advantages, limitations, legal and social implications of UAS use on various tasks; (2) propose Federal Aviation Administration (FAA) compatible guidelines for integrating these systems into GDOT operations; and (3) develop two workshops for GDOT personnel on the use of UAS technology for tasks related to GDOT operations tested in the research.

As of July 2017, the UAS research team has performed several focus group sessions, various field tests, and one workshop seminar for GDOT personnel involved in the UAS research. The seminar agenda included (1) introduction to the research project; (2) overview of UAS and its related regulations; (3) discussion of results from initial field tests; and (4) a brainstorming session on UAS integration through policies and procedures. The research team also works with GDOT Legal Services and GDOT Employee Safety staff that have recently developed a draft UAS policy that could be implemented by GDOT later this year.



**FIGURE 6 Seminar for GDOT personnel on UAS research.**

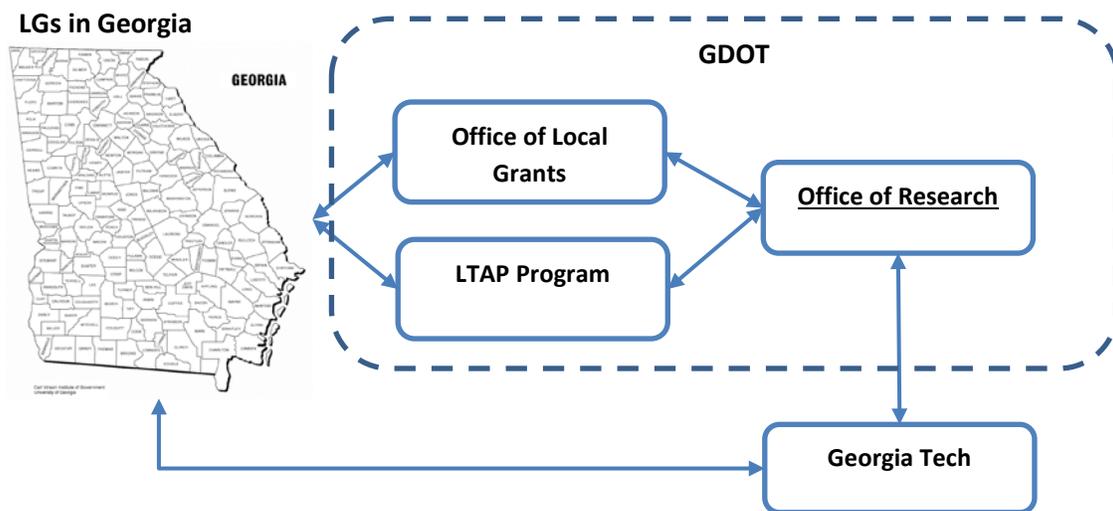
**AASHTO Technical Services Programs (TSPs)—Transportation Curriculum Coordination Council (TC3) [Jeff Conrad; Developmental]**

The AASHTO TSPs were established by the AASHTO Board of Directors to address common needs for policy development, standards setting, and technical activities by pooling voluntary contributions from participating state DOTs. GDOT supports, through research funds, TSPs that have significant research or technology transfer components that benefit GDOT.

TC3 is a technical service program that focuses on developing training products for technical staff in construction, maintenance, and materials. GDOT has integrated the TC3 library of on-line training modules (41 out of 120) into GDOT’s Learning Management System that can be leveraged by state and local government staff. As of July 2017, approximately 490 personnel have utilized this cost-effective TC3 resource for their career development.

**Implementation of An Enhanced Computerized Pavement Condition Evaluation System for Georgia’s Counties and Cities (COPACES-CC) [RP 14-27; Norm Cressman, Beverly Fontenot, Larry Barnes; Developmental]**

Better management of pavement assets is not just a critical task for state DOTs, but it is also an emergent task for local governments (LGs). Since 2012, GDOT has promoted LGs’ capabilities to effectively conduct pavement asset management by transferring GDOT knowledge and practices on pavement performance monitoring, preservation, and management to LGs. In 2014, GDOT developed an enhanced COPACES-CC via RP 14-27 using the most current cloud computing and mobile technologies. However, the most challenging aspect of COPACES-CC was not the software itself but obtaining more local agencies’ buy-in on the tool. Several successful strategies for technology transfer were used to engage all parties, i.e. the developer (Georgia Tech), the sponsor (GDOT), and the end users (LGs), in the development and implementation process (see Figure 7). A pooled-fund plan was developed to obtain voluntary contributions from participating LGs to sustain the use, maintenance, and development of COPACES-CC.



**FIGURE 7** Organizational structure for COPACES-CC development and implementation.

***Synthesis of the Project Leadership Staffing Needs for Successful Development of Alternative Delivery Programs [RP 16-17; Darryl VanMeter; Response]***

Attracting and retaining talented staff has always been a challenge for state DOTs. When it comes to innovative project delivery of GDOT megaprojects in the Major Mobility Investment Program (MMIP), a unique set of project management skills is required to perform design–build (DB) services. The Office of Innovative Delivery (OID) completed this research synthesis to obtain the state-of-practice on staffing in state DOT Offices that focus on alternative delivery.

Besides information already known, the synthesis gathered new and more detailed information that will help inform GDOT’s staffing and delivery of its DB and P3 programs. GDOT is in a transitional period in many respects for this subject, based on market conditions. At the same time, GDOT is challenged to deliver significantly more work with fewer in-house staff. This synthesis provides the snapshot of nationally available information on the subject and enables quick answers to emerging questions as GDOT moves into the next generation of a successful alternative delivery program. This synthesis will be retained and consulted as GDOT moves forward in executing program delivery models that use the Program Management Consultant/General Engineering Consultant model.

**SAFETY**

***Applying the Highway Safety Manual (HSM) to Georgia [RP 12-15 & RP 13-17; Daniel Pass; Developmental]***

GDOT began implementation of Data-Driven Safety Analysis (an HSM methodology) in 2011 and is currently evaluating recent advances in HSM software and capabilities. ODPS began planning for implementation in July 2010, one month after the HSM was published. In August 2011, the Office of Roadway Design began developing guidelines, example studies, and training for implementation within the GDOT design offices. At that time the roadway type to which HSM could be applied was limited, and in many cases the method could not be applied. It was also evident that calibration to Georgia crash data was vitally needed. This local calibration would also refine the specific comparisons that could be made to address specific decisions that would add value to projects. Three research projects related to HSM were begun in 2012 and 2013 to support HSM implementation at GDOT. Two are complete, and one will be complete this year (RP 14-32, “Evaluation of Cost Effectiveness of Illumination as a Safety Treatment at Rural Intersections”).

A major finding from RP 12-15 and RP 13-17 was that the application of HSM is significantly hindered by a lack of local calibration, and that local calibration was difficult due to the condition of crash data in Georgia, data necessary for developing local calibrations. Consequently, application of HSM has been limited largely to in-house design. There are areas that remain useful, notably for evaluation of intersection control and for design exceptions/variance. A policy was published last January which requires use of HSM for design exception/variance. At present, GDOT is moving toward a broader HSM implementation.

Specific areas where GDOT has applied it include: (1) revised concept reports; (2) design exceptions and variances; and (3) value engineering study responses.

***Active Work Zone Safety Using Emerging Technologies [RP 11-10; Ernay Robinson; Feasibility]***

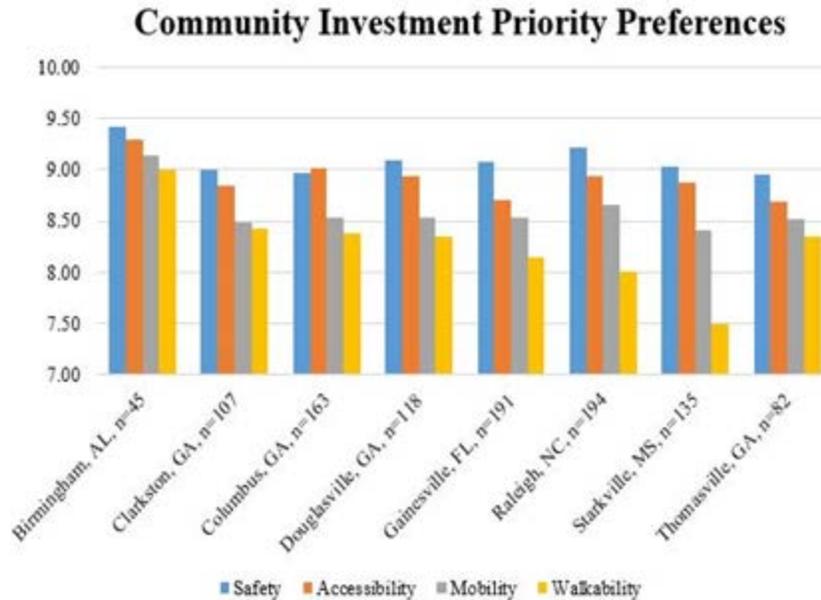
The dynamic nature and limited work space of roadway work zones contribute to a dangerous work environment for construction workers. These characteristics can create hazardous proximity situations since pedestrian workers are required to operate in close proximity to heavy construction equipment. This research aims to identify reliable and cost-effective technologies that can be used in real-time to detect a hazardous proximity situation between construction equipment and pedestrian workers and provide an appropriate warning. The Bluetooth-based technology (see Figure 8) developed by the Robotic and Intelligent Construction Automation Lab at Georgia Tech was proven to be reliable and effective in providing additional layers of hazard avoidance in experimental field trials and one active construction work zone. OM and Georgia Tech are planning for broader implementation of the enhanced Bluetooth design system on linear construction work zones. Furthermore, the safety incident field data could be used in safety planning meetings for construction workers.



**FIGURE 8 Bluetooth proximity detection and alert system—beacon mounted on a wheel loader (left), and personal protection unit held by a test person (right).**

***Sidewalk Survey Implementation for the Southeast [RP 16-35; Katelyn Digoia; Response]***

Active management of community sidewalks as transportation assets requires that agencies inventory and assess the condition of their pedestrian infrastructure and assess deficiencies in light of public input on how to prioritize repairs. This project developed stated preference survey data on the perception of the existing walking environment and how funds should be allocated to address sidewalk deficiencies. Survey responses indicated universal support in prioritizing projects that address safety concerns near schools and transit stops. Safety, accessibility, mobility, and walkability were all considered to be high priorities for addressing pedestrian infrastructure concerns (see Figure 9).



**FIGURE 9 Community Investment Priority Preferences.**

The findings of this research are available for designers and planners to develop a sidewalk repair prioritization system that is responsive to local community values. It is expected that such investment decisions will enhance the partnership between LGs and their constituents, and thus yield an improved sidewalk network that serves local pedestrian transportation needs.

### **STRATEGIC HIGHWAY RESEARCH PROGRAM-2 (SHRP-2)**

Besides managing core GDOT research in direct alignment with GDOT strategic goals, OR also participates in strategic highway research at the national level. An example of this strategic research is SHRP-2, an ongoing program that includes four research focus areas: Safety, Renewal, Reliability, and Capacity. GDOT has participated in the following SHRP-2 projects: L01/L06 (Organizing for Reliability), R09 (Risk Management), R10 (Managing Complex Projects), and R26 (Pavement Preservation). In June 2016, GDOT was selected as a recipient of implementation and technical assistance through Round 7 of SHRP-2 for another project, Nondestructive Testing for Concrete Bridge Decks (R06A).

### **Updates**

The R10 strategies have been rigorously evaluated by OID to enhance its DB manual. Complexity mapping, five-dimensional project management methods, and several R10 tools were incorporated into the DB manual to facilitate managing complexity of GDOT megaprojects in the MMIP over the next ten years. The updated DB manual developed in partnership with OID is found at <http://www.dot.ga.gov/PartnerSmart/DesignManuals/DesignBuildManual>.

For R26, GDOT completed three preservation projects (ultrathin overlay, fog seal, and cold-in-place recycling). The ultrathin asphalt overlay (4.75 mm) was placed in Dahlonega in May

2014. The fog seal project in Macon (I-475) was completed in November 2014, and it received the Asphalt Emulsion Manufacturers Association's 2016 Past Presidents' Award for Emulsion Excellence. It was recognized as a project that utilizes asphalt emulsion technology, which is environmentally sound, energy efficient, and cost effective. OM, GDOT District 3 Maintenance, and Ergon Asphalt and Emulsions, Inc. were the award recipients.