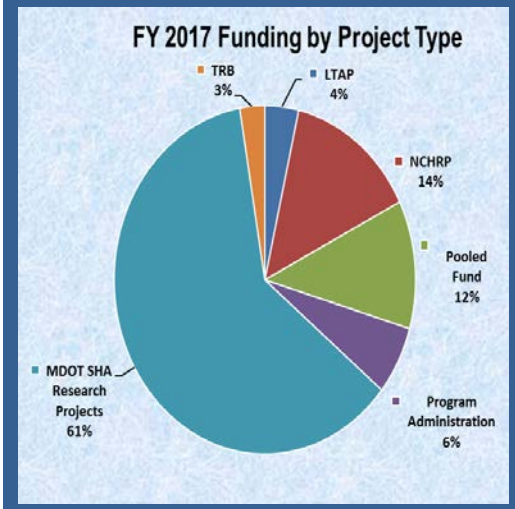
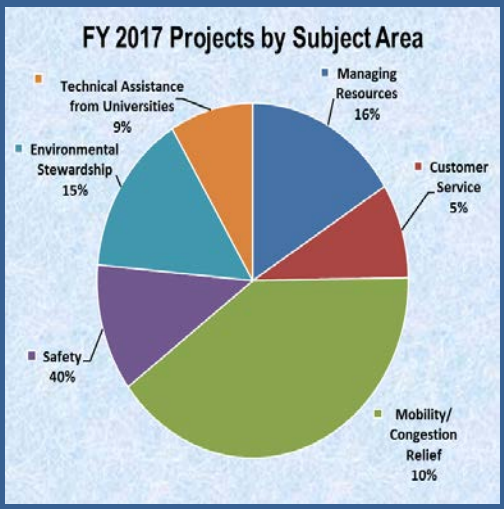
Research Annual Report

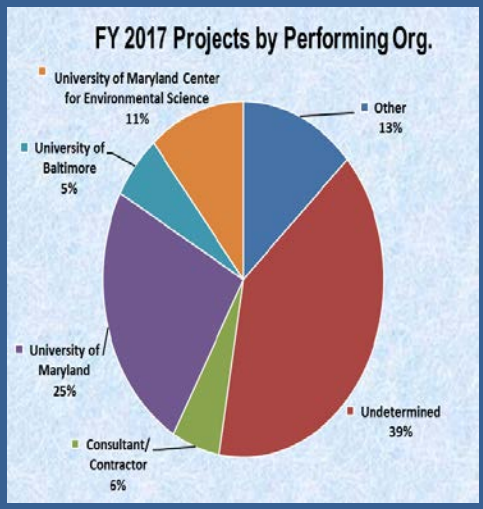
STATE PLANNING & RESEARCH PART II

2017 At-A-Glance JANUARY 1, 2017 – DECEMBER 31, 2017

This report presents a summary of the Maryland Department of Transportation State Highway Administration's (MDOT SHA) State Planning & Research (SPR) Part II Program. The funding statistics are provided for the FY 2017 Research Work Program in the following charts. The tables on pages 2 through 5 list all MDOT SHA-funded research projects by subject area that were active or completed during 2017. Two of the completed projects are highlighted starting on page 6.







LTAP	$ 170,000
NCHRP	$ 658,909
Pooled Fund Studies	$ 560,000
Program Administration	$ 300,000
MDOT SHA Research Projects	$ 2,890,494
TRB	$ 125,810
Total	**$ 4,705,213**

Managing Resources	$ 465,000
Mobility/ Congestion Relief	$ 249,999
Safety	$ 1,157,573
System Preservation/ Maintenance	$ 336,434
Environmental Stewardship	$ 431,488
Technical Assistance from Universities	$ 250,000
Total	**$ 2,890,494**

Other	$ 335,000
Undetermined	$ 1,000,000
Consultant/ Contractor	$ 139,789
University of Maryland	$ 626,514
Morgan State	$ 149,999
UMCES	$ 279,192
Total	**$ 2,530,494**

In 2017 the Research Division focused on providing access to research results from other states and transportation organizations through email announcements. The announcements are posted on the Research Division's Intranet page and routed to an email group of employees who signed up to receive subject specific information. Eighty-seven new users were added to the distribution list in 2017 and one hundred seventy-seven information announcements were disseminated.

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MDOT SHA 2017 Research

TABLES ARE ORGANIZED BY SUBJECT AREAS:

ABBREVIATIONS:

MDOT SHA	Maryland Department of Transportation State Highway Administration
FHWA	Federal Highway Administration
MSU	Morgan State University
TU	Towson University
UB	University of Baltimore
UMBC	University of Maryland, Baltimore County
UMCP	University of Maryland, College Park
UMCES	University of Maryland Center for Environmental Science

Research projects that are still active

Completed research projects

Safety

Project Number	Project Title	Performing Organization	Research Manager	Work Program	Funding	% Complete as of 12/31/2017	FY 2017 Expenditures	Spotlight
SP609B4F	Fatigue Resistant Design Criteria for MD SHA cantilevered Mast Arm Signal Structures	UMCP	Sharon	FY 2016	$153,915	86%	$ 83,277.67	
SP709B4N	Red Light Camera Research	UMCP	Hua	FY 2017	$125,000	90%	$ 45,677.18	X

Mobility/Congestion Relief

Project Number	Project Title	Performing Organization	Research Manager	Work Program	Funding	% Complete as of 12/31/2017	FY 2017 Expenditures	Spotlight
SP609B4E	Development of Traffic Management Decision Support Tool for Freeway Incident Traffic Management (FITM) Plan Deployment	UMCP	Sharon	FY 2016	$168,343	95%	$ 145,178.60	
SP709B4H	Potential Effects of Composition and Structure of Dynamic Message Sign (DMS) Messages on Driver Behavior and Their Decision to Use Freeway Incident Traffic Management (FITM) Routes	MSU	Sharon	FY 2017	$120,000	22%	$ 4,831.89	
SP709B4K	Analyzing Traveler's Response to Different Active Traffic Management (ATM) Technologies in a Simulated Environment	UMCP	Sharon	FY 2017	$150,000	36%	$ 111,501.96	

Administrative

Project Number	Project Title	Performing Organization	Research Manager	Work Program	Funding	% Complete as of 12/31/2017	FY 2017 Expenditures	Spotlight
SP709B42	Research Program Development and Implementation	In-House MDOT SHA	Allison	FY 2017	$300,000	67%	$ 200,293.84	

System Preservation/Maintenance

Project Number	Project Title	Performing Organization	Research Manager	Work Program	Funding	% Complete as of 12/31/2017	FY 2017 Expenditures	Spotlight
SP509B4J	Determination of Asphalt Millings Properties as Related to Stormwater Management Concerns	UMCP	Sharon	FY 2015	$170,520	70%	$ 47,286.44	X
SP709B45	LTPP Maryland Performance Data Collection/Monitoring	In-House MDOT SHA	Allison	FY 2017	$30,000	100%	$ 24,873.15	
SP709B4D	Best Practices for Placing Concrete Overlays on Prestressed Slab Bridges	UMCP	Sharon	FY 2017	$100,000	45%	$ 44,896.37	
SP709B4G	Implementation of Non-nuclear In-Situ Devices to Replace the Nuclear Density Gauge, to Meet the Mechanistic-Empirical Pavement Design Guide (MEPDG) Requirement	UMCP	Sharon	FY 2017	$150,000	19%	$ 1,446.38	

Environmental Stewardship

Project Number	Project Title	Performing Organization	Research Manager	Work Program	Funding	% Complete as of 12/31/2017	FY 2017 Expenditures	Spotlight
SP509B4E	Identification of Low Growing, Salt Tolerant Turfgrass Species Suitable for Use Along Highway Right of Way	UMCES	Hua	FY 2015	$100,651	100%	$ 2,973.33	
SP609B4C	Use of Compost Blankets to Establish Permanent Vegetation	UMCP	Hua	FY 2016	$200,000	70%	$ 41,765.09	
SP609B4G	Evaluating the Success of Meeting Design Objectives on Previously Constructed OOS Stream Stability Projects	Penn State University	Hua	FY 2016	$125,000	100%	$ 49,941.90	
SP609B4H	Long Term Bed Degradation in Western Coastal Plain Streams	Consultant/ Contractor	Hua	FY 2016	$110,000	78%	$ 55,570.11	
SP709B4B	Evaluating Integrated Roadside Vegetation Management Techniques to Improve Pollinator Habitat	UMCP	Hua	FY 2017	$100,000	65%	$ 47,986.55	
SP709B4C	Turfgrasses Suitable for Maryland Right-of-Ways - Phase II Field Tests	UMCES	Hua	FY 2017	$150,000	48%	$ 62,139.15	

Managing Resources

Project Number	Project Title	Performing Organization	Research Manager	Work Program	Funding	% Complete as of 12/31/2017	FY 2017 Expenditures	Spotlight
SP509B4G	Efficient and Effective Implementation of Alternative Project Delivery	UMCP	Sharon	FY 2015	$164,060	90%	$ 17,833.70	
SP709B44	Evaluation of Experimental Features	In-House MDOT SHA	Allison	FY 2017	$80,000	54%	$ 48,024.43	
SP709B47	New Products Evaluation	In-House MDOT SHA	Allison	FY 2017	$80,000	99%	$ 58,913.24	
SP709B48	Project Implementation	In-House MDOT SHA	Allison	FY 2017	$100,000	0%	$ -	

Technical Assistance from Universities

Project Number	Project Title	Performing Organization	Research Manager	Work Program	Funding	% Complete as of 12/31/2017	FY 2017 Expenditures	Spotlight
SP509B4A	Analyzing the Impact of Median Treatment Safety Countermeasures on Bicycle and Pedestrian Safety	UMCP	Hua	FY 2015	$100,000	100%	$ 144,787.74	
SP609B4A	SHA Customer Satisfaction Research	UB	Allison	FY 2016	$200,000	100%	$ 66,857.00	
SP709B46	Morgan State Summer Internship Program	MSU	Sharon	FY 2017	$36,320	100%	$ 36,320.00	

National Initiatives

Project Number	Project Title	Performing Organization	Research Manager	Work Program	Funding	% Complete as of 12/31/2017	FY 2017 Expenditures	Spotlight
NCHRP	National Cooperative Highway Research Program	Other	Allison	FY 2017	$669,638	100%	$ 669,638.00	
SP709C41	Local Technical Assistance Program (LTAP)	UMCP	Allison	FY 2017	$150,000	46%	$ 68,364.76	
SP709B43	TRB Technical Activities Service	Other	Allison	FY 2017	$100,000	0%	$ -	
SP709B4A	AASHTO Technical Services Programs	Other	Allison	FY 2017	$125,810	100%	$ 125,810.00	

Transportation Pooled Fund Studies

Project Number	Project Title	Lead Agency	Research Manager	Work Program	Funding	Transfer Completed?	FY 2017 Expenditures	Spotlight
TPF-5(176)	Traffic Simulaton & Analysis - FFY 2017-2019	FHWA	Sharon	FY 2017	$105,000	Y	$ 105,000.00	
TPF-5(198)	Urban Mobility Study	TXDOT	Sharon	FY 2017	$25,000	Y	$ 25,000.00	
TPF-5(206)	Research Program to Support the Research, Development, and Deployment of System Operations Applications of Vehicle Infrastructure Integration (VII)	VDOT	Sharon	FY2017	$50,000	Y	$ 50,000.00	
TPF-5(267)	Accelerated Performance Testing for the NCAT Pavement Test Track	ALDOT	Sharon	FY 2017	$0	Y	$ -	
SP409B4P/ TPF-5(285)	Standardizing the Lightweight Deflectometer (LWD) equipment for measuring the Modulus/Stiffness of Unbounded Soils and Aggregate	UMCP	Sharon	FY 2014	$371,985	Y	$ 32,991.00	
TPF-5(299)	Improve the Quality of Pavement Surface Distress and Transverse Profile Data Collection and Analysis FFY 2017-2019	FHWA	Sharon	FY 2017	$45,000	Y	$ 45,000.00	
TPF-5(305)	Regional and National Implementation and Coordination of ME Design FFY 2017-2019	FHWA	Sharon	FY 2017	$30,000	Y	$ 30,000.00	
TPF-5(315)	National Accessibility Evaluation	MNDOT	Sharon	FY 2017	$0	Y	$ -	
TPF-5(316)	Traffic Control Device (participation revisited on annual basis)	FHWA	Sharon	FY 2017	$10,000	Y	$ 10,000.00	
TPF-5(317)	Evaluation of Low Cost Safety Improvements (participation revisited on an annual basis)	FHWA	Sharon	FY 2017	$30,000	Y	$ 30,000.00	
TPF-5(326)	Develop and Support Transportation Performance Management Capacity Development Needs for State DOTs - Added 2/10/16	RIDOT	Sharon	FY 2017	$0	Y	$ -	
TPF-5(330)	No Boundaries Roadway Maintenance Practices	ODOT	Sharon	FY 2017	$10,000	Y	$ 10,000.00	
TPF-5(347)	Development of a Maintenance Decision Support System	SDDOT	Sharon	FY 2017	$25,000	Y	$ 25,000.00	
TPF-5(351)	Self De-Icing LED Signals	KDOT	Sharon	FY 2017	$20,000	Y	$ 20,000.00	
TPF-5(353)	Clear Roads Winter Highway Operations	MnDOT	Sharon	FY 2017	$25,000	Y	$ 25,000.00	
TPF-5(364)	Utilization of Laser Induced Breakdown Spectroscopy for Real-Time Testing and Quality Control Monitoring of Aggregate Materials used in Highway Construction	KDOT	Sharon	FY 2017	$150,000	Y	$ 150,000.00	
TPF-5(369)	Collaborative Development of New Strategic Planning Models	ODOT	Sharon	FY 2017	$75,000	Y	$ 75,000.00	
TPF-5(371)	Developing "Hiqhway Capacity Manual" Capacity Adjustments for Agency Connected and Autonomous Vehicle Operational Planning Readiness under Varying Levels of Volume and Market Penetration	ODOT	Sharon	FY 2017	$30,000	Y	$ 30,000.00	

2017 Research Highlights

SP709B4N – Red-Light Cameras' Impact on Driver Behaviors

Red-light cameras (RLC) are a popular countermeasure to reduce red-light running and improve intersection safety. However, studies show that the reduction in side impact crashes at RLC intersections are often accompanied by no-change or an increase in the number of rear-end collisions. Are RLC effective at reducing intersection crashes? Do they have a positive impact on driver behavior? MDOT SHA decided to investigate RLC intersections in Maryland to try and answer these questions.

Phase 1 of the study used crash data to evaluate twenty-seven RLC locations. Phase 2 conducted behavior observations at eight intersections to investigate if RLC impacts driver behavior, especially their responses to a yellow light. The eight intersections, two three-intersection clusters and two individual intersections, are in Montgomery and Prince George's counties of Maryland. An intersection cluster includes a RLC intersection, an upstream, and a downstream no-RLC intersections for control comparisons.

Results

The findings from the crash count comparison at the 27 RLC locations were consistent with findings in other studies. Twenty-five intersections have three years before and three years after RLC deployment crash counts. After RLC deployment nineteen (76%) of them have fewer side impact crashes and eleven (44%) fewer rear-end collisions. Ten intersections (40%) have fewer side impact crashes but more rear-end collisions.

In Phase 2, more than 300 drivers were observed at the eight intersections. Traffic flow characteristics at the two intersection clusters showed that the effectiveness of RLC may be correlated with the percentage of aggressive drivers in its driving populations (see Tables 1 and 2).

The number of drivers trapped in a dilemma zone at a RLC-effective intersection is higher than that in a RLC-ineffective intersection. The Institute of Transportation Engineers (ITE) defines a dilemma zone at a signalized intersection as the space between two points on an approach to a signalized intersection, beginning at a point where approaching drivers—when shown a yellow light—will stop at the stop line of the intersection and ending where drivers will proceed through the intersection before the light turns red. Between these two points, drivers are faced with the dilemma of deciding whether to stop or proceed through the intersection. This is a dilemma because they may not be able to stop comfortably at the stop line, nor pass the intersection before the light turns red.

The results from Phase 2 indicate that the existence of an RLC at an intersection does indeed encourage drivers to stop when the traffic light is yellow. Some drivers were observed stopping when, based on theoretical calculation, they may not be able to stop comfortably at the stop line. This observation may explain why some RLC intersections experience an increase in rear-end collisions.

<u>Possible Positive Behavioral Impacts</u> at a RLC and its downstream intersections:

- Reduction in aggressive driving behavior;
- More drivers reduce speeds when driving through a yellow light;
- More drivers "stop" at a yellow light; and
- Decreased number of red-light-running vehicles and aggressive driving, such as entering the intersection one second ahead of the all-red phase.

Possible Negative Behavioral Impacts:

- May cause some drivers to make improper decisions such as stopping in the "must-go" zone (12% at MD650; 3.9% at US301).
- At the MD 650 intersection cluster, the percentage of improper decisions was higher at the RLC intersection (12%) than at the upstream (0.4%) and downstream intersections (6.1%).

Long-term performance analysis to assess the impacts on traffic flow characteristics and safety is on-going and will be completed in spring 2018.

Table 1: Driver Decisions in Dilemma Zones

Intersection Cluster	**Intersection Position**	**Choose to stop when too close to stop line** (potential rear-end collision)	**Choose to pass when too far from stop line** (potential side impact crash)	**# of Vehicles Trapped** in calculated dilemma zones	**# of Vehicles Observed** encountering a yellow phase
MD 650 (Effective)	Upstream	0.4% (1)	5.9% (15)	23.7% (60)	253
	RLC	**12.0%** (32)	0.7% (2)	6.7% (18)	267
	Downstream	6.1% (12)	2.3% (5)	5.1% (10)	196
US 301 (Ineffective)	Upstream	0.5% (2)	0.9% (4)	**30.1%** (131)	435
	RLC	**3.9%** (21)	1.3% (7)	**37.4%** (202)	540
	Downstream	2.4% (7)	4.7% (14)	**27.0%** (80)	296

Table 2: Red-Light Running Observations

Intersection Cluster	**Intersection Position**	**# of Red-Light Running** (after the onset of the all-red phase)	**Cross 1 second** prior to the all-red phase	**Cross 2 seconds** prior to the all-red phase	**# of Drivers choose to pass** encountering a yellow phase
MD 650 (Effective)	Upstream	3.1% (5)	17.2%		163
	RLC	**2.7%** (7)	15.8%	36.2%	270
	Downstream	2.7% (4)	15.8%		146
US 301 (Ineffective)	Upstream	9.2% (7)	31.6%		76
	RLC	**3.8%** (3)	15.2%	39.2%	79
	Downstream	3.6% (1)	17.9%		28

SP509B4J – Hydraulic and Environmental Behavior of Recycled Asphalt Pavement in Highway Shoulder Applications

Recycled asphalt has also been identified as America's #1 recycled material. Recycled asphalt pavement (RAP) is an excellent material for use as a base course aggregate or hot mix asphalt (HMA) aggregate. However, there is limited guidance on the use of RAP in highway shoulder applications and a lack of information regarding its hydraulic performance and environmental suitability when used to address the highway shoulder edge drop-off created by pavement resurfacing or overlay.

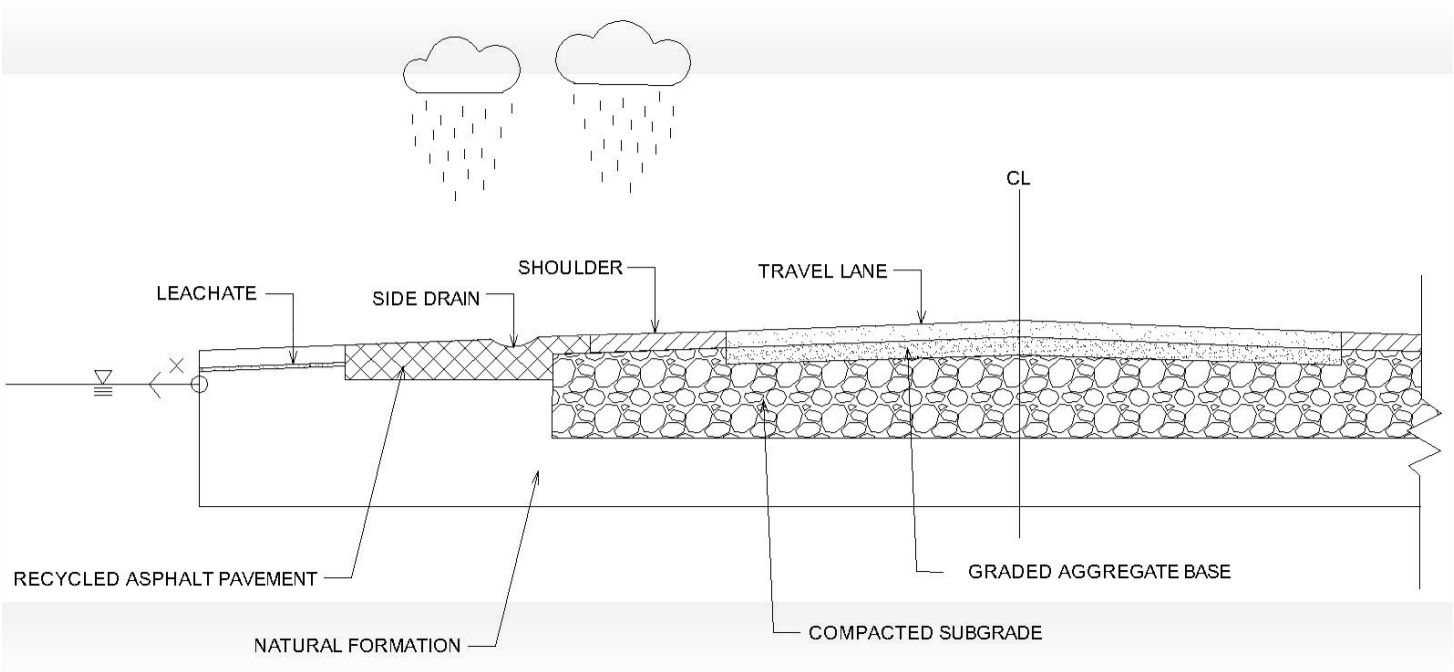

Figure 1: Conceptual model used to analyze the flow of recycled asphalt pavement leachate into surface waters

The goal of this study was to investigate the environmental impacts associated with the use of RAP in highway shoulder edge drop-off applications. The study was divided into five tasks:

1. RAP Collection and Characterization – RAP samples obtained from different highways around Maryland and covering a wide range of characteristics, were investigated.
2. Hydraulic Conductivity Tests – Laboratory tests, using a flexible wall permeameter to determine the vertical hydraulic conductivities of the RAP samples, were performed.
3. Batch Leaching Tests – The goal of the batch leaching tests was to obtain baseline data useful for comparison to regulatory standards. These data were useful for comparison of the leachate concentrations obtained from different RAP samples.
4. Column Leaching Tests – These tests were conducted to understand the leaching performance of RAP samples and evaluate the potential for leaching of metals into surrounding ground- and surface-waters. These tests simulated the flow conditions likely to exist in the field.
5. Computer Model - An analytical framework was developed to simulate variably saturated (saturated and unsaturated) flow and transport of metals leaching from RAP-incorporated roadways into surface waters.

Hydraulic conductivity of seven Maryland (RAPs) was evaluated and was found to be comparable to that of natural aggregates with the gradation of clean sand-gravel mixture as it ranged from 6.9 x 10-3 cm/s to 1.1 x 10-2 cm/s.
The results of the batch leaching tests showed that the concentrations of all metals, except copper, were below the water quality limits. Column leaching tests yielded generally low or non-detectable metal concentrations. The deviation from this trend occurred for copper and zinc concentrations, but they were still below regulatory limits.

WHAT WAS THE OUTCOME?

Concentrations of all metals from RAP conformed to the water quality standards in surface waters. In all cases, the metal concentrations in RAP and control material leachates decrease even further in the surface waters with the increasing horizontal distance. Once the leachates enter the surface waters, the metal concentrations decrease by 50% at a horizontal distance of 26 m and remain below the EPA WQLs; however, these water quality limits are related to drinking water standards and do not apply to stormwater runoff.

Maryland RAPs can be deemed as environmentally sound materials for the construction of highway shoulder edge drop-off applications. They can be classified as free-draining materials but should be avoided in shoulder applications that are in direct contact with waterways or surface waters.

HOW WILL MDOT SHA USE THE RESULTS?

MDOT SHA will seek approval from the Maryland Department of the Environment to use RAP has a highway shoulder edge drop-off material. This includes pavement preservation applications such as resurfacing or overlays in locations that are not directly draining to the waterways.

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