2012 MDOT Research Needs Workshop Summary
Construction and Materials

Ranking	Need Summary
1	**Field of studying of trench widening** Several districts are experiencing problems that could be related to trench widening. Trench widening behavior can become an issue of public safety in some instances, and is an area with potential for economic enhancement. Research is needed to work toward developing a standardized process to provide statewide continuity and improve performance. Issues such as the following warrant investigation: 1) what are the major contributors to problematic performance on trench widening projects; 2) what are pros and cons of current trench widening construction methods; and 3) what effects do trees and vegetation have on performance.
2	**Field aging of asphalt incorporating warm mix technology** In recent years, the number of options to produce and place asphalt concrete has increased tremendously. While these options are positive for the industry, they do bring with them questions such as are all mixes being produced with the different methods the same after a period of service? Research is needed to investigate lower mixing temperatures and also to study longer haul distances. The research should be focused mostly on field aging, with complimentary laboratory aging as appropriate. The research should include compaction of full scale test sections alongside laboratory compacted specimens.
3	**Pavement structural capacity investigation** Structural capacity of pavement layers is an ever present issue that should be re-visited periodically as materials and design methods change. Research is needed where materials are characterized one at a time to capture performance and damage properties for use in pavement design. The research should be aimed at optimizing pavement layer thicknesses using updated material properties.
4	**Ground tire rubber binder evaluation system** Recycling tires in an efficient manner is an environmental and a sustainability issue that can also reduce dependence on virgin polymers and also reduce the cost of polymer modification in some instances. Research is needed toward binder specifications and mix design methods. Major research tasks could include: 1) investigating processing methods; 2) evaluating methods to maintain consistency; 3) measure how tire rubber effects performance; 4) develop standardized mix design methods applicable to various tire addition methods; and 5) consider using SBS polymer and tire rubber in one binder.

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5	**Implementation of intelligent compaction** Intelligent compaction has many appealing characteristics. Roller patterns are difficult to control with conventional techniques. Research is needed where a literature and practice review is coupled with evaluating best practices for the purpose of presenting information to the paving industry in technical forums.
6	**Waterproofing soils** Construction projects can be affected by erosion prevention methods, especially when large exposed areas are present. MDOT and their contractors need tools to protect contractor products that are complete from rainfall. Research is needed where test sites for best management practices in erosion control are established (actual field projects or a dedicated facility are options). Additional research needs are a literature and practice review related to performance in terms of environmental quality and erosion control coupled with screening available products and then testing the best products at the established test sites.
7	**Use of limestone modified portland cements for structural concrete** Portland-limestone cement (PLC) has considerable potential to enhance MDOT structural concrete. Potential enhancements include improved concrete performance and additional sustainability of the cement industry (both of these enhancements are beneficial to MDOT). PLC cements have shown promise worldwide, but there is little experience with MDOT materials. Research is needed related to bridges to assist in developing specifications related to key properties of PLC. Major research tasks could include a literature review, pilot scale admixtures study, a bench scale cement blends investigation, and a mix design suite compared to ordinary portland cement (OPC).
8	**Optimized pavement marking for thermoplastic and glass beads** Pavement markings are a considerable economic and safety consideration for any highway. Research is needed to optimize pavement marking for thermoplastic and glass beads. Research needs include: 1) how to measure reflectivity of pavement markings; 2) performing field evaluation with different applications of the same product in wet and dry conditions; 3) evaluate performance over time; and 4) evaluate design versus as placed properties.

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9	**Costs of construction delays and change orders due to utility conflicts** The interaction between MDOT related construction and utility construction is inevitable. Research is needed to quantify the cost of construction delays and change orders to MDOT and the citizens of Mississippi. The research should also determine if this cost could be reduced by putting additional resources into pre-construction. The research should review RFI information, investigate previous research and the financial implications of utility conflicts, evaluate alternative methods and determine if there are advantages, and utilize a retroactive study.
10	**Mitigate erosion at bridge ends due to long term use** Current design and construction practices lead to susceptibility of bridge ends to erosion that can lead to multiple performance problems including loss of slopes near bridge ends and loss of integrity of the bridge support structure. Density issues from compaction adjacent to structural elements are a problem in some instances. Research tasks needed include: 1) determining the mechanisms leading to erosion (literature review will be useful); 2) investigating performance benefits of joint sealing; and 3) evaluating attributes of various repair techniques (and design methods) including flowable fill, drainage methods, pressure grouting, and geosynthetics.
Other Topics	**Causes of concrete cracking in bridge decks** Concrete bridge deck cracking is a major performance issue for bridges within MDOT and also within other state DOT's. Bridge deck cracking can occur due to a variety of factors. Research is needed to evaluate existing projects with different concrete mix designs. The research should investigate what sources lead to cracking (e.g. bridge stiffness, curing, materials, construction….), and perform a benefit cost analysis of different approaches.

2012 MDOT Research Needs Workshop Summary Traffic, Safety and ITS	
Ranking	**Need Summary**
1	**Communication infrastructures** There is a need to extract and use traffic and safety data to support long term planning and real-time transportation management. The most effective ways to achieve the collection of this information needs to be studied. These efforts would include evaluation of the best ways and places to expand the communication infrastructure and improve the overall quality through application of new and innovative technologies. When possible, this expansion should take advantage of current traffic control systems. The communications infrastructure should be adapted to collect data which can be shared, directly or indirectly, with university researchers.
2	**Traveler information** Mississippi need to work towards improving information dissemination to the travelers and the general public. This could include using social media to broadcast information. It should include enhancement of the website to make it more user friendly and allow broadcasting to subscribers of desired content, including hazards and incident management information. Research efforts should examine the best approaches for this communication in an effective, coordinated, consistent manner.
3	**Event management** Efforts in the state should refer to FHWA guidelines and Part 6 Section I of MUTCD. How these can be fully implemented is an area for investigation. The design and implementation of event management systems (EMS) must be done in coordination with local stakeholders. However, the needs of these stakeholders is not broadly variant so understanding the common EMS needs and opportunities for all applications could services as a foundation for system design with customization to meet local constraints and opportunities being done on a location basis.

2012 MDOT Research Needs Workshop Summary Traffic, Safety and ITS	
Ranking	**Need Summary**
4	**Crash report data accuracy** A research effort is needed to correct, compile and summarize crash data. This effort should include filling data gaps and evaluating the accuracy of the database that exists. An effort is needed to determine additional information needs, evaluate current data collection methods, and identify causes for errors in data collected using the current system.
5	**Performance measures** To prevent needless investigation of approaches and technologies that have little potential for successful deployment in Mississippi, a review of safety and ITS activities in other "appropriate" states and FHWA is needed. This could lead to the development of a set of performance measures and goals for Mississippi which is needed. Though based on lessons learned in other states, this process must also engage state stakeholders to be appropriate and effective. As part of the development of these metrics, baseline values for each measure are needed. The data for these metrics must be easily measured and reported to facilitate transportation system improvement.
6	**Smart work zones** Strategies are needed to implement intelligent work zone safety practices that are relevant for a rural state like Mississippi. This is a complex issue related to perceptions relative to work zone safety and response to signage of state residents on a regional basis. It involves effective communication before, during and after work begins.
7	**Safety analyst** Safety analyst is the analytical tool which accompanies the highway safety manual. It must be designed and adapted to fit an abridged manual to insure proper data preparation and calibration.

2012 MDOT Research Needs Workshop Summary Traffic, Safety and ITS	
Ranking	**Need Summary**
8	**Freeway traffic congestion rerouting** A set of consistent strategies is needed to divert traffic away from congested areas to arterials. This could result in the development of a guidance document or implementation manual, but both would require an education program.
9	**Preventative maintenance of concrete bridge decks using field monitoring** Bridge deck maintenance is a considerable problem in Mississippi, as well as in other states. Research is needed that evaluates field monitoring techniques, and thereafter investigates cracking and reinforcing corrosion and deicing chemical effects. Existing bridge deck sealing products are also of interest to this research.
10	**Sight distances at railroad grade crossings** An effort is needed to benchmark current installations and criterion in Mississippi against those standards from other states. If changes are needed, legislation to codify specific changes in Mississippi will be needed as will appropriate information need to be developed to support these changes.
Other Topics	**Highway safety manual** An updated, abridged version of the highway safety manual is needed with the goal of improving its implementation in Mississippi. As a state-appropriate document is created, an approach to promote broad application will be needed.

2012 MDOT Research Needs Workshop Summary Structures and Geotechnical	
Ranking	**Need Summary**
1	**Research on scour of cohesive soils for bridge foundations** There is a growing need to establish a database on the scour characteristics of soils in in the state. This information would be enhanced if efforts could include the development of appropriate scour formulas specific to the soils cataloged in the database. At a minimum, the database should the predominant soil types most and least susceptible to scour and the factors which result in scour acceleration.
2	**Inspection and inventory of overhead sign trusses and high mast lights** A program for inspection and inventory of these transportation components is needed and a database developed which supports preventative maintenance (PM) and replacement. As part of this, one could develop inspection assessment protocol and metrics related to the type, intensity, and extent of any distress and related this to PM. There might be value in a project which surveys other appropriate state DOT's regarding the criteria and standards of practice used by those agencies.
3	**State DOT survey to compile other DOT pre-stressed concrete beam connection details** Improvements in connections may exist. A review of connection details used in other state agencies could provide better continuity details and best practices for design, specification, and construction. Therefore, effort to contact other State DOT's for their criteria and practice, evaluation of this material in relation to MDOT practices and requirements, and the development of a best practices compilation would appear to have merit. The effort should also identify testing or research that supports that support innovations in this area.
4	**Define appropriate truck-trailer configurations and axle weights for Interstate, US, state and local road systems** This research has been done at the national level, but traffic studies on a statewide basis are needed. Information to be collected would include the types of trucks operating on the different road classifications in Mississippi, and whether the existing legal loads and axle configurations need to be changed. This work should include measurements of "weigh in motion" and would need to be done in coordination with MDOT's Enforcement Office.

2012 MDOT Research Needs Workshop Summary Structures and Geotechnical	
Ranking	**Need Summary**
5	**State DOT survey to compile other DOT pipe pile applications** The criteria and best practices used by other state DOT's might shed light on options and improvement in the application of pipe piles to transportation infrastructure. A study of appropriate states could yield this information. It should identify testing and research that supports advances in this area and the application of results from this research. There are specific areas of interest expressed during the workshop. One would be to have a comparative analysis of the performance of open-end and closed-end pipe piles under varied conditions to define which is better. Similarly, a better understanding of when to use pipe piles as opposed to other types of deep foundations is needed. This decision process would have to be based on cost but must also address of design and construction differences for non-seismic and seismic conditions.
6	**Blending high volume change materials and low volume change materials for acceptable performance** There are a number of issues that must be addressed if effective blending is to be achieved. Is unclear what materials can be used in the blending and still keep swelled down to a respectable level. There is also an issue of how one can quickly test for quality control in the field. Work is needed to solve the problems associated with dealing with the material already at the site and how one can modify an A7 material with a 100% swell to achieve a desire level swell; for example, 50%.
7	**Approach to bridge inspection and monitoring technology for existing bridges** Little attention has been paid to the approach currently used for bridge inspection. The current approach is historic and there is now uncertainty as to if there a limit to the way it is performed now. A review of the current approach in light of new technologies would seem to have merit. Also, are there ways one can "see" inside that existing connection without having to dismantling it? A study of testing and monitoring of joints is needed as is an better understanding of out-of-plane bending fatigue and solutions.

2012 MDOT Research Needs Workshop Summary Structures and Geotechnical	
Ranking	**Need Summary**
8	**Using high volume change materials for acceptable performance with the addition of chemical or mechanical stabilization, moisture control** Modification of materials with characteristics that produce high volume changes might result in a material with acceptable performance properties. These modifications could be achieved through physical or chemical modification resulting in better moisture control. What remain uncertain are the materials or methods that could be employed to yield an acceptable outcome. Determining effectiveness of chemical treatments or additives will need to be evaluated for site-specific conditions, possibly based on the clay mineral level of the soil. Also, a method for field testing and quality control and quality assurance will be needed. This could start with a survey of criteria and standards of practice currently employed by other DOTs.
9	**Mitigation of swelling potential for existing highways** The state has issues with swelling of existing highways. It is possible that by contacting other state DOT's for their criteria and practices in addressing this problem, a compilation of best practices might be developed. There are a number of considerations that would have to be addressed in compiling this information. Practicability and cost- effectiveness of the methodologies for treating existing highways with damage soils that swells would be the basis of analysis. However, site specific and system specific conditions would need to be assessed along with environmental conditions, original design specifications, design and actual use of the system, and more.

2012 MDOT Research Needs Workshop Summary Roadways, Rights-of-Way, Hydraulics and Hydrology	
Ranking	**Need Summary**
1	**Bridge scour in cohesive soils** A survey is needed to determine the extent to which bridge scour is a problem in Mississippi and under what conditions. This should be a regional and state wide approach to analyze bridge scour based upon regional sediment and soil classifications. It should include a literature review to determine what research has been done on the issue.
2	**Reduce scour around outfalls and increase bank stabilization** Better guidelines are needed to address scour and bank stabilization using a regional approach, based on soils and soil conditions found in Mississippi. In some installations rip rap under bridges has been moving or is significantly displaced, and the best solution for correcting this (replace, repair, alternatives, etc.) is uncertain. Therefore, the agency needs to develop standards for replacing rip rap including using reinforced vegetation or other, better products. A review of what other states in this region are doing to provide bank stabilization might produce lessons learns or a best practices manual. A review of the literature might provide an overview of other research and expedite identification of alternatives, but care must be exercised to insure the BMPs are appropriate for Mississippi.
3	**Erosion control** Related to environmental and construction, a review of the literature is needed to determine best practices, lessons learned, and options that apply to this region.
4	**Evaluation of pipe culvert options** Work is needed to examine applications for pipes made out of non-traditional materials. A better understanding of the time and cost associated with using non-traditional materials is needed. Alternatives and best practices need to be clarified for pipe placement under travel lanes and curbs. In some instances there is a need for fish passage allowance and options are sometimes uncertain. The work needs to look at O&M costs and the ratio of benefit and cost. The literature may be a resource in some or all of this work.

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Ranking	**Need Summary**
5	**Cost effectiveness of MDOT purchase ROW for servitude for utilities** Analysis is needed to determine if this purchase of additional right-of-way is a cost effective way to address utilities. Alternatives and cost effective solutions are needed. If properly documented, it may be worth approaching the legislature to change the law. A review of best practices by other states and reported in the literature would strengthen this analysis.
6	**Effects of ADA requirements on intersection designs** Additional information is needed to help address ADA requirements when specifying vertical alignment of the highways, whether for retro-fitting intersections or in new construction. There are a number of uncertainties that impact vertical alignment and not all are identified. The literature might help with this.
7	**Practical guidelines for bike and pedestrian paths** An effort is needed to investigate the use and safety of current bike and pedestrian paths and applications appropriate for urban and rural Mississippi. This work should investigate why some paths are effectively used and others are not and the impact of community support, make-up, and needs. We need to examine the connectivity within the community as it relates to the use of bike paths and pedestrian paths. Also, a review of the information on design criteria from other states should be performed to support the development of a manual of best practices and design standards. Work is also needed to identify when the paths are practical and when are they not. A summary of current research results is needed. Someone should investigate the ROW acquisition preservation needs of paths so a community has this information before they actually need the paths. A better understanding of pre-construction needs (grading, etc.) would be helpful for community planning.

2012 MDOT Research Needs Workshop Summary Roadways, Rights-of-Way, Hydraulics and Hydrology	
Ranking	**Need Summary**
8	**Periodically update rainfall design criteria** The intensity, duration and frequency curves used to estimate runoff need to be reviewed and updated. They define the design life of structures and allow characterization of the impact of land use changes. The values also need to accommodate changes in the future. The impact of climate change and increased rainfall from disasters needs to be investigated. Changes in system design, land use and climate change may have changed the capacity of structures from being able to handle a historical 25-year event to failing during a modern 10-year event. A review of the literature is needed and climatology data needs to be reviewed to assess trends and define design approaches.
9	**Design requirement for 3-D models for automated machine control grading** MDOT wants to be able to deliver 3-D model data to contractors so contractors do not have to make 2-D models into 3- D models. It might be useful for community outreach and involvement to define opportunities and need. However there is no documentation on the design requirements for these models. There are several issues with this approach which remain uncertain regarding accuracy needs, what needs to be provided (deliverables), handling phase construction, and dealing with different material. Manuals are needed that address which models should be supported and their applicability. Working with vendors is part of this process as is a review of the literature to define successes, failures, and opportunities.
10	**Intersection skew angle** Crash modification factors need to be calibrated to Mississippi. Literature needs to be reviewed on what has been done on the issue.

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Other Topics	**Accommodation for new stormwater regulations** The agency has not clearly defined how to match post-construction flows to pre-construction flows (or within a defined percentage) to address this issue. There are no areas in the corridors for retention and detention ponds. A review of options is needed that include the installation of adjacent facilities and increased median width. EPA has documentation that rank BMPs on effectiveness, but they are world-wide and not based upon MS soils. Work is needed to determine how applicable the BMPs are in Mississippi or how to modify them for use in this region. There is a need to compare agricultural and construction BMPs to fine what to apply where. A review of the literature to find what work has been done in this area and what issues need to be addressed should be performed.
	Post-Construction BMPs A better set of guidance and BMPs is needed in selection, design, construction, operation, maintenance of water detention and stormwater treatment systems and estimating costs. This should include detention systems to slow runoff during high flow events, linear storage devices that fit a roadway system. It would be nice to have a list of approved post-construction BMPs for Mississippi and the design criteria for them. A review of the usefulness of continuing to purchasing additional ROW instead of easements if permits are needed for post-construction BMPs in the future is needed. A review of literature from other agencies and research in other areas could help with this effort.
	Siltation To better address siltation issues, a study of alternative multi-cell box approaches to reduce siltation is needed. An additional effort is needed to study alternatives using multiple pipes to reduce siltation. The literature and research could also help identify the other BMPs that would be acceptable for use in Mississippi to reduce siltation.
	Improve roadway safety without increasing median width for non-freeways A search of the literature is needed to identify how other states handling the issues of width versus speed. A summary of key design features (geometries) that make the system safer would be helpful. A study of the benefits and costs needs to be included in this study.

2012 MDOT Research Needs Workshop Summary Roadways, Rights-of-Way, Hydraulics and Hydrology	
Ranking	**Need Summary**
Other Topics	**Alternative materials for sub-grade and base course stabilization** A better understanding of viability of construction methods to improve the application of alternative materials is needed. Understanding when and if alternative construction method produce needed results and when chemical treatment is needed. A comparison of the associated costs and benefits would be important as is a better understanding of the time requirement associated with using all alternative materials.
	Better storm drainage rehabilitation methods An investigation into ways to rehabilitate damaged storm drainage systems (e.g. culverts) without completely replacing them is needed. This work could start with a review of the literature but should relate to Mississippi's transportation systems.

2012 MDOT Research Needs Workshop Summary Professional Development	
Ranking	**Need Summary**
1	**Continued Training** There is a concern about having to go out of the state to get training on software, new design requirements, and a host of other areas in which continuing education is needed. Therefore, an opportunity exists for the development of training resource for specific areas that could be delivered at MDOT or an in-state location. This need applies for consultants, too, and engaging them in the same training has benefit when deployment or implementation occurs for the new methods, software, regulations, etc. There is need to develop a program that improves the process of inspecting construction areas. Research is needed on best practices in other states concerning mentoring and internships programs. There is concern about identifying the "right" person to do mentoring for it to be effective and successful.
2	**Consultants** There are a number of policies and procedures required of contractors and consultants working with MDOT. An educational program is needed to help these stakeholders remain in compliance. Also, as MDOT staff adopts new design, construction, and management procedures, consultants need to be kept educated to these changes. Involving them in training programs with MDOT personnel is an effective option to insure that agency and contractor personal are provided with the same information in a timely manner.
3	**Advanced degrees (MS/PhD) for MDOT engineering staff** Design a program allowing different curriculum paths so people design their continuing education to support licensure continuing professional development requirements while pursuing advanced degrees related to their MDOT career goals. Part of the course work could be done on MDOT time. The rest on the staff's personal time. This education will benefit the staff and the agency, therefore MDOT would pay course costs (part or all) depending on attainment of acceptable class performance. The educational tracks that would be of interest to MDOT and the staff. Having a program such as this could be used for recruiting new employees at a time when salaries at the agency are lagging behind the marketplace, thereby helping to continue attracting quality employees.

2012 MDOT Research Needs Workshop Summary Maintenance and Materials	
Ranking	**Need Summary**
1	**Long term field testing of pavement preservation treatments** Pavement preservation is becoming one of a DOT's key activities due to aging pavements, decreasing budgets, and rising material prices. A formidable obstacle to effective pavement preservation use is having decision trees that are based on long term field performance data. Research is needed that can either validate or enhance maintenance treatment selection decision trees by developing realistic life expectancy for given treatments that could be used for planning purposes. Research that couples literature review, practice review, carefully selected preservation treatments, and long term field monitoring in such a way that provides understanding of if/why a given treatment affects pavement performance, relative performance of different treatments, and changes in pavement layer moduli over time is needed.
2	**Optimize preservation design and construction of chip seals** Chip seals are a widely used pavement preservation technique, but even though they are widely used, performance is not necessarily consistent. Design and construction practices need to be evaluated to provide optimal chip seal performance. Research is needed to evaluate: 1) seasonal and temperature effects on construction practices; 2) current design methods (application rates in particular); 3) current construction tolerances for a given design application rate; and 4) construction timing and similar key specification issues.
3	**Optimization of aggregate gradation for chip seals** Optimal chip seal gradations are suggested in multiple sources available in literature. Research is needed to evaluate optimized gradation benefits and costs for Mississippi. Research in the areas of: 1) investigating extra performance from optimal gradations; 2) investigating allowing increased traffic with optimal gradations; and 3) investigating aggregate types in conjunction with optimal gradations (e.g. limestone, granite, crushed gravel, light weight sources).

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4	**Rapid concrete patch repair methods and products** Concrete patch repairs cause traffic delays as they take a fair amount of time when construction and curing time needs are considered. Research is needed to investigate improved methods of repairing concrete patches in concrete pavements. A literature and practice review of available products (including case studies), full scale demonstrations of promising products, and methods to evaluate candidate products in a consistent manner are needed.
5	**Investigate methods to preserve low traffic pavements from environmental aging** Low traffic areas such as shoulders and turnouts have different needs than mainline materials that aren't addressed as frequently as main line needs. An area of special interest are longitudinal joints between concrete mainline pavement and asphalt shoulders. Research is needed that: 1) investigates rejuvenating sealing methods over time; 2) evaluates performance effects associated with treatment timing pertaining to low traffic areas; and 3) focuses on methods to preserve asphalt shoulders with particular emphasis on the longitudinal joint.
6	**Investigate more efficient management of vegetation** Vegetation management is an ongoing maintenance issue for MDOT that expends considerable funds on an annual basis. Research is needed that investigates vegetation management practices. A study where representative DOT's are surveyed about their vegetation control practices, public perception of various highway aesthetics options are considered, positive and negative attributes of mowing versus other methods are evaluated, zoned vegetation is considered, and soil nutrients are and treatments are monitored over time to optimize turf grown is needed.

2012 MDOT Research Needs Workshop Summary Maintenance and Materials	
Ranking	**Need Summary**
7	**Relative timing of pavement maintenance activities** Maintenance responsibilities of an MDOT district often require many activities to be performed, and some activities have the potential to affect other activities. Research is needed to look into coordinating multiple maintenance activities together (e.g. coordinating striping material properties with fog sealing timing). The research could enhance economics of maintenance activities. Investigation of MDOT's pavement management database alongside striping records and other pertinent activities is needed, and this information needs to be coupled with more effective planning activities.
8	**Long term effects of increased truck weights** Long term performance effects resulting from increased truck weights are a potential issue for any state DOT. Their implications on pavement behavior should be considered when making decisions regarding weight limits. Research is needed to: 1) perform MEPDG simulations and develop summary charts for the needs of any given district; 2) determine if the increased weight effects can be quantified; and 3) develop a cost analysis model.
9	**Preventative maintenance of concrete bridge decks using field monitoring** Bridge deck maintenance is a considerable problem in Mississippi, as well as in other states. Research is needed that evaluates field monitoring techniques, and thereafter investigates cracking and reinforcing corrosion and deicing chemical effects. Existing bridge deck sealing products are also of interest to this research.
10	**Asset management** Asset management is important to agency with responsibilities similar to MDOT. Applying asset management, however, can have many complications. Practical applications of how to apply asset management within day to day operations is needed.

2012 MDOT Research Needs Workshop Summary Maintenance and Materials	
Ranking	**Need Summary**
Other Topics	**Various solutions to slope stability** Slope stability is an ongoing maintenance issue for MDOT that is not necessarily handled in the same manner from one location in Mississippi to another. Research is needed into establish best practices for MDOT to use. A study that evaluates existing products through literature and practice review, conducts a DOT practice survey, investigates repair options near drainage structures, and investigates slope failure repair methods would be useful.
	Life cycle costs of various stabilization methods with long term monitoring Stabilized pavement layers are commonly used by some state DOT's, with MDOT using a considerable amount of stabilized pavement materials. Research is needed to evaluate life cycle costs of various stabilization methods using long term monitoring. A study that: performs a literature and practice review; compares chemical, mechanical, and control sections over time and evaluates crack growth; evaluates layer moduli over time; considers load distribution efficiency of hybrid pavements; and assists with development of decision trees would provide useful information to the state of Mississippi.
	Bond strength investigation Bond strength between pavement layers is a performance issue that has always been present, but with pavement preservation becoming more and more important and surface layers being used that are progressively thinner, the issue is more important than ever. Research is needed that provides more quantifiable information to MDOT related to product bond strengths, as well as for bond strength over time. Research is needed that: 1) investigates bond strength needs for thin overlays (e.g. OGFC and UTAP); 2) measures or otherwise determines properties of commercially available products; 3) investigates bond strength of existing pavement layers and tracks bond strength of pavement layers over time; 4) evaluates existing bond strength specifications and specification approaches; and 5) compares interlayer effectiveness to mitigate reflective cracking.
	Performance of OGFC in freeze thaw conditions Open Graded Friction Course (OGFC) is an important pavement surface treatment. The Mississippi DOT has applications for OGFC. Research is needed including a literature review and OGFC best practices.

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Other Topics	**Effects of directional drilling on pavement performance** Directional drilling is used on MDOT projects. Effects of directional drilling can be problematic for maintenance forces in some instances. Research is needed to investigate effects of depth, investigate effects of material volume removal relative to pipe volume, and to recommend best practices regarding backfill operations.
	Cross drains Cross drains are used on MDOT projects. Liners associated with cross drains are an issue faced by MDOT engineers. Research is needed to evaluate long term benefits of pipe liners.
	Two coat bridge painting systems Bridge maintenance is a considerable issue facing MDOT and other state DOT's. Research is needed to study bridge painting systems. Tasks include a literature review and field monitoring of relative performance of two coat versus three coat approaches.

2012 MDOT Research Needs Workshop Summary Intermodal Transportation of Freight and People	
Ranking	**Need Summary**
1	**Performance measures for intermodal transportation systems** An effort is needed to identify and evaluate performance measures appropriate for assessing the effectiveness and efficiencies of intermodal transportation systems. This need will support the agencies federal-level efforts with outcomes as the performance measure index. However, it is important to identify assessment metrics that MDOT can implement and control.
2	**Factors impacting modal shift** There are a number of factors that are likely to promote a modal shift by transportation system users. These would appear to include fuel prices, alternative fuel options, cost of mode alternatives, system congestion, and freight demands. This could change transit and rail ridership and have direct impact on the cost of transit operations. To help understand this, work is needed to identify the major factors and evaluate the impact of these factors on travel choices made. The work should support an evaluation model and strategies to encourage or mitigate adverse impacts.
3	**Integration of freight and passenger traffic** A clearer understanding of the concepts that keep these systems disconnected is needed. Work is needed on how to integrate freight traffic into the context of sensitive design. This includes a revisit of current design standards and the development of new ones as appropriate. Also needed is a comprehensive set of street design guidelines that take freight into consideration.
4	**Transportation system resilience** System planning is needed to address disaster impacts on network traffic patterns and to insure the state has a reliable, resilient transportation. Issues to study include defining impacts to logistics and manufacturers of overall evacuation response. Research needs include: 1) data collection and traffic simulation modeling, 2) critical infrastructure identification and planning, and 3) case studies from Katrina's impact on coast and Memphis area planning. Result should be the framework for a decision support tools to evaluate reliability of the system and making recommendations for future planning.

2012 MDOT Research Needs Workshop Summary Intermodal Transportation of Freight and People	
Ranking	**Need Summary**
5	**Funding mechanisms at state and local levels** A review of the various funding opportunities at all levels would be beneficial. It would need to address differences in intermodal, transit, and other transportation segments supported by public funds. It should provide a framework for analyzing the cost and benefits. The focus should be on alternative funding options other than gas tax (e.g., VMT). Survey the benchmarks in other appropriate states and generating new ideas in the context of Mississippi's reality. Ultimately the work should make basic recommendations of alternative funding options supported by clear comparisons of pros and cons and the cost-benefit analysis.
6	**Cost impact from truck traffic to Mississippi's state highway system** Financial cost benefit analyses are needed in a number of areas as related to the economic impact of trucks. These include pavement deterioration, road congestion and lost time and increased vehicle operation costs, safety, air quality and emissions, and finally infrastructure (roadways, bridges) design requirements. This information would be the basis for a decision support tool to characterize the true cost and value of truck traffic in the state.
7	**Applying intelligent transportation systems to freight and intermodal transportation** A better characterization of the future intelligent transportation system is needed in all areas, including freight and intermodal systems. Defining how it incorporates new technology to support increased safety and reduced energy use. Design requirements of the data collection and inter-communications infrastructure need to be carefully thought out in the context of unification with national standards. Work should identify technology supporting data collection and intercommunication between vehicles and with the infrastructure communication systems. A summary of this effort should result in a set of guidelines and a framework for design, construction, implementation and management of the system architecture.

2012 MDOT Research Needs Workshop Summary Intermodal Transportation of Freight and People	
Ranking	**Need Summary**
8	**Private and public partnership best practices and roles** There are many questions regarding the opportunities and pitfalls presented by public-private partnerships (3P) for transportation systems though this industry has been using the practice for most of a century. Investigations should address questions about investment strategies and limitations from state and federal regulation of infrastructure financing. Knowing the lessons learned from decades of using toll roads would be beneficial. Defining opportunities and limits of creating and maintaining a multimodal fund to support public infrastructure development and operation is needed. Defining the roles MDOT should and can play in private sector projects is needed, as is an understanding of the legislature's and the public's expectation. It also would be beneficial if documentation of Mississippi-appropriate 3P best practices based on other states existed with special focus on each of the following areas: 1) Identify necessary data types for human capital and data sharing with other agencies (e.g., MDA) and private operators. This could be facilitated by an interactive GIS database tool integrating data from stakeholders; 2) Seamless integrating on intermodal transportation infrastructure into business development process; 3) Develop a model to specify the roles and partnerships and how they cooperate; 4) Best use of existing resources; and 5) How to negotiate with public and private organizations.
9	**Planning and coordination of different modes of traffic** A study on impact of traffic congestion in urban areas is needed. More broadly, work is needed to identify the data availability from railroad companies (e.g., capacity, increase of rail movement) and how to best utilize it to predict demand, conduct a capacity analyses, and create decision making tools to aid in investment decisions. Similar data from other transportation segments is also required so a better understanding of how existing systems impact supply chain cost. All modes (waterway, inland and deep sea ports, airports, public transit, highways, rail) need to be included in this process.

2012 MDOT Research Needs Workshop Summary Intermodal Transportation of Freight and People	
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10	**Freight and passenger demand prediction and system planning** This planning piece can only be done effectively if it takes a global view of freight, including outside state traffic and the opportunities for Mississippi from the Panama Canal expansion. Competition and collaboration among neighboring states is a piece of developing a planning document. Effective and efficient planning will need to incorporate new technologies and factor in safety and energy issues. The final piece would be to examine the impact of predicted system demands on operation and maintenance of infrastructure. This effort should culminate in traffic-demand predictive models and traffic assignment models for each segment of the system and the transportation system as a whole.

2012 MDOT Research Needs Workshop Summary Environmental Issues in Transportation	
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1	**BMPs** There is a need for guidance documentation on best management practices. At this time there is significant uncertainty as to what works and what does not when it comes to environmental protection. Though MDOT has a list that they use, analyses have not been performed on these systems so effectiveness has not been documented. There are geographic and hydrologic issues that need to be addressed, especially in anticipation of climate change and modifications in system design. Therefore, a state-wide program for environmental monitoring of current practices is needed. Other states (NC, CO) have done monitoring and there are lessons on methods to be learned from these efforts. These investigations could be a combination of case studies of existing sites and research pilot sites. Point and non-point sources should be included. Frequency, sampling protocol and methodology, and identifying representative systems will have to be part of the experimental design. Monitoring must include site specific information to allow comparative analysis. Literature can be a starting place but it must be realized that Mississippi is different than other states so looking at other states will have limited benefit. Short term versus long term differences need to be examined and BMP validation is essential with training, demonstration sites, and documentation needed for the agency and its contractors. The MDEQ BMP manual needs to be improved but it's a good start.
2	**Ecological Landscape View** When it comes to wetlands delineation, the protocols are well-established as are the design alternatives for mitigation. However, with proper planning and design using more natural processes could minimize mitigation needed later. A method for doing the cost and benefit analysis and a design analysis of alternatives is needed to allow this. Stream mitigation is becoming more and more of an issue as stormwater regulations and new surface water nutrient regulations are implemented in the state. One option would be too look at road and stream alignment to reduce mitigation requirements, but this will require modeling and sampling. Finally, it was noted that MDOT needs to give engineers design alternatives for designing systems that include templates, design standards, case studies, etc. These options should support stream management options, bank stabilization options, and ways to reduce sediment depositions. A forensic analysis on current systems to evaluate sustainability and the cost-benefit needs to be performed.

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3	**Sustainability** Sustainability is a broad subject. A great deal of work needs to be done in the general area as the agency moves towards ensuring that all projects have the maximum life and minimum cost over its life. This will involve looking at alternative materials used in building the transportation network, how designing transportation systems in alternative ways impact quality of life and economic development, and how the design supports a clearly defined long-term maintenance program. The impact of transportation systems on adjacent environments needs to be understood and considered in the design of systems. Design and system use must be based on the concepts of sustainability, but how that is done is yet to be clearly defined. So, a better understanding of sustainability as it relates to the transportation industry I needed.
4	**Local, State, and Federal Coordination to Minimize Adverse Cumulative Impacts** There are a number of environmental areas that MDOT could take the lead, or at least is a significant stakeholder, when working to minimize cumulative adverse impacts. Areas that provide opportunities include land use, zoning, defining project purpose and scope, and required metrics for performance and monitoring. Each of these needs clarification and consideration. As a basis, a review of case studies and other lessons learned should be used (I 269). Another effort is needed to develop a bench-mark to see how our actions have affected and changed the demography of the area and how this impacts the environment.

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5	**Noise and Visual "Buffers"** There is a need to identify alternatives to structural barriers and conventional materials used to build physical noise and visual barriers. It is know that certain types of vegetation can be employed for both visual and audio barriers but the specifications for these barriers do not exist. Species selection (poplars, pines, etc.) need to be places at minimum spacing at unknown buffer setback requirements. The cost of expanding the ROW is unclear as is the cost versus the benefit. Another option to be studied would be the layout of earthen structures to tie into the topography and provide a physical buffer. Incorporation of alternative materials to produce hybrid structures is another possible option. Further, studies into design alternatives should be pursued. Things to consider include: roadway surface design to reduce noise, setting vehicle standards on tires and vehicle noise, and ROW layout. Variations to conventional wall design might be studied to look at wall treatments to reduce noise, appurtenances that might absorb sound, and alternatives for wall orientation and layout to reflect noise.
6	**Air Quality Standards** Mobile sources are becoming a bigger issue as the standards are becoming tighter. Desoto County might become a non-attainment area due to migrating air pollution from Memphis. Options for addressing air quality issues generated in relation to use of the state's transportation network need to be defined and studied. As idling is a large source of emissions, an investigation into implementing anti-idling policies and optimizing vehicle flow to reduce idling are needed. Studies to determine how much of the impact on non-attainment areas is due to vehicle emissions are needed. Finally, methods to help meet attainment requirements need to be studied, including: traffic management, mass transit, use of alternative fuels and identification of alternative routes.
7	**Wildlife crossings and utilization of ROW areas** Studies are needed on wildlife crossings which are clearly marked and help protect the drivers and the animals. Using ROW areas to support this need should be examined.

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8	**Impacts on different environmental media** Work is needed to understand the impact the state's transportation systems (roads, bridges) are having on the air, land, surface water, and groundwater. This work should focus on providing a baseline for further development and strategies to mitigate adverse impacts.
9	**Issues MDOT has in dealing with environmental issues** The agency is very concerned about insuring that all environmental regulations and permitting requirements are met. This can be problematic as rules and regulations are changing. Errors and omissions can occur if a clear checklist is not available. A better way to involve the public through outreach and engagement is part of the issue as groups are vested in protecting the environment. Need to define ways to engage the public earlier, have mechanisms that allow the community to engage, and having a transparent process. Participation is the key. Preparing environmental impact statements that are current and clearly reflect current population demographic is important. Anticipating data requirements upon which to base your decisions need to be defined. Maybe use money to get community involvement (i.e. school students doing monitoring, etc.) could help with engagement. Using technology to define engagement issues, identifying stakeholders and partners, and identify scope and impact can help if done well. Ultimately, MDOT needs social sciences training on how to best involve the community.
10	**NEPAssist** Training on implementing NEPAssist is needed. This training needs to be done in the context of Mississippi's needs, issues, and opportunities.

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Other Topics	**Turbidity Limits** There is a need to work with MDEQ to get turbidity limits set which are appropriate for the soils and stream conditions in Mississippi. This process should look at research demonstration sites and case studies. Also, there is concern that using NTU for measuring turbidity is an incorrect standard and that a truer measure of turbidity would be Total Suspended Solids. However, TSS requires laboratory analysis and collection of samples while using NTU is easy to measuring it in the field.
	Nutrients Research is reportedly ongoing to measure how much fertilizer stays on the site and how much runs off. The current work is using a constant slope and runoff. There is some effort to provide education on application of fertilizers, pesticides and herbicides. There is a need to look at runoff inhibition and control systems and the impact of rainfall intensity, rate of overland flow, and site specific conditions on the movement of nutrients into surface waters and the impact on dissolved oxygen.
	Pre- and Post-construction flow analysis and permitting Stormwater management systems will soon be required to be permitted and monitored. There is fairly good information available on pre-flow analysis methodologies but there need to be validated when applied. Also, post- construction site conditions may differ from the design expectations and this could impact system performance. Post- construction analyses could be supported by remote sensing technologies such as LIDAR, though the agency is not currently looking at doing topographic comparison of project sites pre- versus post-construction. The quality and cost of remote sensing methodologies for this application needs to be reviewed. It was also noted that other states are keeping BMPs in place for post-construction applications. However, there was concern about put something in place that required continued monitoring. ROW management post construction is a concern, too. It was noted that some states may allow the conversion from construction easement to “green” easements.

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Other Topics	**Change policy** A comprehensive review of the agencies policies is needed with a goal of minimizing impact on the environment and ensuring regulatory compliance. Part of this process must include a comparison of positive and negative impacts of change.
	Alternative materials for sub-grade and base course stabilization A better understanding of viability of construction methods to improve the application of alternative materials is needed. Understanding when and if alternative construction method produce needed results and when chemical treatment is needed. A comparison of the associated costs and benefits would be important as is a better understanding of the time requirement associated with using all alternative materials.
	Better storm drainage rehabilitation methods An investigation into ways to rehabilitate damaged storm drainage systems (e.g. culverts) without completely replacing them is needed. This work could start with a review of the literature but should relate to Mississippi's transportation systems.

2012 MDOT Research Needs Workshop Summary Economic Development	
Ranking	**Need Summary**
1	**Infrastructure Plan** A statewide infrastructure plan requires input and support from more than MDOT. A comprehensive plan must include infrastructure information for the energy industry (electrical power, natural gas, and petroleum transmission), water (community water systems, authorities, and surface water resources), and any other missing pieces which impact the efficiency of developing and maintaining the state's transportation infrastructure. A goal for this plan would be to identify the best areas for economic development and where infrastructure is lacking to effectively support such development. This later data could be used to support infrastructure improvements. It would help support MDA activities, and allow MDA to work effectively with MDOT in supporting economic development through infrastructure development. MDA is a proactive agency and an asset in this process if a plan can be developed. Also, by having an infrastructure plan Mississippi moves to the "exceptional" category rather than being in the "norm".
2	**Web-based transportation network information** There is a need to provide stakeholders with easy access to information about the state's transportation network. A variety of web-based options could help deliver this information. They should be visually attractive and interactive with interfaces for computers, mobile devices, and smart vehicles. For economic development purposes, there should be easy access to information for key contacts for detailed information not readily available from the sites. Information should provide data on multimodal and intermodal networking, resource capacities, and opportunities for connecting to the system. Information providing transportation maps for all transportation modes and interfaces could be presented, possibly with some level of GIS capability to depict data. The GIS system could have layers of information relevant to capacities, densities, user contacts, and more. However, it is important to have accurate data and define mechanisms for keeping it updated. It might involve developing a toolbox to deliver detailed off-site information. This would require a coordinated effort between MDOT and MDA, partnering to define need and work with the Legislature to support state initiatives.

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3	**Permitting** One effort should be develop policies, procedures and supporting documentation to help reduce the level of communication breakdown that often occurs at the beginning of the permitting process. Easy and clear access to management policies is needed. A robust communication process is needed between local, regional, and national constituencies. This would likely require coordinated education and clarification of the communication routes. Communication and education routes need to be clarified and strengthened between the agency (NDOT) and the public, MMA, ACEC, MES, MWA and other stakeholder organizations to foster a cooperative exchange of information. There is a need for research on how other states have implemented effective permitting processes. .
4	**Planned communication for processes internally between divisions** There is a need in the agency to promote earlier engagement between divisions and within divisions on activities that cut across administrative units. There must be enough time available to allow each division to exercise due diligence in addressing issues. A similar process is needed between MDOT and FHWA when using federal funds so that opportunities are maximized.
5	**Conference and Workshops** Conferences and workshops related to transportation infrastructure and agency needs need to be held regularly, possibly annually but at least biennially. These meetings should focus on prioritizing the needs identified and framing out opportunities, limitations, and urgencies. This information is probably out there. It just needs to be complied through a collaborative process that engages stakeholders. The conferences and workshops would have single focus in some instances, but others could have multiple issues to review, characterize, and compile need information. The outcome should be an action plan supported by participants and implemented after due process.