Research Proposal Development and Submission Process

for the

Mississippi Department of Transportation Annual Research Work Program

Federal FY 2015

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General Information

The purpose of a research proposal is to present a research study to the Mississippi Department of Transportation (MDOT) for funding consideration. If the proposal is accepted for funding, then portions of it become part of a study contract between the Department and the Consultant.

The MDOT research work program does not operate on a grant basis. It is an applied research program committed to providing implementable solutions to problems facing MDOT.

The Consultant may obtain ideas for developing a research proposal by networking with MDOT personnel and reviewing the results of the MDOT Research Needs Workshop. For Federal FY 2015, use the following link to access these results: http://mdot.ms.gov/documents/research/Results/Research%20Needs%20Results%20Updated%202010.pdf

Prior to developing a research proposal, the Consultant will become familiar with the entire research proposal development and submission process included in this document. This will enable the Consultant to determine whether he/she can meet the MDOT submission and execution requirements included herein. The Consultant will affirm that he/she has reviewed and understands the content of this document by signing the statement to this effect included in Section 9, "Research Proposal Submitted By."

It is the responsibility of the Consultant to provide a proposal that is relatively free of grammar and spelling errors. A proposal can be eliminated for funding consideration if, at the discretion of the MDOT proposal reviewers, it includes a significant number of such errors. These errors are considered indicative of future negative issues with written project deliverables.

A submitted proposal becomes the property of MDOT.

Request for Research Proposals

MDOT sends out electronic request for proposals (RFPs). It is the responsibility of the Consultant to possess capability for receipt of such request via this mode of transmittal. The research proposal is developed by the Consultant and electronically submitted to MDOT in the format shown in Appendix A, "Mississippi DOT Research Proposal Format."

MDOT Research Study Champion

The Consultant is responsible for identifying one or more MDOT individuals who will be an advocate, or Research Study Champion,

(RSC) for the proposed study. Each identified MDOT RSCs name and contact information will be included in the research proposal as shown in Appendix A, section 8, "MDOT Research Study Champion(s) of Proposed Research."

A proposed study will not be considered for funding unless at least one individual is identified as a Champion. Appendix F, "Responsibilities of Technical Advisory Committee (TAC) Members," elaborates TAC member tasks to enhance the probability that MDOT funded research studies result in implementable products and/or services to the Department. Consultants are encouraged to discuss these TAC member tasks with their identified Champion(s) prior to developing a research proposal to help ensure the potential Champions' subsequent written agreement to perform such tasks.

Research Study Tasks

The Consultant develops a plan to conduct the proposed research. This plan is outlined using study tasks and subtasks as discussed in Appendix A, section 3, "Research Plan." These research study tasks/subtasks should be developed via collaboration with MDOT Champions. After proposals are received by the MDOT Research Division, they are sent out to the identified Champions as well as others within the Department considered subject matter experts within the proposed research field of knowledge. These individuals critically review the study tasks/subtasks and provide feedback to the Research Division indicating whether the proposed study addresses Department needs.

A Research Proposal Review Form is provided to each identified individual for each study to facilitate their evaluation of the proposal(s). These individuals complete the review forms and submit them back to the Research Division. The Research Division evaluates the reviewer responses to make funding recommendations to the MDOT Research Advisory Committee (RAC). If study tasks/subtasks are initially developed with Champion input, the responses on the proposal review form should favorably reflect the initial collaboration. This should enhance the probability of funding for the given study; however, this does not guarantee funding of the study.

Technical Advisory Committee

Subject to available funds, proposed research receiving favorable relative reviews are generally considered for funding recommendation. A Technical Advisory Committee (TAC) is formed for each recommended study with committee members including those individuals who have indicated a willingness to do so in accordance

with the guidelines provided in Appendix F, “Responsibilities of Technical Advisory Committee (TAC) Members.” A TAC chairperson is selected by the TAC members via simple majority vote.

The TAC includes one individual from the MDOT Research Division to function as an Assistant Project Manager to the State Research Engineer. This individual provides study contract development and administrative support, and represents the interests of the Division where implementation of study results may potentially impact Division responsibilities. This person may also provide technical input if they are a subject matter expert in the field of study being addressed by the research.

TAC Meetings

At the first TAC meeting, the TAC members must review and approve, or recommend changes to, the research plan tasks and subtasks, Project Schedule, and funding allocation per task and subtask. If any changes are recommended, the Consultant revises the proposal accordingly and then sends it back to the TAC members for review and approval of same. These three aspects of the proposal must be finalized before beginning development of a contract for the study. Subsequent TAC meetings may be held as needed throughout the duration of the study.

For all TAC meetings, the Consultant will develop a draft of meeting minutes. Emphasis of these minutes will be discussion of potential changes to the content of, or funding for, the study tasks/subtasks and the Project Schedule. A draft of these minutes will be distributed to the TAC members for review and comment within one week of the given meeting. The TAC members will provide any feedback regarding the draft to the Consultant within one week of receipt of same. The Consultant will address any TAC member concerns and then distribute a final version of the meeting minutes.

Discussion of alternate points of view will be included in the minutes if consensus is not achieved during the meeting regarding issues relative to the conduct of the study. Unresolved issues will be settled via TAC member vote by simple majority. In the case of a tie, the TAC chairperson vote prevails as the decision. The final meeting minutes must reflect any decisions on the part of the TAC regarding changes to the conduct of any task/subtask or funding reallocation.

Appendix A. Mississippi DOT Research Proposal Format

A research proposal will include the following twelve sections:

1. **Research Project Title –** Make the title as short and concise as possible.
2. **Problem Statement and Research Objectives –** The research proposal should address a current or future potential problem in Mississippi where research may be employed to provide recommendations to address the problem. This statement should answer questions such as:
   - What is the nature of the problem requiring research?
   - How does the problem impact MDOT transportation facilities or services?
   - What are the objectives of this research? These should be defined in terms of the expected product that will result from conducting the research to provide solution to the problem. Describe the anticipated product. Examples of a product include construction or materials specifications, technical standards or practices, improvements to work flow, a new or revised design procedure, or other process, etc.
   - What are potential benefits to MDOT transportation facilities or services as a result of implementing this product? Briefly describe these benefits in this section of the proposal and include a detailed consideration of same in section 6. “Anticipated Research Results.”

   Include discussion of any known past or current state, national or international level research efforts that are similar to the one proposed. If any exist describe how this study differs in scope or potential application.
3. **Research Plan –** This section addresses how the research will be conducted via a Research Plan designed to produce an implementable product meeting the research objectives.

Research Plan Becomes Part of Research Contract

The Research Plan constitutes the scope of work for the research contract, memorandum of understanding, or other contractual vehicle employed to control the conduct of the study. The intent is that the Research Plan will simply be copied from the proposal and pasted into the applicable contract document once all parties involved agree to the content of, and responsibility for, same. Given this intent, the Research Plan is formatted as numbered

tasks/subtasks, each expressed as concise contractual terms. Note that the definition of the problem and justification for conducting the research are topics addressed in the Problem Statement and Research Objectives section of the proposal and should not be repeated in any of the tasks or subtasks.

The following provides details to be considered, and as applicable, addressed in the Research Plan. Appendix A1. "Example Research Plan" provides an example of the type of information and level of detail expected for the expression of tasks and subtasks.

MDOT Support for Study

The Consultant will advise if the proposed research requires MDOT provision of data, materials sampling and testing, traffic control, or some other service to facilitate conduct of the study. This will be accomplished by including separate tasks/subtasks in the research plan clearly defining these services. Do not combine work required by MDOT and the Consultant in the same task/subtask.

The Consultant will identify individuals within MDOT Division(s) or District(s) who agree to provide the required MDOT support services, or aid in provision of these services. The name and contact information of these individuals will be included in the research proposal under section 8, "MDOT Research Champion(s) of Proposed Research."

Define Who Does What

All tasks/subtasks included in a research plan will clearly state the responsible party for the given task/subtask. Where MDOT services are required, include the responsible MDOT Division(s) or District(s). For example, the Consultant may be required to analyze pavement distress data provided by the MDOT Research Division. In this example, one task in the research plan states that the MDOT Research Division will provide the pavement distress data to the Consultant, and a separate task states that the Consultant will analyze the data.

As a second example, the research study requires coordination of Consultant testing in conjunction with contractor construction operations. In this hypothetical study, the Consultant intends to test cementitious stabilized material (CSM) at the time of placement by the contractor and at time intervals subsequent to its placement. The Research Plan needs to include one task/subtask that addresses the Consultant testing activities and another task/subtask that addresses the requirements of, and responsible

party for, coordinating the testing activities of the Consultant with the contractor.

Identify MDOT Personnel Providing Services

The Consultant will identify individuals within MDOT Division(s) or District(s) who agree to provide the required MDOT support services, or aid in provision of these services. The name and contact information of these individuals will be included in the research proposal under section 8, "MDOT Research Champion(s) of Proposed Research."

When research proposals are reviewed by the Department for funding consideration, each individual identified in section 8 is sent a proposal review form. This review form includes a question asking the reviewer if they agree to provide the required MDOT service. Each MDOT service required, by the Consultant, to complete the research effort must have an MDOT individual agreeing to provide that service prior to development of a research contract. In addition, the Division Head or District Engineer of that individual must also agree to allow his/her employee the time and resources to complete the task.

Incorporate MDOT Involvement in Project Schedule

Tasks/subtasks for which MDOT is responsible are not reflected in the funding for the study; however, they are reflected in the Project Schedule that tracks overall study progress. This enables MDOT personnel to plan for providing the required services to the Consultant at the appropriate time to maintain the progression of the study and allow submission of project deliverables per the Project Schedule.

Percentage of Total Consultant Research Effort by Task

For each task/subtask performed by the Consultant, assign the percentage of total Consultant research effort to complete the study. In the first example included in the section "Define Who Does What," the pavement distress data provided by MDOT is not considered part of the Consultant research effort; however, the Consultant will analyze the data. If the analysis requires 15 percent of the total effort on the part of the Consultant to complete the study, then 15 percent is assigned as the percentage of total Consultant research effort for this task/subtask.

Consultant Travel and Purchase of Equipment

Proposed Consultant travel for presentation of study findings and/or purchase of equipment by the Consultant to conduct the study will be included as separate tasks/subtasks of the research plan.

Consultant travel must be approved, in writing, by the MDOT State Research Engineer prior to the scheduled travel. The Consultant will submit a letter of request with a format including a location for signature and dating by the State Research Engineer. Appendix H. "Sample Letter Requesting Approval to Use Study Funds to Present Research Results" illustrates the required detailed breakdown of anticipated travel expenses.

Project Management

The Consultant is responsible for submitting the following Project Management deliverables:

(a) Minutes for all Technical Advisory Committee meetings

(b) Quarterly Progress Reports (QPRs)

(c) Annual Progress Reports (APRs)

(d) Supporting documentation with submission of invoices

All Research Plans will include a standard task with four subtasks as illustrated in Appendix A1. "Example Research Plan," Task C6.

Interim and Final Reports

Include a task for Consultant presentation and submission of the final study report. If the study requires an interim report, such as a document providing the details of field test section construction, a separate task will be included in the research plan for that interim report. Appendix A1. "Example Research Plan," Task C7, illustrates the inclusion of this type task in a research plan. Refer to Appendix B. "Project Schedule," section "Submission of Interim and Final Reports" for the sequence and time requirements for presentation and submission of these reports.

Both of these types of reports must include a Technical Report Documentation Page located immediately following the front cover of the report. The MDOT Research Division TAC member will complete the MDOT-specific entries for this page and provide it to the Consultant. The Consultant will complete this page by entering appropriate Consultant and study specific information.

The Consultant will provide 7 bound copies of the final version of any interim or final report, along with two electronic versions of same – one .doc and one .pdf. per the progress schedule shown in

the Gantt chart. A stapled report is not considered a bound report and will not be accepted as a project deliverable.

General Requirements for all Project Deliverables

Note that should the proposed study be funded, it is the responsibility of the Consultant to provide all project deliverables by the required submission dates and be relatively free of grammar and spelling errors. At the discretion of the MDOT Research Division TAC member, deliverables that include a significant number of such errors will be deemed unacceptable and sent back to the Consultant for revision.

The occurrence of either issue; i.e., late submission of any project deliverable at any time, or submission of these deliverables with a significant number of grammar and spelling errors, will also be documented and used with other funding considerations for potential future research studies with the Consultant. To address the second issue the Consultant may consider securing the services of a technical writer at no cost to MDOT to review the content of all written deliverables prior to submission to MDOT.

Changes in Work Tasks/Subtasks or Funding

Subject to TAC approval, changes are allowed to the content and ordering of the tasks/subtasks, or reallocation of funds to same, at any point prior to or after award of the study contract. However, if the study is already included in an approved Research Work Program, the total amount of the study, after reallocation of funds, cannot exceed the total amount provided in the Research Work Program. In this case, should the TAC and Consultant identify work requiring funds in an amount exceeding that already approved, a follow up, or second research study effort should be considered for funding at a later date. Note that any revisions to a given task/subtask time interval or allocated funds will require corresponding update of the project progress schedule and the planned project progress and planned gross expenditures graphs (Appendix B).

4. **Funding –** The total cost of the research should be accounted for in the research proposal in two different formats, with each format represented in a separate table. These formats are discussed in the following subsections 1 and 2.

    1. Provide a table which lists the funding requirements for each Federal Fiscal Year (FY) included throughout the duration of the study, as well as the total cost of the study. The Federal FY

begins the 1st of October and extends through September 30th of the following calendar year.

When estimating the funding requirement for the first Federal FY within which the study is proposed for funding, do not assume that the study will start on October 1. This is because work cannot begin for, and charges cannot be made to, a study until a notice to proceed (NTP) is issued by MDOT. An NTP is issued after all contract documents have been developed and received the required signatures. For the purpose of estimating the required funding for the first Federal FY, assume the NTP will be issued February 1 of that Federal FY. Note that February 1 is not put in the Gantt chart (refer to section 5, Duration) as the study start date. February 1 is only used for the purpose of estimating study cost for the first Federal FY in the study budget.

2. Provide a second table that divides the total study cost based on Consultant performed tasks/subtasks outlined within the research plan. All Consultant costs associated with the conduct of a research study should be appropriated to a research study task or subtask. For example, if the study requires the purchase of equipment by the Consultant, then the purchase of that equipment is considered as a separate task/subtask. Consultant travel, funded by research study funds, to present research findings is considered as a separate task/subtask. While it is understood that exact travel or equipment costs cannot always be anticipated at the time of submission of the research proposal, an estimate of such costs must be included in the proposal.

Do not submit any tables in the research proposal document of proposed study costs formatted in accordance with traditional accounting line items such as salaries, overhead, profit, etc.

Do submit a separate document from the research proposal that includes a table accounting for proposed study costs in terms of traditional accounting line items. The format for this table will be in accordance with the requirements of an anticipated contract for the study. This table will be included in the research contract documents.

Figure A1. “Template to Appropriate Study Costs for Contract Governing State Entity Conducted Research” provides the type cost breakdown to be used by Universities performing research under a master contract. Figure A2. “Template to Appropriate Study Costs

Institution:		**(State Entity Name)**		
Project Period:		**(Duration of Project)**		
Budger Year:		**(Year 1, 2, 3, etc.)**		
	Number of Hours	**Hourly Rate of Pay**	**Total**	
Faculty Name				
Staff Name/Title				
Faculty/Staff Labor				*Total of Faculty/Staff Labor
Faculty/Staff Fringe Benefits	RATE			*Total of Faculty/Staff Fringe Benefits (Faculty/Staff Fringe Rate * Faculty/Staff Labor)
Graduate Student Research Assistant				
Graduate Labor				* Total of Graduate Labor
Graduate Fringe Benefits	RATE			*Total of Graduate Fringe Benefits (Graduate Fringe Rate * Graduate Labor)
Undergraduate Student Research Assistant				
Undergraduate Labor				*Total for Undergraduate Labor
Raw Labor Total				*Raw Labor Total (Faculty/Staff Labor + Faculty/Staff Fringe Benefits + Graduate Labor + Graduate Fringe Benefits + Undergraduate Labor)
Direct Costs:	**No. of Units**	**Cost per Unit**		
mileage				*Mileage, lodging, and meals must be shown as separate amounts regardless of their total values. Supplies, equipment, etc. must be show individually if the total value of an item exceeds $500.
lodging				
meals				
tuition				
supplies				
Direct Costs Total				*Total of all Direct Costs
Subconsultant Costs Firm #1				
Subconsultant Costs Total				*Total of all Subconsultant amounts
Subtotal				*Subtotal (Raw Labor Total + Direct Costs Total + Subconsultant Cost Total
Indirect Costs Total	RATE			*Indirect Costs Total (Indirect Cost Rate times Subtotal, excluding any amounts for tuition, equipment, and any other nonallowable costs) [Indirect Cost Rate * (Subtotal - Nonallowable Costs)]
Project Total				*Project Total (Subtotal + Indirect Costs Total)

Figure A1 - Template to Appropriate Study Costs for Contract Governing State Entity Conducted Research

(Non-State Entity Name)

Labor Classification	Number of Hours	Hourly Rate of Pay	Total	
Raw Labor				*Total of All Raw Labor Wages
Overhead	RATE			*Total Overhead Amount (does not include FCCM amounts) (Overhead Rate * Raw Labor)
Total Labor				*Total Labor Cost (Raw Labor + Overhead)
Fixed Fee/Profit	%			*Total Fixed Fee/Profit Amount (does not include FCCM amounts) (Fixed Fee/Profit Percentage * Total Labor)
FCCM	RATE			*FCCM Amount (FCCM Rate * Raw Labor)
Direct Costs:	No. of Units	Cost per Unit		
mileage				*Mileage, lodging, and meals must be shown as separate amounts regardless of their total values. Supplies, equipment, etc. must be show individually if the total value of an item exceeds $500.
lodging				
meals				
supplies				
Total Direct Costs				*Total of all Direct Costs
Subconsultant Costs				
Firm #1				
Firm #2				
Total Subconsultant Costs				*Total of all Subconsultant amounts
Project Total				*Project Total (Total Labor + Fixed Fee + FCCM + Total Direct Costs + Total Subconsultant Costs)

Figure A2 - Template to Appropriate Study Costs for Contract Governing Non-State Entity Conducted Research

for Contract Governing Non-State Entity Conducted Research" provides the type cost breakdown to be used by private firms performing research for the Department.

If these templates are not provided with the annual call for MDOT research proposals, Consultants are encouraged to acquire from MDOT the most current version of the applicable template and use it to develop the table. Questions related to the inputs for these templates should be directed to the MDOT Consultant Services Unit at (601) 359–7037.

The total amount shown in all three of these tables will be same - to the penny.

5. **Duration –** Develop a project schedule, via a Gantt chart, that illustrates how long it will take to perform this research. Appendix B includes the format and other details to be considered for developing this schedule. The project schedule will be included in the research contract documents.
6. **Anticipated Research Results –** The outcome of conducting the Research Plan should be some product providing solution to the problem described in Section 2, "Problem Statement and Research Objectives." This section provides the following:
    - Detailed description of the anticipated product
    - Evaluating the benefits to MDOT transportation facilities or services as a result of implementing this product
    - Implementation Plan

Evaluate Potential Value of Recommended Product and/or Service

What is the potential value of these products and/or services to the Department? Potential value can include, but not limited to, one or more of the following:

- Lives saved
- Reduced vehicle crashes
- Protection of the environment
- Reduced traffic congestion
- Department cost savings

Where possible, quantify these values.

- How many lives can be saved?
- How many vehicle crashes can be avoided?
- How much money can be saved by the Department?

Suggest analytical methods that could be employed to quantify these potential values. If the methods can be utilized during the study contract period, then include them as tasks/subtasks within the Research Plan. If not, then include them in the Implementation Plan for post study use by the Department.

Additional MDOT Resources to Implement New Product

A decision to implement the research product requires consideration of additional MDOT financial, physical asset, or human resources to incorporate the product into current MDOT practice. Will implementation impact human resource requirements such as:

- Increase the work load for existing employees?
- Require additional employees?
- Require special training for any of these employees?

Will implementation require increased use of existing, or purchase of new, physical assets such as material test or maintenance equipment, computers, etc.?

If a product is going to be developed that will require ongoing maintenance, identify who will take responsibility for this maintenance after study completion. Examples include:

- If computer software is a study deliverable, which MDOT Division(s) or District(s) will be responsible for using and maintaining it?
- If data for inputs to a software program are required from Divisions or Districts other than the user Divisions or Districts, are the data providers willing and able to provide such data?
- If new materials testing equipment is recommended for use by the Districts or Central laboratory, are these entities willing and able to both purchase and use this equipment with their employees?

Consider funding required by the Department to implement the product and, where possible, a cost/benefit analysis. If such an evaluation can be performed during the contract period, then include as tasks/subtasks within the Research Plan. If not, then provide guidance in the Implementation Plan for post study evaluation by the Department.

Implementation Plan

The MDOT Research study Champions and the Consultant work together to develop an Implementation Plan that considers, as appropriate for the given study, activities to promote application of

the product within the Department. It is likely that this plan will evolve as the Research Plan is conducted. This plan should include:

- Identification of the MDOT Divisions and/or Districts that will utilize the product
- Future activities necessary by the Department for successful implementation
- Criteria for judging the progress and consequences of implementation
- When not conducted as part of the study, suggestion and direction for use of analytical methods that can be employed to quantify the potential benefits of the research product
- When not conducted as part of the study, suggestion and direction for quantifying funding required by the Department to implement the product and, where possible, cost/benefit analysis
- Consideration of impediments to successful implementation of the product within the Department

The research may not result in a product that is conducive to implementation. In some of those cases, the results preclude subsequent research. In other cases, suggestions may be provided for future research that utilizes the knowledge obtained in the current effort that may ultimately result in an implementable product. Either way, a discussion should be included that addresses this issue when an implementable product cannot be obtained as a result of the current research.

7. **Summary –** Include a one or two paragraph summary (250 words maximum) of the proposed research. Include only succinct statements that identify the MDOT problem, the approach to solve the problem, and anticipated research products and/or services that will provide solution to the problem.

8. **MDOT Research Study Champion(s) of Proposed Research** – Include the following information for each of the identified MDOT Research Study Champions (RSCs) or other MDOT personnel who have agreed to provide MDOT services in support of the study:

   Name:
   Title:
   MDOT Division:
   Work address:
   Phone:
   Email address:

9. Research Proposal Submitted By:

Name:
Title:
Organization:
Address:
City, State, Zip:
Phone/Fax:
Email address:

The Consultant affirms that he/she has reviewed and understands the requirements included in the version of this document corresponding to the Federal Fiscal year for which proposal funding consideration is requested. Such affirmation is evidenced by the following signature:

_____ _____

Signature Date

10. Qualifications and Experience of Principal Investigator(s) -

The MDOT Research Study Champion(s) reviews and rates the proposal using a rating scheme that includes consideration of the technical qualifications and the project management experience of the PI(s) to conduct the proposed research. This section of the proposal consists of five subsections that collectively allow the PI(s) to convey to the Department how they are technically qualified and possess the necessary management skills to conduct the tasks outlined in the research plan.

This section of the proposal is limited to three pages for each PI. The content of these pages should emphasize PI qualifications and experience that are relevant to the proposed research – **do not** submit a complete resume. The following is a list of the five subsections including corresponding discussion:

Professional Preparation

For each PI provide a list of the individual's undergraduate and graduate education and postdoctoral training as indicated below:

Undergraduate Institutions(s)	Major	Degree & Year
Graduate Institutions(s)	Major	Degree & Year
Postdoctoral Institution(s)	Area	Inclusive Dates (years)

Work Experience

In this subsection the PI will list each job title and/or appointment in reverse chronological order beginning with his/her current employment. Include the beginning and ending date for each listed item. Corresponding to each item the PI should also include a brief discussion of any relevant work experience that enhanced his/her technical qualifications and/or project management skills to perform the proposed research. Do not include discussion of experience that is not germane to the proposed research.

Publications

A list of up to five publications, preferably most closely related to the proposed project, may be included by the PI in this subsection. Each publication identified must include the names of all authors (in the same sequence in which they appear in the publication), the article and journal title, book title, volume, number, page numbers, and year of publication. For a PI who has never performed research for MDOT, one of these publications should be sole-authored by that PI and available upon request by MDOT. Provide the website for any of these documents that are available online.

For unpublished manuscripts, list only those submitted or accepted for publication (along with most likely date of publication). Patents, copyrights and software systems developed may be substituted for publications. Additional lists of publications, invited lectures, etc., must not be included.

All other factors being equal, publications related to the project are preferred to those that are not, and this should be reflected in the rater's evaluation. However, a researcher may desire to expand his/her scope of research interest and should not be precluded from doing so if the Department agrees to fund his/her proposal. In these cases, the researcher probably does not have five publications in the proposed field of study, or may not have any, so his/her list may include up to five unrelated publications to allow the rater to generally evaluate the PI's quality of published work and project management experience. In any case the total number of related and unrelated published and unpublished documents, patents, copyrights, and/or developed software systems should not exceed five.

When an individual has obtained an advanced degree, but has not published enough to demonstrate experience in the proposed research topic area and/or the necessary project management skills, that individual should list his/her dissertation and/or thesis in this subsection and be prepared to provide a copy of same to MDOT.

This individual should provide a list of the courses that they have taken which are **relevant** to the proposed research - **do not** include a list of every course taken. Also include a description of how his/her professional preparation qualifies them to conduct the proposed research. Note that individuals who possess a proven track record of successful research within the proposed research subject area should include their list of professional preparation, but do not have to include this supporting information.

Related Experience

A list of up to five activities related to the subject matter in the proposal, in which the PI has been involved, may be listed in this subsection. For example, if the PI is submitting a proposal to evaluate cementitious stabilized materials (CSMs) for MDOT and the PI is on the Transportation Research Board (TRB) ASF 80 Committee on Cementitious Stabilization, the PI should include his/her membership in this list.

Another example would be a proposed research study where soil sampling and testing are required as part of the conduct of the study. Specifically AASHTO T 89, "Determining the Liquid Limit of Soils" and

AASHTO T 90, “Determining the Plastic Limit and Plasticity Index of Soils,” tests may be required. If the PI has conducted training classes for technicians to sample soils and perform these tests, then this information should be included in this subsection to illustrate how the PI is qualified to either do this testing themselves, or manage others to accomplish these tasks, to ensure adherence to the applicable sampling and testing protocols.

Accomplishments

Describe known instances of how the results of previously funded research, in the same or closely related problem area to that of the current proposal, were implemented by the funding agency. Examples of implementation include changes to state or national specifications, test methods, and/or practices.

For each of these instances describe the known benefit(s) to that agency as a result of those implementation activities. Optimally this description will include the benefit(s) expressed in both quantitative and qualitative terms such as: number of lives saved, reduced number of crashes, money saved by that agency, etc.

Include the name of the funding agency and name and contact information for all individuals within that agency that facilitated those implementation efforts. If there are no known cases of implemented research results, then a statement to this effect will be included in this subsection of the proposal.

11. Testing Facilities and Technician Experience –

If the proposed research includes construction materials sampling and/or testing tasks then the PI and RSC will follow the guidance provided in this section when developing the research proposal. If the proposed research does not include these type tasks, then the PI will include a statement to this effect in this section, and then advance to Section 12, "Submission."

MDOT practice for obtaining materials test data for pavement, bridge and other design applications, and subsequent construction quality control/quality assurance (QC/QA) follow industry accepted testing standards. This section of the proposal allows the Consultant to convey to the Department how the proposing agency's laboratory and technician qualifications meet these same standards when construction materials testing tasks are included in the research work plan. The premise is the same level of quality in test results will be realized to support research study conclusions and recommendations as for design and construction QC/QA applications of similar test data.

Identify all Laboratories

The research proposal will identify all laboratories that will be employed for construction materials testing. In those cases where more than one laboratory is included, the proposal will identify which tests will be performed in each laboratory.

All Laboratory Tests Conducted in either an MDOT Certified or AASHTO Accredited Laboratory

All laboratory construction material testing will be conducted in either an MDOT certified or American Association of State Highway and Transportation Officials (AASHTO) accredited laboratory. The proposal will address whether the proposed laboratory is certified by MDOT and/or accredited by AASHTO to perform the tests listed in the proposal. In those cases where the proposing laboratory does not meet either of these qualifications at the time of submission of the proposal, a plan will be included in that proposal outlining the steps the proposing laboratory will follow to meet one of these qualifications.

The MDOT Research Division will not compensate a private testing firm to obtain either of these credentials; however, accommodation is made for university laboratories and student conduct of tests. See Section 11, "Universities."

If the proposing laboratory is not certified or accredited, and the proposal does not include a plan to obtain one of these credentials prior to conducting the tests, the RSC will determine whether to allow use of that laboratory. If the RSC does allow use of a laboratory that is not either certified or accredited, the RSC will provide the rationale for this decision to the MDOT State Research Engineer through the proposal review process.

MDOT Certified or AASHTO Accredited Laboratories

The process followed by a laboratory to obtain MDOT certification is similar to that used to obtain AASHTO accreditation in that both require an inspection of the laboratory and verification that the technicians can perform the required test procedures. However, AASHTO accreditation includes a third significant requirement, laboratory participation in a Proficiency Sample Program, (PSP).

The process that an entity must go through in order to initially obtain AASHTO accreditation for specific test procedures conducted in its laboratory, and the subsequent maintenance of that accreditation, fosters high end user confidence in the quality of test results provided by that laboratory. Appendix K, "AASHTO Proficiency Sample Program," provides rational for preferring the use of an AASHTO accredited laboratory in studies where construction material test results have a significant impact on the implemented deliverables of those studies.

Subcontract to AASHTO Accredited Laboratory

Those agencies that are otherwise qualified and interested in performing a study for the Department, but do not have direct access to a qualified laboratory, may subcontract their testing needs to an AASHTO accredited laboratory. This option is not available to a principal investigator (PI) working through the Mississippi State University Master Contract for Research, Technology Development and Engineering Services because that contract does not allow for subcontracting any work related to the conduct of a university study.

Sampling and Testing – General Requirements

All material sampling and testing shall be in accordance with an industry accepted test standard such as an AASHTO, American Society for Testing and Materials (ASTM), or Mississippi Test (MT) procedure. The conditional exceptions to this requirement are when the objectives of the given study are either revising an existing test procedure, or developing a new test procedure.

The proposal will list all applicable AASHTO, ASTM, or MT sampling/testing standards included in the research effort. When selecting test standards, preference will be given to the AASHTO standard in those cases where a comparable ASTM standard exists, unless final application of the test data dictates use of the ASTM version of the test standard.

Any planned deviation from the prescribed standard test methods; i.e., AASHTO, ASTM, or MT, shall be clearly defined in the proposal and ultimately discussed in the final report. During the conduct of the tests any unplanned deviation from the prescribed standards shall be immediately brought to the attention of the RSC. Reporting of test results shall be in accordance with the requirements set forth in AASHTO R18 – Standard Recommended Practice for Establishing and Implementing a Quality Management System for Construction Materials Testing Laboratories.

Field Sampling Plan

For research studies that call for field sampling of construction materials, the Consultant and RSC will develop a detailed sampling plan that includes sampling locations, types of materials to be sampled, and the number of samples to be obtained. This information will be compiled into one or more associated work tasks in the research study scope of work.

This section will also include a description of the Consultant's equipment to perform any material sampling, sample processing, and sample storage as part of the conduct of the research study. For example, if the proposed study is evaluating the engineering properties of soil cement base layers, using six-inch diameter cores taken from existing pavement sections, the proposal will provide details of the drill rig and associated apparatus/equipment to be used for the pavement coring and sample extraction operations. This would allow the RSC to evaluate whether the Consultant's proposed drilling/sampling equipment is actually capable of obtaining intact testable cores.

Field Testing Plan

For research studies that call for field testing of construction materials, the Consultant and RSC will develop a detailed testing plan that includes test locations and types of testing to be conducted. This information will be compiled into one or more associated work tasks in the research study scope of work. This section will also include a

description of the Consultant's equipment to perform any field testing as part of the conduct of the research study.

This plan is based on anticipated field conditions; however, deviation from this plan may be required at the time the field work is conducted due to differences between anticipated and actual field conditions. When such a situation occurs the Consultant will advise the RSC and both entities will collaborate in an attempt to develop a revised plan that both accommodates the actual field conditions and provides the required test data to achieve the research study objectives. In certain cases the RSC may allow the Consultant to deviate from the field testing plan solely at the discretion of the Consultant; however, this will be agreed upon between the two entities prior to such occurrence.

Any deviations from the original plan will be reported in the quarterly progress report (QPR) in which such deviation occurred along with the reason(s) for their occurrence. The potential impact on achieving the research study objective(s) will also be documented in this QPR for future reference. The final report will include discussion of any deviations and their corresponding impact(s) on achievement of the research study objective(s).

Laboratory Testing Plan

For research studies that call for laboratory testing of construction materials, the Consultant and RSC will develop a detailed testing plan that includes the desired testing and an approximate number of tests to be completed. This information will be compiled into one or more associated work tasks in the research study scope of work.

This section will also include a description of the Consultant's equipment to perform any laboratory testing as part of the conduct of the research study. Particular attention will be focused on use of equipment not included in typical AASHTO accreditation or MDOT certification laboratory inspections. For example, if the proposed study involves the fabrication of lime stabilized soil test specimens in the laboratory for subsequent resilient modulus testing, the proposal should provide details of the environmentally controlled room that will be used for curing those specimens, and the equipment that will be used to perform the resilient modulus tests.

In summary, the idea is to convey to a reviewer of the proposal that the Consultant has thoroughly considered all aspects of required field sampling/testing and laboratory testing in support of the proposed research.

General Laboratory Equipment Requirements

The testing equipment in either an MDOT certified or AASHTO accredited laboratory shall meet the following requirements before performing any tests for the given research study:

- Laboratory will be fully equipped to perform the tests for which it is certified.
- Laboratory will have equipment that meets the requirements of the specified tests.
- Equipment will be set up.
- Equipment will be calibrated according to the procedures and frequencies given in AASHTO R18. For equipment not listed in R18, calibration will be in accordance with the manufacturer's recommendations.
- PI or laboratory manager will maintain proof of testing equipment calibration.
- All test equipment will be inspected by either MDOT or through the AASHTO Accreditation Program (AAP).

Determining if a Laboratory is Certified by MDOT

If a private; i.e., non MDOT, laboratory is included in a research proposal to provide testing services for a research study, it is the responsibility of the RSC to ensure that laboratory is either certified by MDOT, or accredited by AASHTO, to perform the requisite testing services. The MDOT Materials Division maintains a list of laboratories that are certified by MDOT. Table 1 provides the position title of the responsible MDOT Materials Engineer for five general types of construction materials. The RSC may contact the appropriate MDOT Materials Engineer to confirm the certification of a laboratory for a given type construction material.

Table 1. Responsible MDOT Materials Engineer for each Type Construction Material

MDOT Materials Engineer	Type Construction Material
Asphalt and Chemical Testing Engineer	HMA
Cement and Concrete Testing Engineer	Concrete and Aggregates
Soils, Geotechnical, Aggregates, Physical Testing Engineer	Soils and CSMs

Determining if a Laboratory is Accredited by AASHTO

The AASHTO Materials Reference Laboratory (AMRL) maintains a Directory of AASHTO Accredited Labs at the following website (1):

http://www.amrl.net/amrlsitefinity/default/aap/r18labs.aspx

The RSC will confirm if a laboratory is accredited for the particular test(s) listed in the proposal by accessing this website and entering the name of the laboratory. If the PI or RSC is in need of specific testing, but has not yet selected a laboratory, the website allows a search for all accredited laboratories that offer the required testing service.

Personnel

The proposal will include an organizational chart for the laboratory that displays each individual's name and corresponding job description involved with providing sampling/testing services for the study. The proposal will include a resume for the laboratory manager and any other supervisory technical staff, and a copy of MDOT certification for each of the technicians involved in providing test data and/or records for the study.

Note that the requirements discussed in this section should not be confused with those for the PI. PI qualifications are considered in Section 10, "Qualifications and Experience of Principal Investigator(s)," while the focus in the current section is on the laboratory, including its management, technicians, and testing equipment. This distinction does not preclude the PI from assuming laboratory management responsibilities. If the PI does assume such responsibility, it will be conveyed in Section 11 along with his/her qualifications to perform in this capacity.

Certified Technicians

All of the test standards listed in the research proposal shall be tested by an MDOT certified technician, or under the direct supervision of an MDOT certified technician. The research proposal will identify all certified technicians proposed to conduct/oversee testing for the study. In those cases where more than one laboratory is included, the proposal will identify the certified technicians in each laboratory. The RSC will confirm that each of the listed technicians is certified prior to the conduct of any materials testing.

Hot mix asphalt (HMA) and concrete construction materials are tested by technicians that may be certified at one or more of several available levels of certification. Each level of certification includes a list of corresponding test procedures. A technician who is certified at a given level has demonstrated proficiency in the performance of those tests included in that certification level. Soils, aggregates, and cementitious stabilized materials (CSMs) are not included in particular certification levels per se, but are covered under an MDOT certification program.

The PI and RSC will determine which type and level of construction material certification is required by the technician(s) to perform all tests listed in the proposal. The following sections provide details of the various levels of certification available for both HMA and concrete, and the corresponding test procedures, to aid the PI and RSC in selecting the appropriate type and level of certification for the study. The PI and RSC may also use Table 1 to select an MDOT Materials Division engineer to aid in making this determination. These sections also provide means by which the RSC may confirm requisite certification of technicians.

HMA Technicians

Table 2, "HMA Technician Certification Levels and Corresponding Test Procedures," may be used to aid in determining which level of certification is necessary to perform the HMA tests and/or mix designs included in the research proposal. This table provides the HMA technician tasks and set of test procedures that correspond to each of three levels of available certification for HMA materials. Note that obtaining the Certified Mixture Design Technician (CMDT) certification will also satisfy the requirements for Certified Asphalt Technician (CAT) CAT-I certification. Appendix I provides a correlation of each of the test standard designations included in Table 2 to test title; i.e., AASHTO T2, Sampling of Aggregates.

It is anticipated that the course content and corresponding test procedures included in each level of HMA certification training will change with advances in HMA mix and pavement design technologies; therefore, future RSCs are advised to periodically review and, when appropriate, update Table 2. To obtain the information needed to accomplish this task, the RSC should begin by contacting the MDOT Materials Division Asphalt and Chemical Testing Engineer. If that engineer does not have direct access to the course content, he/she should be able to provide the RSC with the contact information for either a current instructor of the HMA certification classes, or for one

of the members of a Board of Directors overseeing the HMA Certification Program. Paragraph 1.3.3.2, "Program Administration," included in reference (2) describes the responsibilities of this Board, including the course content. References are included in Appendix K.

Table 2. HMA Technician Certification Levels and Corresponding Test Procedures

HMA Technician's Tasks	Test Method Required	Certification Required
Responsible for daily sampling, testing, data calculations, charting and process monitoring at the HMA plant	AASHTO Designation: T2, T11, T27, T166, T209, T269, T275, T308, T312, ASTM Designation: C1252, D3665, D5821, MT Designation: 6, 16,31,59,63,76, and CSD-50-70-54-00	Certified Asphalt Technician – I (CAT-I)
Responsible for the successful operations of the QC program at the HMA plant and the necessary adjustments to the process to maintain the mixture within the required control limits	AASHTO Designation: T2, T11, T27, T84, T85, T166, T209, T269, T275, T308, T312, ASTM Designation: C1252, D3665, D5821, MT Designation: 6, 16, 31, 59, 63, 76, and CSD-50-70-54-00	Certified Asphalt Technician – II (CAT-II)
Responsible for testing according to MDOT design procedures for the development of a job mix formula for HMA mixtures	AASHTO Designation: T2, T11, T37, T84, T85, T88, T90, T166, T209, T269, T275, T308, T312, ASTM Designation: C1252, D4791, D5821, MT Designation: 24, 59, 63, 78	Certified Mixture Design Technician (CMDT)

Determining if a Technician is Certified to Test HMA

The Mississippi Asphalt Pavement Association (MAPA) maintains a list of certified HMA technicians within the state. This list can be accessed through the MAPA website. The list provides the name, level of

certification, company, and other relevant information for each of these technicians. The MDOT Materials Division also maintains a list of certified HMA technicians. During the review of a research proposal that includes HMA testing, the RSC should check one of these sources to ensure that the PI has included a certified technician who is qualified to either directly perform, or oversee the performance of, the specific HMA test(s) listed in the proposal.

Concrete Technicians

Table 3, "Concrete Technician Certification Levels and Corresponding Test Procedures," may be used to aid in determining which level of certification is necessary to perform the concrete tests and/or mix designs included in the research proposal. This table provides the concrete technician tasks and set of test procedures that correspond to each available certification level for concrete materials. Appendix I provides a correlation of each of the test standard designations included in Table 3 to test title.

As for HMA, it is anticipated that the American Concrete Institute (ACI) course content and corresponding test procedures will change with advances in concrete mix and pavement design technologies. The Mississippi Concrete Industries Association (MCIA) document, "Certified Concrete Technicians," includes descriptions for each level of certification, and a corresponding list of test procedures. Future RSCs should access the latest version of this document via the MCIA website to periodically review and, when appropriate, update the content of Table 3.

Determining if a Technician is Certified to Test Concrete

MCIA maintains a list of certified concrete technicians within the state. This list is included in the MCIA document, "Certified Concrete Technicians," which can be accessed through the MCIA website. The list provides the name, level of certification, company, and other relevant information for each technician. The MDOT Materials Division also maintains a list of certified concrete technicians. During the review of a research proposal that includes concrete testing, the RSC should check one of these sources to ensure that the PI has included a certified technician who is qualified to either directly perform, or oversee the performance of, the specific concrete test(s) listed in the proposal.

Table 3. Concrete Technician Certification Levels and Corresponding Test Procedures

Concrete Technician's Tasks	Test Method Required	Certification Required[2]
Sampling or Testing of Plastic Concrete	AASHTO Designation: T23, T119, T121, T141, T152, T196, and ASTM Designation: C1064	MDOT Class I certification
Compressive Strength Testing of Concrete Cylinders	AASHTO Designation: T22 and T231	MDOT Concrete Strength Testing Technician certification
Sampling of Aggregates	AASHTO Designation: T2	Work under the supervision of an MDOT Class II certified technician
Testing of Aggregates	AASHTO Designation: T19, T27, T84, T85, T248, and T255	MDOT Class II certification
Proportioning of Concrete Mixtures[1]	AASHTO Designation: M157 and R39	MDOT Class III
Interpretation and Application of Maturity Meter Readings	AASHTO Designation: T325 and ASTM Designation: C1074	MDOT Class III or Two hours maturity method training

1. Technicians making concrete test specimens for meeting the requirements of Subsection 804.02.10.1.2 shall be MDOT Class I certified and under the direct supervision of an MDOT Class III certified technician.

2. MDOT Class I certification encompasses the same test procedures and specifications as ACI Concrete Field Testing Technician Grade I. MDOT Class II certification encompasses the same test procedures and specifications as ACI Aggregate Testing Technician – Level I. MDOT Concrete Strength Testing Technician encompasses the same test procedures and specifications as ACI Concrete Strength Testing certification.

Soils, Aggregates, and CSMs Technicians

The MDOT Soil Certification Program (SCP) allows a technician to be certified for specific test procedures rather than a suite of tests such as those included in the various HMA and concrete certification levels. A list of the test procedures and specifications included in the MDOT SCP is included in Appendix J, "MDOT Certified Soil, Aggregate and CSM Test Procedures." During the development of a research proposal that includes soil, aggregate, and/or CSM testing, the PI and RSC should refer to this appendix to determine which of the proposed tests are available for MDOT certification.

Currently two MT standards are included in the SCP related to testing CSMs. CSMs are a class of pavement construction materials including lime, lime-fly ash, and cement stabilized soils, each requiring mix designs that are performed in the MDOT Soils and Physical Laboratory. It is anticipated that the available test procedures included in the SCP will increase with advances in methods to characterize CSMs for pavement design.

Future RSCs should periodically review the content of the SCP, and when appropriate, update the content of Appendix J. The MDOT Soils, Geotechnical, Aggregates, Physical Testing Engineer can provide the content of the SCP at the time of the review.

Determining if a Technician is Certified to Test Soils, Aggregates and/or CSMs

The MDOT Soils, Geotechnical, Aggregates, Physical Testing Engineer maintains a list of technicians certified to test soils, aggregates and CSMs. The RSC should contact this engineer to ensure that the PI has included a certified technician who is qualified to either directly perform, or oversee the performance of, the specific soil, aggregate, and/or CSM test(s) listed in the proposal.

Cases Where Proposed Test Procedure(s) are Not Included in Either an MDOT Certification or AASHTO Accreditation Program

Research studies may employ test procedures that are not included in either the MDOT Certification or AASHTO accreditation programs. Two other variations of this theme include:

- modifications to an existing test standard that is part of one of the aforementioned certification/accreditation programs,
- development of a new test standard.

Several factors may be considered to enhance the confidence of an RSC in test results obtained in these cases. These factors include:

1. The status of the laboratory's certification or accreditation to perform supporting tests.
2. Certified technicians performing the supporting tests.
3. The proposed tests are performed by technicians certified in the same type of construction material.
4. Calibration of equipment not included in either of these programs.
5. Interlaboratory side-by-side testing.

Test procedures that are not included in either the MDOT certification or AASHTO accreditation programs often utilize supporting test results derived from use of other test procedures that are included in one of these programs. For example, AASHTO T307, "Determining the Resilient Modulus of Soils and Aggregate Materials," is not included in either of these programs; however, in order to conduct the procedure outlined in T307, a number of other AASHTO test procedures must to be employed to properly characterize the material, and then prepare a test specimen of same – these are supporting test procedures. Many of these supporting test procedures are included in either the certification or accreditation program. If an RSC is considering use of a particular laboratory to perform AASHTO T307, that laboratory should be certified or accredited to perform all supporting tests for which certification or accreditation is available.

The majority of proposed test procedures will require use of laboratory equipment that is included in either the MDOT certification or AASHTO accreditation program, such as electronic balances, loading frames, and sieves. This laboratory equipment is supposed to meet industry-accepted standards if it has been inspected via one of these programs. Therefore, even if the proposed test procedure is not included in either the certification or accreditation program, knowing that the equipment has been checked via one of these programs can enhance the confidence of an RSC in the test results from use of that procedure.

In summary, the first factor to enhance the confidence of an RSC in test results from a test procedure not included in either program can be addressed by doing each of the following:

- Identify required supporting tests to perform the test in question.
- Determine if supporting tests are included in either the MDOT certification or AASHTO accreditation programs.

- Determine if the proposing laboratory is certified or accredited to perform those supporting test procedures.

Relative to the second factor listed to enhance RSC confidence in test results, the laboratory should have certified technicians performing any supporting tests for which certification is available. For example, AASHTO T307 includes a supporting test, AASHTO T89, "Determining the Liquid Limit of Soils." A technician can be certified to perform this test procedure via the MDOT SCP. The RSC should confirm that the proposed technician is certified to perform this supporting test prior to his/her performance of the test.

Relative to the third factor, the proposed test procedure should be performed by a technician that is certified in the same type of construction material as that being used in the test procedure, and at a level of certification that most closely corresponds to the requirements of the proposed procedure. For example, if the objective of a proposed research study is to develop a new way of designing HMA mixes, the PI and RSC should require a CMDT to be responsible for performing the requisite testing, not a CAT I.

Proof of proper calibration of any specialized testing equipment not included in the MDOT certification or AASHTO accreditation program laboratory inspections complements the laboratory's qualifications to perform the proposed test(s). For example, a local engineering firm uses an Interlaken Soil & Asphalt Test System to perform the resilient modulus (M_R) test. This particular test apparatus is not included in a current laboratory inspection program; however, the manufacturer of this equipment provides detailed guidelines for how this equipment should be calibrated. In addition, the services of a private testing firm that specializes in M_R testing can be employed to ensure proper calibration of this equipment.

Knowing that a laboratory's specialized test equipment is properly calibrated addresses the fourth factor for enhancing an RSC's confidence in test results provided by that laboratory. Therefore, the proposing laboratory will provide, upon request by the RSC, proof of calibration of such equipment.

The Federal Highway Administration (FHWA), private testing firms, and universities experienced in the conduct of specific test procedures can provide training and side-by-side testing for those procedures. For example, MDOT funded State Study (SS) No. 177, "Inputs of Portland Cement Concrete Parameters Needed for the Design of New and

Rehabilitated Pavements in Mississippi." In this study twenty concrete mixes were tested for their requisite pavement design properties.

The FHWA mobile concrete laboratory was deployed to Mississippi that allowed training for various concrete test procedures. In addition, side-by-side, or comparison, testing of concrete specimens was conducted between the university students involved in performing SS 177, and the FHWA technicians. Based on an analysis of the difference in test results between these two entities, two of the test procedures followed by the university were modified. Concrete samples fabricated and tested using the revised procedures for modulus of rupture and splitting tensile strength resulted in improved test results. The side-by-side testing employed in this study did enhance the RSC's confidence in the test results provided by that university.

Test Reports and Supporting Records

All reports of test results and supporting test records will be provided to the Department as study deliverables. The content of the test reports shall be in accordance with the requirements of the specific test procedure(s) employed in the conduct of the study. The following quote from paragraph 6.3.2 of AASHTO R18 provides details of what constitutes "supporting test records:"

> Test Records – The laboratory shall maintain test records that contain sufficient information to permit verification of any test reports. Records pertaining to testing shall include original observations, calculations, derived data, and an identification of personnel involved in sampling and testing. (3)

Laboratory test methods used for measuring the stiffness of soils, unbound aggregates, and HMA under varying environmental and loading conditions entail multiple observations and calculations to generate the test data. As a specific example, consider AASHTO T307. It entails a relatively complicated test procedure requiring sophisticated equipment to condition a test sample, and then record a large number of load and displacement measurements on that sample. The test results that it produces must then be subjected to a numerical optimization routine to produce the value for each of three "k" coefficients. These "k" coefficients are in turn used in the generalized equation for predicting the resilient modulus of a soil under varying stress conditions.

Another example is AASHTO T342, "Standard Method of Test for Determining Dynamic Modulus of Hot-Mix Asphalt Concrete Mixtures,"

that provides test data used in numerical optimization routines to derive fitting parameters for developing an HMA master curve. Both of these examples illustrate the generation of large sets of data that are digitally recorded and stored during testing for subsequent use in calculating final test results and products.

In these and similar cases, both the test data and derived data will be provided in electronic format to the Department as a research study deliverable. The final report should clearly convey to the RSC the techniques used to reduce the test results to the form(s) required for final application.

All test records and reports will be included in the electronic versions of the final report submitted to the Department. However, at the discretion of the RSC, the paper copy version of the final report may omit these records and reports.

Experience

The proposal will describe similar type work completed during the past five (5) years which qualifies the laboratory, laboratory management, and technicians to perform the proposed testing tasks. The five-year period coincides with the time frame required for an accredited agency to retain the various records listed in paragraph 5.8.1 of AASHTO R18. These records include technician training and evaluation.

Performance Charts

Depending on how critical high quality test results are to the successful implementation of a research study, an RSC may want to know how the proposing laboratory has performed over time for one or more of the proposed tests. This information can be found in the form of a performance chart provided to that laboratory each time it participates in a round of proficiency testing. Details of laboratory proficiency testing and an example of a sample performance chart with some interpretive text are included in Appendix K, “AASHTO Proficiency Sample Program.”

An example of a general category of research studies, where an RSC may consider requesting performance charts, would be when the implementable deliverable of the study is some sort of predictive equation. In this general category, the predictive equation would be used to estimate a fundamental engineering material property from the results of relatively inexpensive and easy to perform routine tests.

As a specific example, consider AASHTO T307. It can be used to predict the resilient modulus (M_R) of a soil; however, as previously discussed, it is a relatively complicated test procedure. The M_R of a soil can be estimated from the results of routine laboratory soil tests, such as those used in the following predictive equation for fine-grain soils found in Mississippi (4):

$$M_R = 16.75((LL/w_c \text{ X } \gamma_{dr})^{2.06} + (\#200/100)^{-0.59})$$

Where: M_R = Resilient modulus, MPa;
LL = Liquid Limit, %;
w_c = Moisture content, %;
γ_{dr} = dry density/maximum dry density;
γ_d = dry density, kN/m^3;
#200 = Passing #200 sieve, %

In this equation five test results are required to estimate a value for the M_R, each according to an AASHTO test standard. The routine soil test results used to initially develop such an equation must be of the highest quality because the intended end use of the equation is to provide input values for pavement design.

The AASHTO Materials Reference Laboratory (AMRL) will not provide to the public a laboratory's ratings from the last round of proficiency sample testing or the corresponding performance chart for a given test procedure; however, this does not preclude the RSC from requesting this information directly from the laboratory in question. It would be informative if that laboratory refused to share its last ratings or its performance chart with the RSC. In this situation the RSC may want to consider using another laboratory to obtain the required testing services.

Universities

MDOT Certification of University Laboratories

The universities participating in the Mississippi State University Master Contract for Research, Technology Development and Engineering Services typically do not have MDOT-certified construction materials testing laboratories. Therefore, when a PI from one of these universities proposes a research study, the university's laboratory must be certified by MDOT. The laboratory will be inspected by personnel from the MDOT Central Laboratory, and the students scheduled to perform the tests will become certified by successfully

completing technician training commensurate with the testing needs of the given study.

The PI will include an MDOT performed task in the proposed study scope of work that accounts for this laboratory inspection. Any deficiencies noted during the inspection will be corrected by the university. Personnel from the MDOT Central Laboratory will confirm that such deficiencies are corrected prior to certifying that the university test equipment meets the applicable test standards. MDOT will not compensate the university for any corrective actions taken to address the deficiencies.

The MDOT Research Division will compensate the MDOT Materials Division for all inspection services rendered through a support study to the PI's study. The MDOT Research Division technical advisory committee (TAC) member will be responsible for the administration of this support study. Note that such compensation will only be rendered in support of certifying a university laboratory.

It is the responsibility of the RSC to ensure that the university laboratory is certified prior to any materials testing. However, the MDOT Research Division TAC member will provide administrative assistance to the RSC to help facilitate the laboratory certification process. Any issues related to obtaining such certification will be reported to the MDOT State Research Engineer.

Student Certification to Perform Construction Materials Testing

The PI will include a university performed task in the proposed study scope of work that accounts for student certification. The PI will be responsible for making all arrangements to ensure that his/her student(s) receive the requisite certification training, including enrollment of students in each certification training class, transportation, food and lodging. The MDOT Research Division will compensate the university via the research work assignment for all costs associated with this task. Note that such compensation will only be rendered in support of certifying students. The RSC will ensure that the student(s) are certified prior to conducting any tests requiring such certification.

In certain instances the PI may employ one or more non-certified students to assist in the conduct of university laboratory testing. This may be acceptable to the RSC so long as those students are overseen by a certified technician; i.e., an undergraduate or graduate student who is certified to perform that testing. The research proposal will

include anticipated occurrence of any such instance(s) for consideration and approval by the RSC.

Special Consideration of Experience Requirement for Certification of Students Performing HMA Testing

All three levels of HMA certification include prior work experience requirements that would typically preclude university students from becoming certified at any level. Depending on the scope of the research study, an RSC may waive the experience requirements and allow the student(s) to attend the technician training level commensurate with the HMA testing needs of the given study. Upon successful completion of training the students could be considered qualified to perform HMA testing for the research effort; however, they would not be considered "certified" by industry standards.

Enhancing Quality of University Student Test Results Using Precision Statements

Typically the private engineering/testing firms employed in a Department funded research study are AASHTO accredited and have experienced technicians on staff to provide reliable test data. However, university students typically do not have the testing experience of these practicing technicians. Depending on how critical quality test results are to implementing the findings of a study funded with a university, two additional steps may be required by the RSC to help ensure quality test results are provided by the students.

Assuming step one is MDOT inspection of the university laboratory equipment and step two is certification of the students, steps three and four employ the use of test standard precision statements. A review of these statements is included in Appendix K, "AASHTO Proficiency Sample Program."

Subsequent to the appropriate certification training, the third step is for the student to practice the test procedure at the university laboratory until he/she achieves a measurable level of proficiency at performing the test. Measuring this level of proficiency is made by considering the repeatability of test measurements within the same laboratory. Note that not all test procedures have such a statement, but if the test under consideration does, then it should be used to help ensure quality test results.

After the student has practiced the test procedure to the point that he/she is able to repeat the test result in the university laboratory to within the tolerance allowed by the applicable test procedure within-

laboratory precision statement, then the fourth step of the solution is for that student to demonstrate proficiency at performing the given test by participating in split sample testing with an MDOT technician. Corresponding to the **within**-laboratory precision statement is a **between**-laboratory precision statement for the same test standard.

The MDOT technician would run the particular test on his/her half of the split sample at the MDOT laboratory, and the student would run the same test on the other half of the sample at the university laboratory. The two test results should be within the prescribed tolerance of the applicable between-laboratory precision statement. Again, not all test procedures include a precision statement, but when it does, it should be utilized in this fourth step.

If the RSC requires these two additional steps, they will be included in the appropriate research study tasks.

12. Submission – Submit research proposal as a Microsoft Word document, via email, to Robbie Vance at rvance@mdot.state.ms.us. Also submit, to Mr. Vance, a document separate from the research proposal that includes the table accounting for the proposed study costs in terms of traditional accounting line items as discussed under section 4, “Funding” per either Figure A1 or A2.

Appendix A1. Example Research Plan

Note that the study used to develop this example Research Plan is not the same study used to develop the Project Schedule shown in Figure B1. “Example of a Project Schedule Using a Gantt Chart.”

Task C1. The Consultant will:

(a) Compile publications and documentation (literature search) applicable to characterizing expansive clays

(b) Copy Yazoo Clay data from existing computer files and documents

Task M1. The MDOT Materials Division will make available to the Consultant archived MDOT database and spreadsheet files containing approximately 800 borehole test data for researching soil and mineralogy property indicator correlations.

Task C2. The Consultant will categorize available MDOT Yazoo Clay data (past studies and experiments) archived in MDOT computer files, published reports, and unpublished documents. Perform statistical analyses of the data searching for applicable soil and mineralogy property indicator correlations.

Task C3. The Consultant will:

(a) Observe Yazoo Clay soil sampling, testing, and characterization procedures performed by MDOT

(b) Mobilize testing setup and initiate testing procedures

Task M2. The MDOT Materials Division will:

(a) Perform rotary drilling and undisturbed sampling in Yazoo Clay at two immediately adjacent locations designated herein as boreholes ‘A’ and ‘B’. In-situ soil strata permitting, continuous undisturbed Shelby-tube samples will be obtained from each location to a depth of thirty (30) feet below the ground surface. Sampling intervals will correspond between the two boreholes; i.e., sample interval 0-1 ft. in borehole ‘A’ will have the same corresponding elevations to borehole ‘B’ sample interval 0-1 ft.

(b) Collect additional data for each location including lat-long data, ground surface elevation, depth, and descriptive stratigraphy shown on each borehole log.

(c) Seal and tag samples by location, depth, and vertical orientation

(d) Deliver borehole ‘A’ samples to the MDOT Central Laboratory and provide borehole ‘B’ samples to the Consultant for laboratory testing.

Task M3. The MDOT Materials Division will:

(a) Perform each of the following tests in accordance with the standard MDOT procedures (TMD-20-14-00-000 and others as appropriate) for each one-foot sample interval in borehole ‘A’:

- Natural water content
- Shear strength (unconfined compressive strength or hand-held penetrometer and/or Torvane
- In-situ density
- Atterburg limits (LL and PL)
- Volume change and shrinkage limit
- Grain size distribution
- Percent clay
- USCS/AASHTO classification

(b) All surplus and remolded soil from each sample interval of borehole ‘A’ will be recompiled into one sample for the given sample interval; i.e., remaining soil from different sample increments will not be combined. Each recombined sample will be seal-bagged and tagged for location and sample interval identification. The MDOT Materials Division will provide these bags of remaining soil to the Consultant for further testing.

(c) Provide all test data from testing borehole ‘A’ samples to the Consultant.

Task C4. The Consultant will perform the following tests on adjacent borehole ‘B’ undisturbed sample 1-ft intervals and remaining borehole ‘A’ bagged (disturbed) soil (as described elsewhere herein):

(a) Shrink-swell tests including oedometer, free swell, FHA PVC, expansion index, Australian, and innovative methods;

(b) Suction tests including filter paper, chilled mirror, psychrometer, and alternative methods; and,

(c) Physio-chemical tests including specific surface, cation exchange, and soil chemistry methods.

Each borehole ‘B’ sample interval will correspond to each borehole ‘A’ sample interval for experimental and/or standardized testing

procedures. Surplus and remaining soil will be remolded at differing water contents for additional experimental and/or standardized tests.

Task C5. The Consultant will analyze test results for correlations to indicators, engineering properties including published empirical correlations, and soil depth profiles. Correlations of results will assume negligible lateral variability between boreholes 'A' and 'B' at each sample interval. Evaluate test equipment, methods, procedures, and results.

Task C6. The Consultant will provide the following Project Management deliverables in accordance with the indicated sections/subsections and appendices of the MDOT Research Division document *Research Proposal Development and Submission Process for the Mississippi Department of Transportation Annual Research Work Program Federal FY 2014*:

(a) Minutes for all Technical Advisory Committee meetings according to "General Information," subsection "TAC Meetings";

(b) Quarterly Progress Reports according to the format and schedule in Appendix C, "Quarterly Progress Reports";

(c) Annual Progress Reports according to the format and schedule in Appendix D, "Annual Progress Reports"; and,

(d) Supporting documentation with submission of invoices per Appendix E, "Supporting Documentation with Submission of Invoices."

Task C7. The Consultant will provide a final report that includes compiled and documented test results, findings, correlations, evaluations, and conclusions as well as a Technical Report Documentation Page and study deliverables per the requirements of the MDOT Research Division document *Research Proposal Development and Submission Process for the Mississippi Department of Transportation Annual Research Work Program Federal FY 2015,* Appendix A, "Mississippi DOT Research Proposal Format," section 3, "Research Plan," subsection "Interim and Final Reports" and section 11, "Testing Facilities and Technician Experience," subsection "Test Reports and Supporting Records."

Task M4. The MDOT Materials Division will review both the draft and final versions of the final report and provide feedback to the Consultant and the MDOT Research Division TAC member.

Appendix B. Project Schedule

All research proposals will include a Project Schedule, via a Gantt chart, that graphically illustrates the duration of each study task/subtask as well as the relative concurrence and sequence of same as developed for the research plan. If the proposal is selected for funding by MDOT, this schedule will be incorporated as part of the contract document. After a notice to proceed (NTP) is issued, the Project Schedule will be updated by the Consultant and will serve as supporting documentation with submission of quarterly progress reports and invoices.

After the NTP has been issued and the study is under contract, changes are allowed to the content and ordering of tasks/subtasks with TAC approval. Any approved revisions require corresponding update, by the Consultant, of the Project Schedule and the planned project progress and planned gross expenditures graphs.

Show NTP as Start Date in Project Schedule with Initial Proposal Submission

Do not put October 1 as the start date in the Project Schedule when initially submitting a proposal because the NTP date is unknown at the time of submission. Develop the Project Schedule in terms of "Months from Notice to Proceed (NTP) Date" as illustrated in Figure B1. "Example of a Project Schedule Using a Gantt Chart." After the NTP is issued, the Project Schedule is revised relative to the date of the NTP.

Quarterly Progress Reports

Consultant submission of quarterly progress reports (QPRs) is shown as a separate subtask in both the Research Plan and the Project Schedule. Figure B1. illustrates this requirement in the Project Schedule as Task C5, a), QPRs, with the initial submission of the research proposal. Note each QPR is shown as a two week period of time following each three-month increment of time within the thirty month study period.

After the NTP is issued, the Project Schedule must be updated to show the submission of QPRs relative to the date of the NTP per the schedule shown in Appendix C, "Quarterly Progress Reports." See Figure B4. "Example of Updated Project Schedule after NTP is Issued."

Annual Progress Reports

Consultant submission of annual progress reports (APRs) is shown as a separate subtask in both the Research Plan and the Project Schedule. Figure B1. illustrates this requirement in the Project Schedule as Task C5, b), APRs, with the initial submission of the research proposal.

Note each APR is shown as a two week period of time following each twelve-month increment of time within the thirty month study period.

After the NTP is issued the Project Schedule must be updated to show the submission of APRs relative to the date of the NTP per the schedule shown in Appendix D, "Annual Progress Reports." See Figure B4. "Example of Updated Project Schedule after NTP is Issued."

Submission of Interim and Final Reports

Each interim report and the final report follow a three-month review, comment and revision period of time prior to submission of the final version of the given report. Each three-month time period is included in the Project Schedule per the following time sequence:

- The Consultant will submit a draft of the interim/final report to the MDOT study TAC three months prior to the time shown in the Project Schedule as the particular report completion date.
- At the time of initial submission of the draft report the Consultant will provide a presentation focused on the content of the given report to the TAC committee. This presentation may be face-to-face with the TAC either at the Consultant or MDOT location, or via Web conferencing. If Web conferencing is used, the Consultant will be responsible for setting up the conference with a service provider that allows for all requirements of the given presentation.
- The TAC will have one month to review the draft of the report and submit comments to the Consultant. If no comments are provided by the TAC by the end of this one-month review period then the report will be considered approved by the TAC and the Consultant will proceed with providing the final version of the interim/final report.
- If comments are provided by the TAC, the Consultant will have one month to address the TAC comments and submit a second version of the draft interim/final report to the TAC members.
- The TAC members will have two weeks to evaluate the adequacy of how their comments were addressed by the Consultant in the report and provide any feedback to the Consultant.
- If no comments are provided by the TAC by the end of this two-week review period, then the interim/final report will be considered approved by the TAC.

The Project Schedule will show the draft of the final report submitted three (3) months prior to the end of the proposed Project Progress

schedule. The final version of the final report will be submitted by the contract termination date.

Figure B1 illustrates these requirements in the Project Schedule as Tasks C2, d) Interim Report and C6, Final Report with the initial submission of the research proposal. Note the MDOT review and Consultant revision sequences shown in this example for both reports.

Planned Progress and Planned Expenditure Graphs

Two additional graphs are also required at the time of submission of the proposal: one displaying planned progress with time and the other showing planned expenditures with time. If the proposal is selected for funding by MDOT, each of these graphs will be periodically updated throughout the duration of the study by the Consultant and will serve as supporting documentation with the submission of both quarterly progress reports and invoices.

The example Project Schedules and corresponding graphs included in the following figures were developed using Excel. Therefore, no special software is required by the Consultant to display this information in the required format.

Example of a Project Schedule Using a Gantt Chart

Figure B1 illustrates the required format for a Project Schedule at the time of initial submission of a proposal. In this example a thirty month contract period is anticipated for completion of this hypothetical study. Note that the study used to develop this example Project Schedule is not the same study used to develop the tasks and subtasks included in Appendix A1. “Example Research Plan.”

The Research Task and Sub-Task columns include the tasks and subtasks developed in the research plan by the Consultant. The Work % column represents, for each task/subtask, the amount of work required to complete the given task/subtask relative to the total amount of work required to complete the study. As illustrated near the bottom of the Work % column, the Total Work % should be 100, including all the tasks and subtasks.

As an example, consider Task C1, Subtask a, the Literature Search. The Consultant indicates that this effort will require 5% of the total effort to complete the study. Note that 20% of the effort to complete the literature search task/subtask is planned to be performed during the first month, 40% of the effort to complete this task/subtask will be performed during the second month, and 40% during the third month. At the end of the third month, it is planned to have 100% of the literature review task/subtask complete.

MDOT Research Project Progress Schedule

Research Study Title _____

State Study Number _____ NTP Date _____ Federal FY _____ QPR Period _____ Overall % Complete 0 %

Research Agency _____

Principal Investigator _____

Research			Months from Notice to Proceed (NTP) Date																												Estimated %
Task	Sub-Task	Work	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Completion
C1	a) Literature	5%																															
	Search		20%	40%	40%																												
	b) Questionnaire	5%																															
				30%	20%	50%																											
M1	Aggregate Samp																																
C2	a) Materials	16%																															
	Analysis						10%	15%	15%	10%	10%	10%	10%	10%	10%																		
	b) Screening	16%																															
	Tests						10%	15%	15%	10%	10%	10%	10%	10%	10%																		
	c) Performance	16%																															
	Tests						10%	15%	15%	10%	10%	10%	10%	10%	10%																		
	d) Interim	2%																															
	Report														50%	50%																	
M2	MDOT Review																																
C3	a) Natural	15%																															
	Weathering																	10%	25%	20%	15%	10%	20%									
	b) Salt	15%																															
	Exposure																						15%	35%	20%	15%	15%					
C4	Field Study	4%																															
	Design																										50%	50%					
C5	a) QPRs																																
	b) APRs																																
C6	Final Report	6%																															
																											20%	35%	30%			15%	
M3	MDOT Review																																
Total Work		100%																															
Planned Overall Progress, %			1	5	8	10	15	22	29	34	39	44	48	53	59	60	60	62	65	68	71	72	77	83	86	88	93	97	99	99	99	100	0

Figure B1. Example of a Project Schedule Using a Gantt Chart

In this example study, the MDOT Materials Division will provide aggregate samples for testing by the Consultant. Figure B1. illustrates MDOT providing these samples to the Consultant by the end of month four. Displaying MDOT's responsibility for this task in the Project Schedule is important because timely provision of these samples by MDOT will enable the Consultant to complete aggregate testing by the end of month thirteen. This, in turn, allows the Consultant to maintain the schedule for completion of the rest of the tasks and provide the final report within the planned thirty month study period.

MDOT will also review the interim and final reports. The tasks/subtasks for this study include all of MDOT's responsibilities which are shown in the Project Schedule with designations M1 through M3.

The lower left-hand corner of the chart includes a cell entitled Planned Overall Progress, %. The project progress schedule allows for an account of the cumulative amount of planned work to be completed by the end of each month included in the duration of the study. Note the bottom row of cells, including the numbers one through one hundred, corresponding to months one through thirty. At the end of the first month, 20% of the literature search is planned for completion, which represents 1% of the total work effort to complete the study. This value is calculated as:

$$0.05*0.20*100 = 1$$

Where:

0.05 = Percent, expressed in decimal form. Five percent of the total research effort is required to complete the literature search subtask.

0.20 = Percent, expressed in decimal form. Twenty percent of the total effort to complete the literature search.

During the second month it is planned to complete 40% of task 1 subtask a and 30% of task 1 subtask b with 5% of the total research effort planned for completion by the end of the second month. This value is calculated by adding the cumulated planned work shown in the previous month calculations to the current month.

$$1 + (0.05*0.40+0.05*0.30)*100 = 5$$

Where:

1 = percent of total work effort planned for completion by the end of the previous month.

0.05 = Percent, expressed in decimal form. Five percent of the total research effort is required to complete the literature search subtask.

0.40 = Percent, expressed in decimal form. Forty percent of the total effort to complete the literature search subtask.

0.05 = Percent, expressed in decimal form. Five percent of the total research effort is required to complete the Questionnaire subtask.

0.30 = Percent, expressed in decimal form. Thirty percent of the total effort to complete the Questionnaire subtask.

Planned vs. Actual Project Progress

Figure B2 illustrates the planned versus actual progress for the study which is developed from information included in the progress schedule chart – Planned Progress, % vs. Months from NTP and Actual Progress, % vs. Months from NTP.

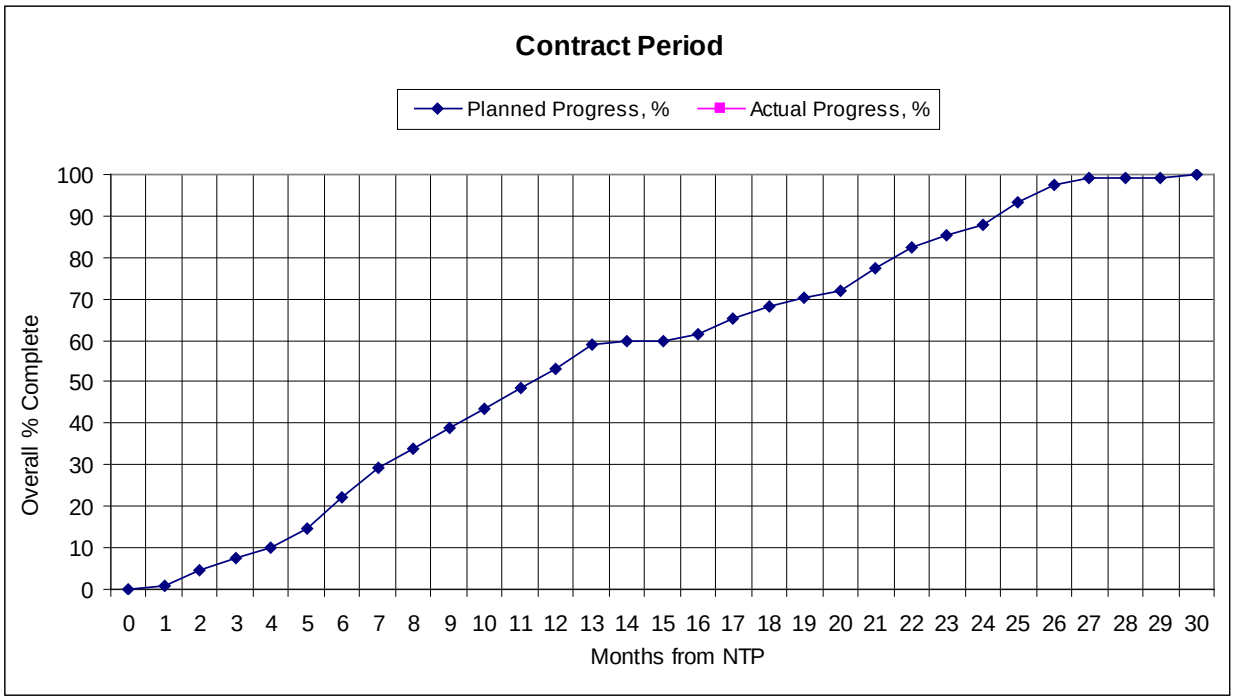

Figure B2. Planned vs. Actual Project Progress

At the onset of the study, only the Planned Progress, % vs. Months from NTP curve is available, but as the study progresses, the "Actual Progress, %" curve evolves from data that is periodically entered into the last column of the progress schedule chart, "Estimated % Completion," for each task/subtask by the Consultant. Information regarding the calculation and entry of values into this column is included in Appendix C, Quarterly Progress Reports. The MDOT

Assistant Project Manager monitors the tracking of this curve relative to the Planned Project Progress curve and advises the State Research Engineer of occurrence and cause of significant deviation between these two curves. For convenience, the Consultant may want to submit an invoice at the same time a quarterly progress report is submitted, but this is entirely at the discretion of the Consultant.

Planned vs. Actual Cumulative Gross Expenditures

Figure B3 illustrates the planned versus actual cumulative gross expenditures with time for the study. The Planned Cumulative Gross Expenditure, $ vs. Months from NTP curve is fully developed at the time the proposal is submitted by the Consultant.

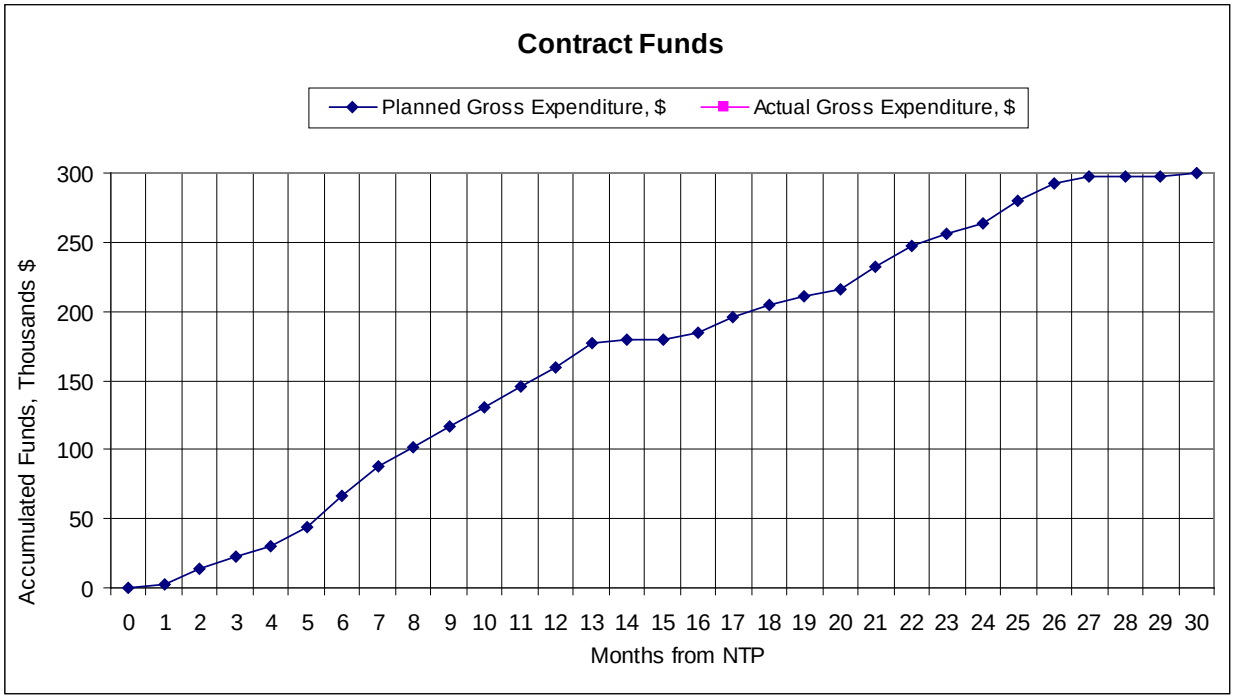

Figure B3. Planned vs. Actual Gross Expenditures

The data to develop this curve is derived from two sources. The first source is the second funding table discussed in Appendix A, section 4, Funding where the total study cost is subdivided based on tasks/subtasks. This information is used in conjunction with the appropriation of task/subtask per month in the progress schedule. For example, assume in the hypothetical study that Task 1 Subtask 1 was a literature search and the Consultant determined that $15,000 would be required for its completion. From Figure B1, 20% of this literature search is planned to be completed during the first month of the study, so the expenditure for this subtask for the first month is calculated as:

0.2*$15,000 = $3,000

For the second month, the Consultant estimates that an additional 40% of the literature search will be completed and the planned funding would be calculated as:

0.4*$15,000 = $6,000

For the third month, the Consultant estimates the final 40% of this subtask will be completed:

0.4*$15,000 = $6,000

The Planned Cumulative Gross Expenditure, % vs. Months from NTP for the end of month two would be determined by adding the expenditure for month one to the planned expenditure for month two. For the end of month three, the Planned Cumulative Gross Expenditure, % would be determined by adding the cumulative value at the end of month two to the planned expenditure for month three. For the end of month four, the Planned Cumulative Gross Expenditure would be determined by adding the cumulative value at the end of month three to the planned expenditure for month four, etc.

In the event of the purchase of equipment included in a task/subtask, the planned expenditure for the cost of that equipment would be included in the month during which the Consultant planned to pay for the purchase of that equipment.

The “Actual Cumulative Gross Expenditure, $” curve evolves from data provided by the Consultant with submission of quarterly progress reports and invoices. The Actual Cumulative Gross Expenditure represents the total funds, invoiced by the research agency, as of the date of its calculation and is plotted relative to the study NTP date. The MDOT Assistant Project Manager monitors the tracking o f this curve relative to the Planned Cumulative Gross Expenditure curve and advises the State Research Engineer of occurrence and cause of significant deviation between these two curves. For convenience the Consultant may want to submit an invoice at the same time a quarterly progress report is submitted, but this is entirely at the discretion of the Consultant.

Update Project Schedule after NTP is Issued

After an NTP is issued for a study, the Project Schedule is updated by the Consultant using the date of the NTP as the starting date for planned sequence of tasks and subtasks. The date of the NTP and corresponding Federal FY will be included in the Progress Schedule header information. Additional revisions to the Progress Schedule, relative to this NTP date, are made by replacing the verbiage “Months from Notice to Proceed (NTP) Date” with subdivision of the research

contract period based on Federal FY. Each number of month entries from the NTP is replaced with the actual month from the NTP.

Figure B4. “Example of Updated Project Schedule after NTP is Issued” illustrates these updates for the same example study used in Figure B1. In this example, the NTP date is December 23, 2010, which is in Federal Fiscal Year 2011. Note the Federal Fiscal Years 2011 through 2013 included in the thirty-month study period, beginning with the NTP date, replace the row of cells labeled “Months from Notice to Proceed (NTP) Date.” Also, note the corresponding months included in each Federal FY encompassing the duration of the study. As a result of updating the Project Schedule in this manner, each of the Research tasks and subtasks are shown relative to December 23, 2010.

There are practical applications for updating the Project Schedule after the NTP is issued. For example, the MDOT Materials Division can now schedule aggregate sampling activities during April 2011 to provide the samples to the Consultant by the end of that month. The Consultant can, in turn, schedule testing these samples from May 2011 through January 2012. Planning these activities during these particular periods of time will facilitate producing a final report by the scheduled end of the study - June 2013.

MDOT Research Project Progress Schedule

Research Study Title
State Study Number _____ NTP Date December 23, 2010 Federal FY 2012 QPR Period _____ Overall % Complete 0 %
Research Agency
Principal Investigator

Research			Federal FY 2011										Federal FY 2012												Federal FY 2013										Estimated %
Task	Sub-Task	Work	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Set	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Completion
C1	a) Literature	5%																																
	Search		20%	40%	40%																													
	b) Questionnaire	5%																																
				30%	20%	50%																												
M1	Aggregate Samp																																	
C2	a) Materials	16%																																
	Analysis						10%	15%	15%	10%	10%	10%	10%	10%	10%																				
	b) Screening	16%																																
	Tests						10%	15%	15%	10%	10%	10%	10%	10%	10%																				
	c) Performance	16%																																
	Tests						10%	15%	15%	10%	10%	10%	10%	10%	10%																				
	d) Interim	2%																																
	Report														50%	50%																		
M2	MDOT Review																																	
C3	a) Natural	15%																																
	Weathering																	10%	25%	20%	15%	10%	20%											
	b) Salt	15%																																
	Exposure																						15%	35%	20%	15%	15%							
C4	Field Study	4%																																
	Design																										50%	50%						
C5	a) QPRs																																	
	b) APRs																																	
C6	Final Report	6%																																
																											20%	35%	30%			15%		
M3	MDOT Review																																	
Total Work		100%																																
Planned Overall Progress, %			1	5	8	10	15	22	29	34	39	44	48	53	59	60	60	62	65	68	71	72	77	83	86	88	93	97	99	99	99	100		0

Figure B4. Example of Updated Project Schedule after NTP is Issued

Appendix C. Quarterly Progress Reports

The MDOT Research Division is required to submit a quarterly progress report (QPR) to the Federal Highway Administration (FHWA) that includes relevant information for each study included in the work program for the given Federal fiscal year (Federal FY). To facilitate this submission to the FHWA in a timely manner, the Consultant will write and submit, to MDOT, QPRs in accordance with the format provided herein and submit no later than the 15th of the second month following a given quarter.

Submission Schedule

A Federal FY begins October 1st. The following are the scheduled dates that each Consultant needs to submit their QPR:

Quarter	QPR Period	Submission Deadline
1st	October 1 – December 31	February 15
2nd	January 1 – March 31	May 15
3rd	April 1 – June 30	August 15
4th	July 1 – September 30	November 15

When the Consultant receives written notice that his/her study has been approved for funding, the Consultant must begin accounting for the progress of the study. There is a lapse of time between the written notice of funding approval and the issuance of a notice to proceed. This time must be accounted for by the Consultant via a quarterly progress report(s). The information included in the Progress and Plans for next quarter sections of the QPR will account for the development of the research contract. For example, a TAC meeting held during this interim period may identify issues not previously addressed in the proposal research plan. Resolution of these issues may require some modification to the tasks/subtasks included in the research plan to develop an acceptable scope of work for inclusion in the research contract.

It is the responsibility of each Consultant to provide the MDOT Research Division with a QPR without this Division being required to remind the Consultant each quarter that a report is due. To address this issue, the MDOT Research Division will keep record of all late submissions of QPRs, and this information will be considered in awards of subsequent research.

QPRs will be submitted to all TAC members of a given study via email and to Robbie Vance at rvance@mdot.state.ms.us. Direct any

questions regarding completion of these reports to Bill Barstis at wbarstis@mdot.state.ms.us.

Quarterly Progress Report Format

An electronic copy of the QPR format will be provided to the Consultant subsequent to MDOT approval of a research study. This format is included in an Excel workbook file that includes two worksheets:

- Sheet 1-Progress and Plans
- Sheet 2-Project Schedule and both Planned vs. Actual Graphs

Sheet 1-Progress and Plans

The following provides direction on completion of select QPR column entries in Sheet 1.

Months Included in Progress Reporting Period

Enter one of the following four entries corresponding to the time frame for which Progress is reported:

- October-December
- January-March
- April-June
- July-September

Progress

Under this heading include a brief **one-paragraph** summary of what was accomplished for each work task/subtask during the last quarter. **Include only those tasks/subtasks for which work was actually performed.** Also, provide an estimate of the percent work completed for each of those tasks/subtasks.

As an example, consider Figure C1. "Example of a Project Schedule Included with Submission of a QPR." The QPR Period is October, November and December in Federal FY 2012. Assume work was performed during this QPR Period on two subtasks. The information for both subtasks would be included in one simple paragraph with corresponding amount of work expressed as a percent completed for each subtask.

> Task 2 Subtask a) Materials Analysis – 30% (Interpreted as 30% of the total amount of work required to complete this task/subtask was actually performed during the months October, November and December). The Consultant would include a brief description of the actual work performed during this period of time. Task 2 Subtask b) Screening Tests – 30% The Consultant

would include a brief description of the actual work performed during this period of time.

This entire paragraph would be entered into the cell located immediately below the cell labeled “Progress.”

Plans for Next Quarter

Under this heading include a brief **one-paragraph** summary of what is planned to be accomplished during the next quarter for each work task/subtask. **List only those tasks/subtasks for which work is actually planned.** Follow the same direction provided for “Progress” by combining all tasks/subtasks into a one paragraph entry for the cell located immediately below the cell labeled “Plans for Next Quarter”.

Problems Encountered or Anticipated

Include discussion of any problems encountered during the previous quarter, or anticipated during the next quarter, that may delay submission of any project deliverables. In the example from Figure C1, problems may have been encountered with obtaining all of the requisite test equipment to complete the planned 30% work for the Performance Tests during the quarter under consideration. Although work was planned, if no work was actually performed, it will not be listed under Progress. The Consultant would include discussion of these problems and how they may affect submission of the interim report due in February 2012. **List only those tasks/subtasks corresponding to problems actually encountered or anticipated.** Follow the same direction provided for “Progress” by combining all tasks/subtasks into a one paragraph entry for the cell located immediately below the cell labeled “Problems Encountered or Anticipated.”

Total Staff

The remaining entries in Sheet1-Progress and Plans pertain to EEO and Title VI Information. Enter the total number of staff that worked on this project during the last quarter under the Total Staff heading. Show the distribution of the total number of staff based on gender and race under the appropriate adjacent headings. Make sure that the sum of this distribution equals the total.

Sheet 2-Project Schedule and both Planned vs. Actual Graphs

In workbook sheet 2, the Consultant will enter an updated Progress Schedule, Planned vs. Actual Project Progress graph, and Planned vs. Actual Gross Expenditures graph with each QPR submitted subsequent to the issuance of the NTP.

Project Schedule

Consider Figure C1. "Example of a Project Schedule Included with Submission of a QPR." The Federal FY and QPR entries in the Project Schedule header will be updated to correspond to the particular three-month reporting period with the actual months entered for "QPR Period." Note the last column in this figure "Estimated % Completion." This refers to the cumulative estimated percent completion of the corresponding task or subtask as of the end of the given QPR Period – in this example, the end of the QPR Period October, November and December in Federal FY 2012. The previous QPR for this study; i.e., Federal FY 2011 QPR Period July, August and September, would have shown all three subtasks of Task 2 at 60% complete.

During the previous quarter; i.e., October, November and December, the Consultant indicated that thirty percent additional progress was made on the first two subtasks of Task 2 as discussed under the Progress section of the QPR. These two subtasks were updated to reflect ninety percent completion as of the end of December.

Note that Estimated % Completion for each task/subtask corresponds to a point in time during the duration of the study; i.e., in this case, the end of the given QPR Period. If several invoices were submitted during the previous quarter, the Project Schedule was updated in accordance with direction provided in Appendix E, Supporting Documentation with Submission of Invoices. Those invoices would reflect work performed during the last quarter. The update of the Project Schedule for the end of the last QPR period should be relative to the submission of the last invoice during the last quarter, not the end of the previous QPR period.

At the bottom of the last column in this chart is a cell containing the number forty-eight, which corresponds to Overall % Complete as shown in the header information. This means that 48% of the total amount of work required to complete this research study was completed by the end of the last quarter. This overall 48% includes 100% completion of the Literature Search and Questionnaire Subtasks, 90% completion of the Materials Analysis and Screening Tests Subtasks, and 60% completion of the Performance Tests Subtask. Note that the Planned Overall Progress by the end of this QPR Period was 53%. Therefore, the overall study is 5% behind schedule.

MDOT Research Project Progress Schedule

Research Study Title
State Study Number ____ NTP Date December 23, 2010 Federal FY 2012 QPR Period Oct - Dec Overall % Complete # %
Research Agency
Principal Investigator

Research			2011										2012												2013									Estimated %
Task	Sub-Task	Work	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Completion
C1	a) Literature	5%																															100
	Search		20%	40%	40%																												
	b) Questionnaire	5%																															100
				30%	20%	50%																											
M1	Aggregate Samp																																
C2	a) Materials	16%																															90
	Analysis						10%	15%	15%	10%	10%	10%	10%	10%	10%																			
	b) Screening	16%																															90
	Tests						10%	15%	15%	10%	10%	10%	10%	10%	10%																			
	c) Performance	16%																															60
	Tests						10%	15%	15%	10%	10%	10%	10%	10%	10%																			
	d) Interim	2%																															
	Report														50%	50%																	
M2	MDOT Review																																
C3	a) Natural	15%																															
	Weathering																	10%	25%	20%	15%	10%	20%										
	b) Salt	15%																															
	Exposure																						15%	35%	20%	15%	15%						
C4	Field Study	4%																															
	Design																										50%	50%					
C5	a) QPRs																																
	b) APRs																																
C6	Final Report	6%																															
																											20%	35%	30%				15%	
M3	MDOT Review																																
Total Work		100%																															
Planned Overall Progress, %			1	5	8	10	14.8	22	29.2	34	38.8	43.6	48.4	53.2	59	60	60	61.5	65.3	68.3	70.5	72	77.3	82.5	85.5	87.8	93.2	97.3	99.1	99.1	99.1	100	48

Figure C1. Example of a Project Schedule Included with Submission of a QPR

Planned vs. Actual Graphs

In workbook sheet 2, the Consultant will also include an updated project progress graph, Planned vs. Actual Project Progress, with Actual Progress, %, plotted to date (Figure C2). An updated project expenditures graph, Planned vs. Actual Gross Cumulative Expenditures, will also be provided with Actual Gross Expenditure, $, plotted to date (Figure C3). Both of these graphs are included on the same workbook sheet and horizontally aligned to allow vertical correspondence of the months along both horizontal graph axes. Note that the labeling along the x-axis of both graphs has been modified from number of months from the NTP date to the first letter of each month subsequent to the NTP date.

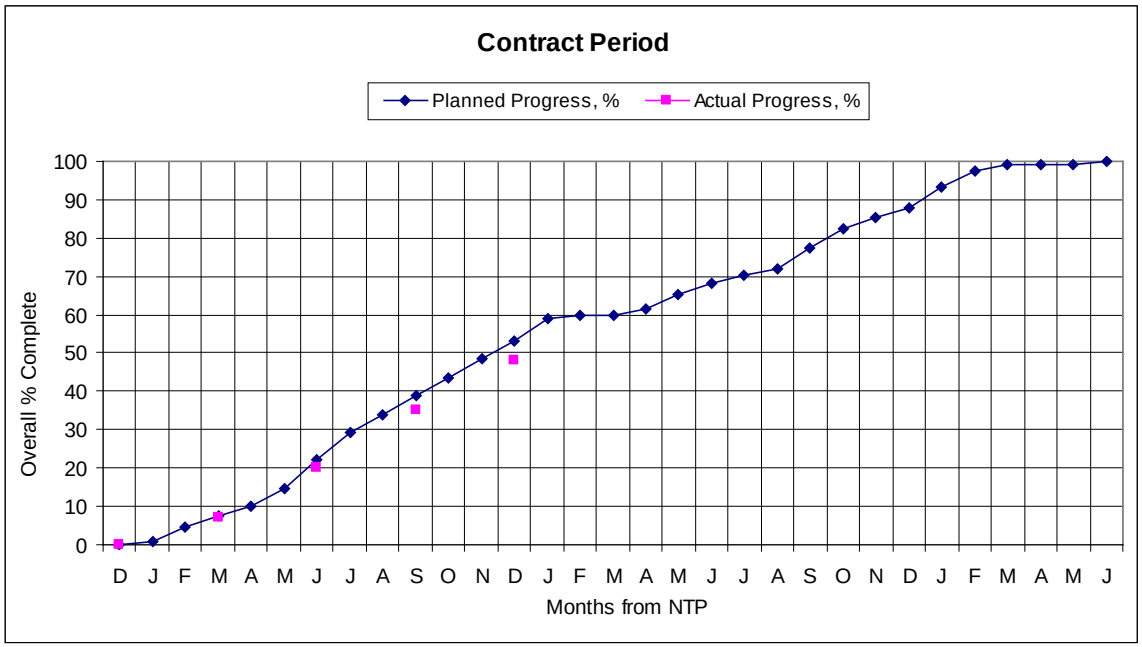

Figure C2. Planned vs. Actual Project Progress

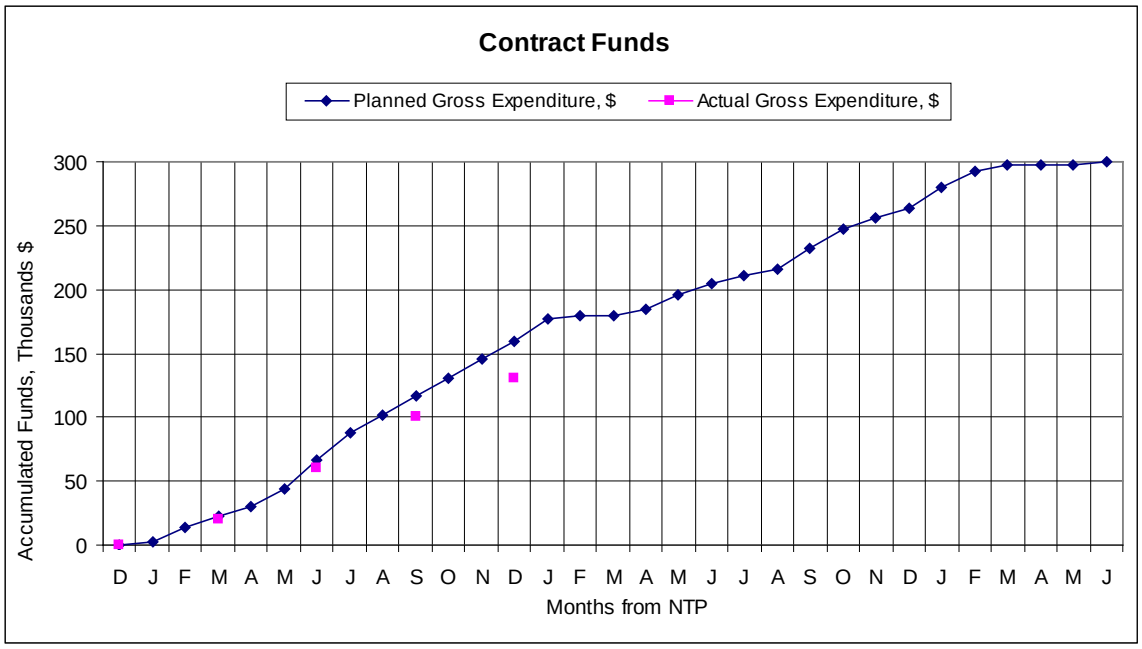

Figure C3. Planned vs. Actual Gross Expenditures

Appendix D. Annual Progress Reports

Every year the MDOT Research Division is required to submit a proposed work program to the FHWA for the next Federal Fiscal Year (FY). If a currently funded study is programmed to continue into the next Federal FY, that study is included in the proposed work program.

For a study continuing into the next Federal FY; i.e., after September 30th of a given calendar year, the Consultant will submit to MDOT, by the preceding July 15th, an Annual Progress Report (APR) in accordance with the format provided herein. APRs will be submitted to Robbie Vance at rvance@mdot.state.ms.us. Direct any questions regarding completion of these reports to Bill Barstis at wbarstis@mdot.state.ms.us.

Annual Progress Report Format

An electronic copy of the Annual Progress Report (APR) format will be provided to the Consultant subsequent to MDOT approval of a research study. This format is included in an Excel workbook file. The following provides direction on completion of select APR column entries in this file.

Progress for Federal FY 2014 (October 1, 2013 to September 30, 2014)

Under this heading, include a brief **one-paragraph** summary of what was accomplished for each work task/subtask during the current Federal FY. Note that the instruction for this type entry is the same as for a QPR - include only those tasks/subtasks for which work was actually performed. Combine this information into one paragraph for entry into the cell located immediately below the cell labeled "Progress for Federal FY 2014." Since the APR submission deadline is July 15th and the end of the Federal FY is September 30th, estimate the work that will be completed for the remainder of the current Federal FY to complete this entry in a timely manner.

Plans for Federal FY 2015 (October 1, 2014 to September 30, 2015)

Under this heading, include a brief **one-paragraph** summary of what is planned to be accomplished during the next Federal FY for each work task/subtask. List only those tasks/subtasks for which work is actually planned. Follow the same direction provided for "Progress for Federal FY 2014" by combining all tasks/subtasks into a one paragraph entry for the cell located immediately below the cell labeled "Plans for Federal FY 2015".

Problems Encountered or Anticipated

Include discussion of any problems encountered during the current Federal FY, or anticipated during the next Federal FY, that may delay submission of any project deliverables. List only those tasks/subtasks corresponding to problems actually encountered or anticipated. Follow the same direction

provided for “Progress for Federal FY 2014” by combining all tasks/subtasks into a one paragraph entry for the cell located immediately below the cell labeled “Problems Encountered or Anticipated.”

Expected Expenditures for Federal FY 2015 (October 1, 2014 to September 30, 2015)

Provide an estimate of the total amount of funding required to accomplish all of the planned work for Federal FY 2015.

Project Schedule and both Planned vs. Actual Graphs

An updated Progress Schedule, Planned vs. Actual Project Progress graph, and Planned vs. Actual Gross Expenditures graph **are not** required with submission of each APR; however, they are required for submission of each QPR and invoice.

Appendix E. Supporting Documentation with Submission of Invoices

Invoices submitted to the Department will be formatted in accordance with the requirements of the research contract. Supporting documentation must also be submitted with each invoice for interpretation of the invoiced amount in terms of the research tasks and subtasks. The following paragraph provides the requirements for this supporting documentation.

List each task/subtask for which work was completed and billed for in the invoice. Include a brief one or two paragraph summary of what was accomplished for each of these tasks/subtasks that warrant reimbursement. **List only those tasks/subtasks for which work was actually performed and billed for in the invoice.** Provide an estimate of the percent work completed and a corresponding amount of money for each these tasks/subtasks.

For example, assume that the literature search subtask planned cost is $15,000.00 and that 50% of this subtask is complete. The Consultant submits an invoice. The estimated percent work completed would be 50% and the corresponding amount of money would be $7,500 for this subtask. The total amount billed in a given invoice will equal the total amount appropriated to the various tasks/subtasks in the supporting documentation for that invoice. By extension, the total amount billed from all of the invoices submitted throughout the duration of the study will equal the total amount appropriated to the various tasks/subtasks as shown in the breakdown of study costs in accordance with Appendix A, section 4, "Funding," subsection 2.

Attach Updated Project Schedule and Project Progress and Expenditures Graphs

The Consultant will use sheet 2 of the QPR Excel workbook to submit the following with each invoice:

- An updated Project Schedule (Figure C1)
- Planned vs. Actual Project Progress, with Actual Progress, %, plotted to date (Figure C2)
- Planned vs. Actual Gross Cumulative Expenditures, with Actual Gross Expenditure, $, plotted to date (Figure C3)

Refer to Appendix C for details on how to update the Progress Schedule and accompanying graphs. **Note that Estimated % Completion for each task/subtask corresponds to a point in time during the duration of the study; i.e., in this case, the invoice date.**

Consultant cannot bill for more than the contract amount. The overall dollar amount of the contract must remain the same unless an increase in study funding is approved by the MDOT RAC and FHWA.

The last invoice will be submitted at the same time the final version of the final report is submitted to MDOT. This invoice will be marked “Final Invoice” at the top of the page signifying to MDOT’s Consultant Services Unit that all contract study deliverables have been received and accepted by MDOT.

Appendix F. Responsibilities of Technical Advisory Committee (TAC) Members

Research Study Champions and Development of Research Proposals

- "Begin with the end in mind." Research study Champions know best what the overall goal is for the study; for example, a specification or incorporation of new technology into business processes. The objective is implementation of the results of the study. Champions work with the Consultant towards this objective beginning when the Consultant first presents the research idea to the Champion.
- Some studies require MDOT services for successful conduct of the study. Such services might include provision of data, materials sampling and testing, traffic control, etc. Champions provide such services or assist the Consultant in identifying MDOT personnel within the MDOT Divisions or Districts needed to secure the services.
- Champions advise the Consultant if they know of any other research work that may be related to the proposed research – either completed or ongoing.
- Subsequent to submission of the research proposal to the MDOT Research Division, a "Research Proposal Review Form" is provided to each identified Champion to evaluate the proposal. These individuals complete the review forms and submit them back to the Research Division. The Research Division evaluates the reviewer responses to make funding recommendations to the MDOT Research Advisory Committee (RAC). If the study is initially developed with Champion input, the responses on the proposal review form should favorably reflect this input.

Technical Advisory Committees

- Subject to available funds, proposed research receiving favorable relative reviews are generally considered for funding recommendation. A Technical Advisory Committee (TAC) is formed for each recommended study. TAC members are individuals who have indicated a willingness to serve on this committee in accordance with the guidelines provided in this Appendix. A TAC chairperson is selected by the TAC members via simple majority vote.
- The TAC includes one individual from the MDOT Research Division to function as an Assistant Project Manager to the State Research Engineer. This individual provides study contract development and administrative support, as discussed in Appendix G, and may function as a research Champion if they are a subject matter expert within the given field of research.

TAC Responsibilities

- Research Division personnel do not always have Champion expertise on the study subject matter. Therefore, other than the Research Division TAC member, a TAC member's primary responsibility is to monitor and guide the research effort technical aspects towards implementable results throughout the duration of the study. Champion participation in TAC meetings, round table discussions, and possibly technology demonstrations is essential for getting good results. TAC members also review meeting minutes, quarterly progress reports, interim and final reports, and evaluate study deliverables.

TAC Meetings

- At the first TAC meeting, the TAC members must review and approve, or recommend changes to, the research plan tasks and subtasks, Project Schedule, and funding allocation per task and subtask. If any changes are recommended, the Consultant revises the proposal accordingly and then sends it back to the TAC members for review and approval of same. These three aspects of the proposal must be finalized before beginning development of a contract for the study.
- Subject to TAC approval, changes are allowed to the content and ordering of the tasks/subtasks, or reallocation of funds to same, at any point prior to or after award of the study contract. However, if the study is already included in an approved Research Work Program, the total amount of the study, after reallocation of funds, cannot exceed the total amount provided in the Research Work Program. In this case, should the TAC and Consultant identify work requiring funds in an amount exceeding that already approved, a follow-up or second research study effort should be considered for funding at a later date.
- TAC members communicate early and often with the Consultant and Research Division TAC member. TAC meetings may be held as needed throughout the conduct of the study to monitor study progress. TAC members should advise Research Division if they do not feel that the study is progressing as it should.

Review Quarterly Progress Reports

- TAC members review quarterly progress reports and advise Research Division TAC member of any concerns.

Review of Interim and Final Reports

- TAC members review all interim and final reports in accordance with a three-month review, comment and revision period of time per the following sequence:

- The Consultant will submit a draft of the interim/final report to the MDOT study TAC three months prior to the due date of the particular report.
- The TAC will have one month to review the draft of the report and submit comments to the Consultant via the MDOT Research Division TAC member. If no comments are provided by the TAC by the end of this one-month review period, the report will be considered approved by the TAC and the Consultant will proceed with providing the final version of the interim/final report. TAC members will be provided an "Evaluation of Interim and Final Reports" document from the MDOT Research Division TAC member along with the draft of the given report to aid in the review and evaluation of that report.
- If comments are provided by the TAC, the Consultant will have one month to address the TAC comments and submit a second version of the draft interim/final report to the TAC members.
- The TAC members will have two weeks to evaluate the adequacy of how their comments were addressed by the Consultant in the report and provide any feedback to the Consultant.
- If no comments are provided by the TAC by the end of this two-week review period, the interim/final report will be considered approved by the TAC.

Review/Evaluate Research Study Deliverables

- The end result of conducting the Research Plan should be some product and/or service providing a solution to the issue described in Appendix A. "Research Proposal," section 2, "Problem Statement and Research Objectives." TAC members review/evaluate research study deliverables such as construction or materials specifications, technical standards or practices, a new or revised design procedure, etc., then provide feedback to the Research Division TAC member.

Research Study Champions and Implementation of Research Results

- The MDOT Research study Champions and the Consultant work together to develop an Implementation Plan that considers, as appropriate for the given study, activities to promote application of the product of the research within the Department. It is likely that this plan will evolve as the study is conducted.
- Subsequent to completion of the research study, the Research study Champions conduct, or manage the efforts to conduct, the Implementation Plan.

Appendix G. MDOT Research Division TAC Member Responsibilities

The TAC includes one individual from the MDOT Research Division to function as an Assistant Project Manager to the State Research Engineer. This individual provides study contract development and administrative support including:

- Become familiar with the entire research proposal development and submission process included in this document.
- Schedule and attend all TAC meetings.
- The Consultant is supposed to indicate if MDOT needs to provide data, materials sampling and testing, traffic control, or some other service to facilitate conduct of the study. The Consultant does this by including within the Research Plan MDOT performed study tasks and subtasks. If the Consultant does include such MDOT performed service(s) in the Research Plan, determine if a support study is required to pay for same.
- The initially submitted Research Plan may not always include required MDOT provided services to complete the study. Review the Consultant performed tasks/subtasks and determine if MDOT performed tasks/subtasks need to be added to the Research Plan. If so, determine if a support study needs to be developed to pay for the MDOT provided services.
- Extract Research Plan and Project Schedule (Gantt chart) from the research proposal and incorporate same into appropriate contract development process.
- Appendix A. “Mississippi DOT Research Proposal Format,” section 4, “Funding” refers to a separate document submitted with the research proposal that includes a table accounting for proposed study costs in terms of traditional accounting line items. This table is to be used along with the Research Plan and Project Schedule for development of the contract documents.
- Provide technical input if conduct of study and implementation of study results impact MDOT Research Division responsibilities.
- Monitor study progress and corresponding expenditures.
- Review quarterly progress reports.
- Consultant travel must be approved, in writing, by the MDOT State Research Engineer prior to the scheduled travel. The Consultant will submit a letter of request with a format including a location for signature and dating by the State Research Engineer. Appendix H.

"Sample Letter Requesting Approval to Use Study Funds to Present Research Results" illustrates the required detailed breakdown of anticipated travel expenses. Ensure Consultant submits travel request and it is approved before date of actual travel.

- Review submitted invoices with supporting documentation and advises State Research Engineer regarding payment of invoiced amounts.
- Advise the Consultant that the last invoice submitted should be stamped "Final Invoice."
- The last invoice should be submitted when the final version of the final report is submitted. Follow up with the Consultant if the last invoice is not submitted at that time.
- Monitor and keep record of actual receipt of study deliverables compared to the planned receipt per the Progress Schedule.
- A Technical Report Documentation Page is included in all interim and final study reports. This TAC member completes the MDOT-specific entries for this page and then provides the page in electronic format to the Consultant for completion of remaining required entries.
- Review all interim and final reports. As part of this review process the MDOT Research Division TAC member will provide all TAC members an "Evaluation of Interim and Final Reports" document along with the draft of the given report to aid in the review and evaluation of that report. The MDOT Research Division TAC member will compile all of the responses from the individual TAC members and submit same to the Consultant.
- 3-6 months after completion of the study, send the Post-Study Implementation Questionnaire to the TAC subject matter experts (SMEs) for their completion.
- Compile the results and enter into the Research Performance Measures database. If necessary, meet with the TAC SMEs to discuss the results further.
- Keep State Research Engineer informed of any significant issues pertaining to:
    - Contract issues
    - Conduct of study
    - Study deliverables
    - Implementation Plan

Appendix H. Sample Letter Requesting Approval to Use Study Funds to Present Research Results

John Doe October 31, 2011
ABC Engineering, Inc.
100 Hwy 98
Destin, Florida 78234

Ref: Request to Use MDOT Project Funds to Attend 2012 TRB Annual Meeting

Dear Mr. Watkins

ABC Engineering, Inc. requests your approval to use Mississippi Department of Transportation (MDOT) funds from State Study (SS) Number XXX to travel to Washington DC and attend the 91st annual meeting of the Transportation Research Board (TRB). The purpose for this travel is to present research results for SS Number XXX. Dates of travel would be January 21 to 26, 2012. This request will not change the total cost of the project. The following is a summary of the anticipated costs:

Item	Estimated Cost
Registration	$ 380.00
Lodging	$1,047.70
Airfare	$ 521.13
Meals	$ 276.00
Personal Vehicle Mileage to Airport	$ 15.30
Baggage Fees	$ 50.00
Airport Parking	$ 60.00
Total for all items	$2,350.13

-Registration for the meeting is $380.
-Lodging costs were calculated at 5 nights at $183/night with 14.5% tax as per a hotel reservation.
-Airfare cost was booked at $521.13.
-Meals were calculated at a rate of $46.00 per day of travel for Washington DC per the Mississippi Department of Finance and Administration Travel Manual
-Vehicle mileage was calculated at $0.51/mile.

MDOT State Research Engineer Date

Appendix I
Test Standard Designation and Name for Tests Included in HMA and Concrete Certifications

AASHTO M157	Standard Specification for Ready-Mixed Concrete
AASHTO R39	Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
AASHTO T2	Sampling of Aggregates
AASHTO T11	Materials Finer Than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
AASHTO T19	Bulk Density (“Unit Weight”) and Voids in Aggregate
AASHTO T22	Compressive Strength of Cylindrical Concrete Specimens
AASHTO T23	Making and Curing Concrete Test Specimens in the Field
AASHTO T27	Sieve Analysis of Fine and Coarse Aggregates
AASHTO T37	Sieve Analysis of Mineral Filler for Hot Mix Asphalt (HMA)
AASHTO T84	Specific Gravity and Absorption of Fine Aggregate
AASHTO T85	Specific Gravity and Absorption of Coarse Aggregate
AASHTO T88	Particle Size Analysis of Soils
AASHTO T90	Determining the Plastic Limit and Plasticity Index of Soils
AASHTO T119	Slump of Hydraulic Cement Concrete
AASHTO T121	Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
AASHTO T141	Sampling Freshly Mixed Concrete

Note: T141-11 has been revised in such a manner that it no longer produces a test result. This revised standard has become R-60, Standard Practice for Sampling Freshly Mixed Concrete

AASHTO T152	Air Content of Freshly Mixed Concrete by the Pressure Method
AASHTO T166	Bulk Specific Gravity of Compacted Hot Mix Asphalt (HMA) Using Saturated Surface-Dry Specimens

AASHTO T196	Air Content of Freshly Mixed Concrete by the Volumetric Method
AASHTO T209	Theoretical Maximum Specific Gravity and Density of Hot Mix Asphalt (HMA)
AASHTO T231	Capping Cylindrical Concrete Specimens
AASHTO T248	Reducing Samples of Aggregate to Testing Size
AASHTO T255	Total Evaporable Moisture Content of Aggregate by Drying
AASHTO T269	Percent Air Voids in Compacted Dense and Open Asphalt Mixtures
AASHTO T275	Bulk Specific Gravity of Compacted Hot Mix Asphalt (HMA) Using Paraffin-Coated Specimens
AASHTO T308	Determining the Asphalt Binder Content of Hot Mix Asphalt (HMA) by the Ignition Method
AASHTO T312	Preparing and Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor
AASHTO T325	Estimating the Strength of Concrete in Transportation Construction by Maturity Tests
ASTM C1064	Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C1074	Estimating Concrete Strength by the Maturity Method
ASTM C1252	Test Method for Uncompacted Void Content of Fine Aggregate (as Influenced by Particle Shape, Surface Texture, and Grading)
ASTM D3665	Standard Practice for Random Sampling of Construction Materials
ASTM D4791	Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D5821	Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
MT-6	Nuclear Determination of Bitumen Content of Bituminous Paving Mixtures

MT-16	Nuclear Method for Field In-Place Density Determination
MT-24	Determination of the Specific Gravity of Fine Aggregate Using the Le Chatelier Flask
MT-31	Quantitative Analysis of Hot Bituminous Mixtures
MT-59	Determination of Loss of Coating of HMA (Boiling Water Test)
MT-63	Resistance of Bituminous Paving Mixtures to Stripping (Vacuum Saturation Method)
MT-76	Microwave Method of Determining the Moisture Content of Hot Bituminous Mixtures
MT-78	Volumetric Mix Design of Hot Bituminous Paving Mixtures Using The Superpave Gyratory Compactor

CSD-50-70-54-00Random Sampling

Appendix J
MDOT Certified Soil, Aggregate and CSM Test Procedures

AASHTO M145	Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes
AASHTO R58	Dry Preparation of Disturbed Soil and Soil-Aggregate Samples for Test
AASHTO T88	Particle Size Analysis of Soils
AASHTO T89	Determining the Liquid Limit of Soils
AASHTO T90	Determining the Plastic Limit and Plasticity Index of Soils
AASHTO T92	Shrinkage Factors of Soils (Using Mercury)
AASHTO T99	Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in) Drop
AASHTO T100	Specific Gravity of Soils
AASHTO T180	Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in) Drop
AASHTO T191	Density of Soil In-Place by the Sand-Cone Method
AASHTO T217	Determination of Moisture in Soils by Means of a Calcium Carbide Gas Pressure Moisture Tester
AASHTO T265	Laboratory Determination of Moisture Content of Soils
AASHTO T288	Determining Minimum Laboratory Soil Resistivity
AASHTO T310	In-Place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
AASHTO T311	Grain-Size Analysis of Granular Soil Materials
ASTM D1140	Amount of Material in Soils Finer than No. 200 (75-um) Sieve
ASTM D2487	Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D2488	Description and Identification of Soils (Visual-Manual Procedure)
MT-7	Moisture-Density Relations of Soils (using family of curves)

MT-8	Moisture-Density Relations of Soils
MT-9	Moisture-Density Relations of Treated Soils
MT-10	In-Place Density of Soil
MT-11	Preparation of Field Specimens of Soil Cement
MT-16	Nuclear Method for Field In-Place Density Determination
MT-22	Sieve Analysis of Granular Materials
MT-23	Hydrometer
MT-61	Method of Test for Determining Soil Resistivity
MT-92	Shrinkage Factors by Spray Wax

Appendix K
AASHTO Proficiency Sample Program

If the standards for performing a particular test are adhered to, i.e., if the same method for making a particular measurement is followed each time the measurement is made, then is it possible to numerically characterize the quality of each test result. By virtue of knowing that the test procedure is being followed correctly, the RSC can have a quantifiable level of confidence in the test results provided for a given research study. Use of an AASHTO accredited laboratory allows an RSC this confidence because the laboratory participates in a Proficiency Sample Program (PSP). This confidence is derived from three results of laboratory participation in a PSP:

- Laboratory Z-score
- Laboratory Performance Chart
- Precision Statements

The AASHTO Materials Reference Laboratory (AMRL) provides laboratory equipment inspection, observation of technician competency, and a review of the quality management system for those laboratories engaged in the testing of asphalt cement, hot mix asphalt, emulsified asphalt, aggregate, soil, metals, plastic pipe, and sprayed-applied fire-resistive materials (SFRM) (5). The Cement and Concrete Reference Laboratory (CCRL) provides similar services for those laboratories engaged in the testing of cement, concrete, aggregate, steel reinforcing bars, pozzolan, and masonry materials (mortar and solid units) (6).

Both AMRL and CCRL sponsor a PSP for their respective spheres of construction materials. This program is essentially the same for both entities. Multiple test samples of the same material are produced and distributed to participating laboratories in the respective PSP. Each laboratory performs the same test(s) on the samples and returns the test results to the sponsoring agency for analyses. The end result of following this procedure allows the participating laboratories a way for comparing a given laboratory test result to the collective, or average, result of all of the laboratories for the given test standard – such a comparison is numerically expressed in terms of the standard deviation of the data. AASHTO T89, the test standard for determining the liquid limit (LL) of a soil, is part of the AMRL PSP and will be used as an example to illustrate in more detail the general procedure used for all construction materials included in either the AMRL or CCRL PSP.

Each year AMRL procures two large bulk samples of soil for processing and distribution to the laboratories participating in the AMRL PSP soil series of tests. AASHTO T89 is one of the tests included in the soil classification and

compaction test series. Each bulk sample is processed to remove impurities and then thoroughly mixed to ensure homogeneity of soil composition throughout the respective sample. Each sample is assigned a number, such as 165 and 166. Typically the composition of both bulk samples are very similar, but not exactly the same.

Each bulk sample is then subdivided into smaller samples. Due to the way the soil was processed, each of the smaller samples from sample 165 are essentially the same in composition – likewise with the smaller samples from sample 166. A pair of the smaller samples, one from 165 and one from 166, is then distributed to each of the participating laboratories. In this example, each laboratory performs AASHTO T89 on the two samples and then reports the LL test results to AMRL. A single cycle of sample distribution to, and testing by, the various laboratories is called a "round of proficiency testing." All of the samples that are distributed in this cycle are collectively referred to as a "round sample."

AMRL compiles all of the LL test results from sample 165 into one data set, and all of the results from sample 166 into a second data set. A four-step series of analyses is then performed on each set of data to extract two core sets of the best quality data (test results) and ultimately quantitatively characterize that quality (7).

Laboratory Z-Score

In the context of the current discussion, a Z-score is a laboratory performance indicator. Numerically, it is the number of standard deviations a laboratory's test result is located from the average value of all the test results included in a given core set of test data. Two Z-scores are calculated for each laboratory for a given round of proficiency testing – for the LL example, this would one Z-score corresponding to the laboratory's sample 165 test result, and a second Z-score for the laboratory's sample 166 test result.

Laboratory Rating

A laboratory's ratings for a given test procedure are dependent on the laboratory's proficiency sample test results for that procedure. If a laboratory delivers a poor proficiency sample result, the AASHTO Accreditation Program (AAP) Procedures Manual prescribes a procedure the laboratory must follow to address that poor result:

> Proficiency sample test results which are beyond 2 standard deviations of the grand average are considered to be poor results. The laboratory shall, within 60 calendar days of the issuance of the proficiency sample report, (1) investigate to

> determine the reason(s) for the poor results, (2) record and report to AMRL the results of the investigation and any corrective actions taken, and (3) maintain records of the investigation and corrective actions taken. (8)

Note that poor test results are supposed to be documented along with the results of investigations, and any corrective actions taken. This process fosters the future delivery of quality test results in rounds of proficiency testing, and of significant interest to the RSC, quality test results to support research study conclusions and recommendations.

Laboratory ratings are based on a set of defined ranges in Z-scores. A rating is assigned by determining which range in Z-scores a given test result Z-score is located. From reference (9) the following is the laboratory rating scheme for AMRL sponsored tests based on the Z-Score:

> If Z-Score <= 1 then Rating = 5
> If Z-Score > 1 and <= 1.5 then Rating = 4
> If Z-Score > 1.5 and <= 2 then Rating = 3
> If Z-Score > 2 and <= 2.5 then Rating = 2
> If Z-Score > 2.5 and <= 3 then Rating = 1
> If Z-Score > 3 then Rating = 0

For example, if a sample 165 test result had a Z-score of 0.74, then the laboratory rating would be a five for that test result because 0.74 is located in the range of Z-scores from 0 to 1. Figure K1, copied from reference (10), graphically illustrates this relationship between a given range of Z-scores and the corresponding laboratory rating. This laboratory rating scheme provides for higher ratings as the value of the Z-score is reduced; i.e., as the corresponding individual test results approach the average value of the data set; therefore, the closer the individual test result to the average, the better the quality of the test result.

In summary, a laboratory Z-score is one basis for numerically characterizing the quality of a test result, and can be used to develop a level of confidence on the part of an RSC in future test results provided by the proposing laboratory. A given Z-score should be between -2 and +2 for it to be acceptable to AMRL, with preferred values approaching zero.

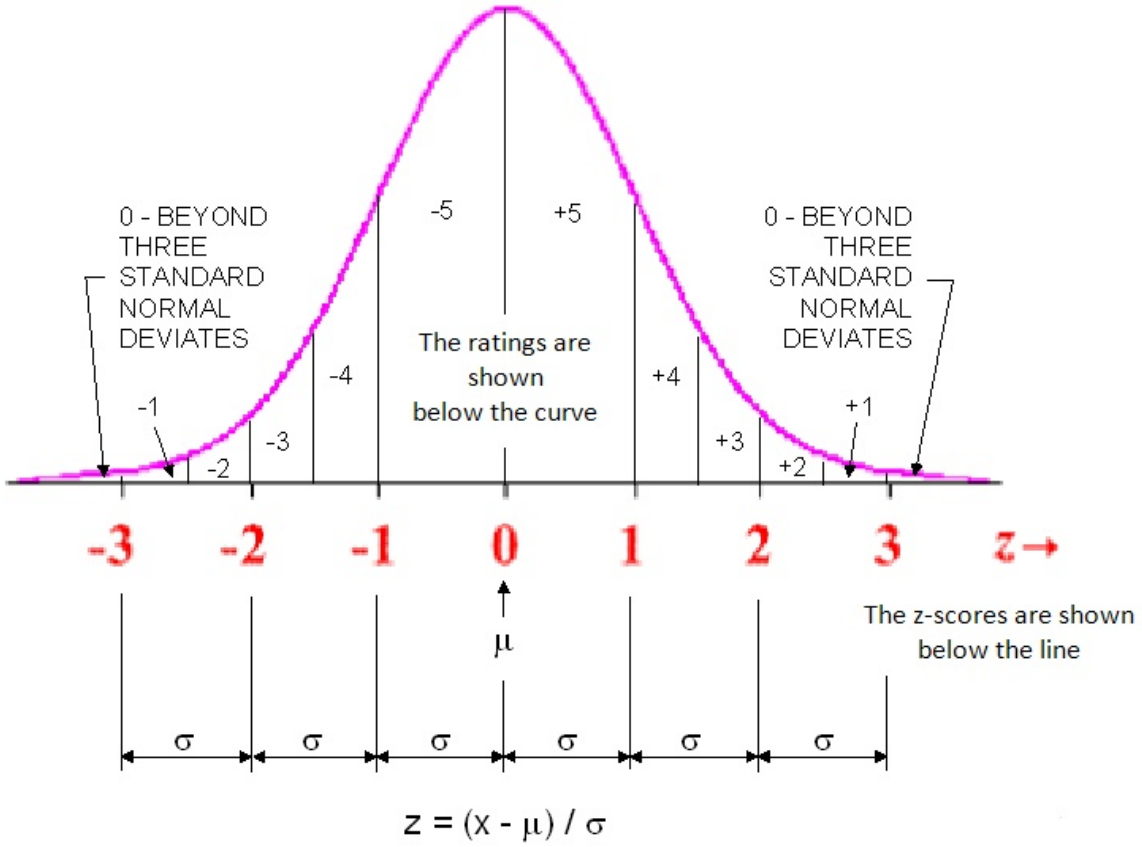

Figure K1: The Normal Distribution of AMRL Proficiency Sample Data (10)

The key point from the current discussion is that if a laboratory maintains its AASHTO accreditation for a given test method, then an RSC can have a quantifiable level of confidence in the test results provided by that laboratory. Generally speaking, that laboratory will provide results at least within two standard deviations of an average value from multiple laboratories performing the same test on the same, or similar, test sample. If it is not accredited, then there is no level of certainty in any range for the spread of test data because there is no basis for comparative analyses to quantify it; i.e., the laboratory is not participating in a PSP.

Performance Chart

Depending on how critical high quality test results are to the successful implementation of a research study, an RSC may want to know how the proposing laboratory has performed over time in multiple rounds of proficiency testing for one or more of the proposed tests. This information can be found in the form of a performance chart provided to that laboratory each time it participates in a round of proficiency testing.

Figure K2 is a performance chart copied from reference (10) for total material passing the No. 8 sieve. An LL test performance chart would be developed the same way; i.e., the ordinates of each data point in a performance chart consist of a Z-score and the sample number corresponding to that Z-score. Since pairs of samples are tested at specific intervals of time, the y-axis is analogous to time.

Should an RSC obtain a performance chart for any test procedure, reference (10) stresses that one "bad" result from the laboratory in question is inevitably going to periodically occur:

> Performance charts provide an easy way to gauge your laboratory's proficiency testing performance over time (see Figure 3). As stated above, too much emphasis should not be placed on an occasional low rating. However, patterns in performance charts should be analyzed carefully, as they are usually good indicators of testing problems. The ideal scenario is to have all points over the center line – results right on the average time after time. Generally speaking however, points scattered within the bands of +2 and -2 are indicative of good testing performance. Points drifting away from the centerline and points consistently on one side of the centerline are indicative of performance problems. (10)

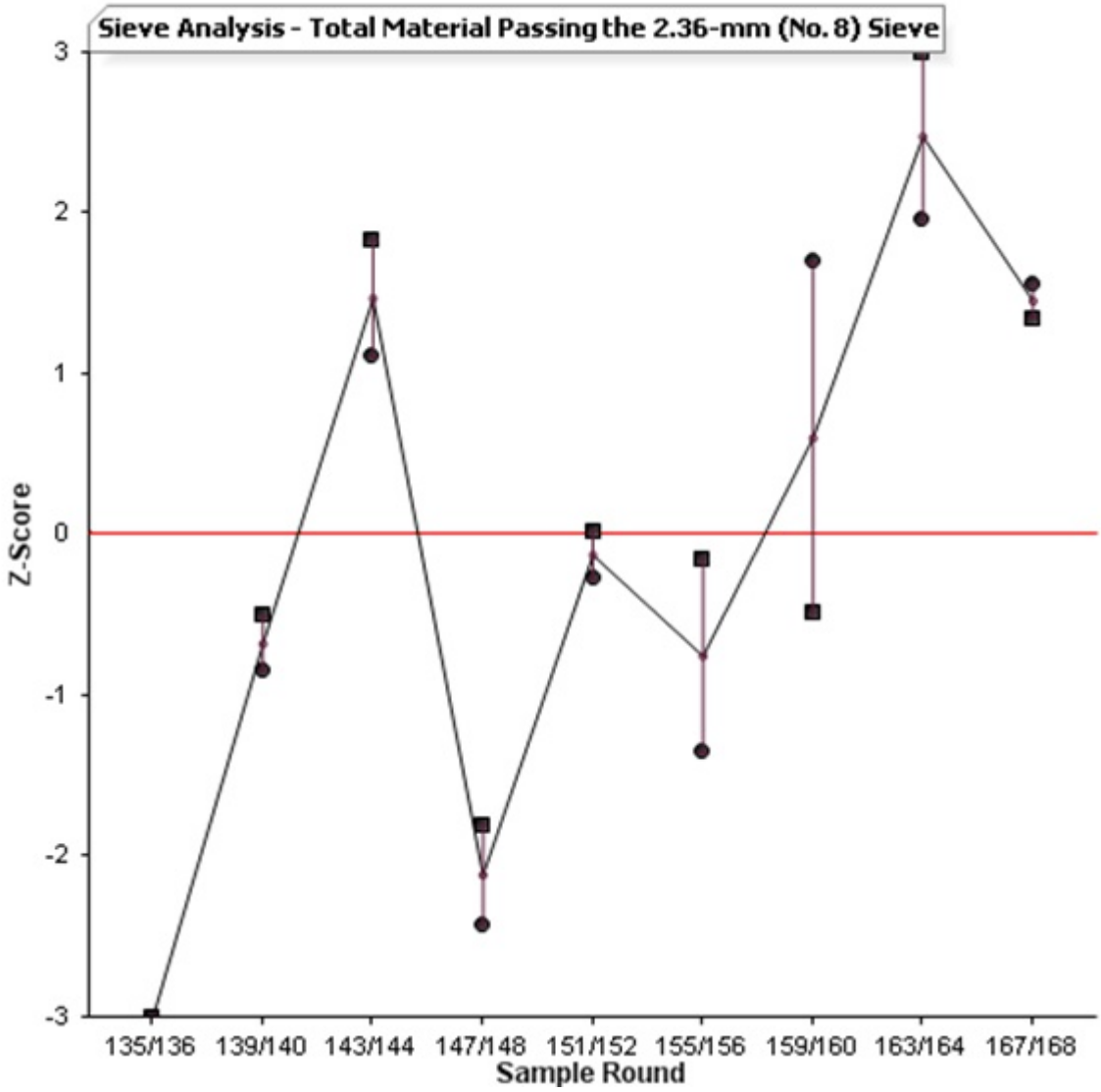

Figure K2: A Sample Performance Chart (10)

Precision Statements

Up to this point in the discussion, the focus has been on considering a large number of test results from an AMRL or CCRL round of proficiency testing to numerically characterize the inherent variability in the test results of a given test procedure. The Z-score is the basis for numerically characterizing the quality of one of the test results included in the core set of data relative to all of the other test results included in that core set.

Quantifying inherent variability in test results also allows for comparison of one test result to another, such as between those submitted by two different accredited laboratories. Comparison of individual test results is an indispensable component of any successful quality control/quality assurance

(QC/QA) program, and it offers an integral part of the solution to address use of non-accredited university laboratories employing students to perform testing for MDOT funded research studies.

AASHTO T89, as for many other test standards, includes what is referred to as a "Precision Statement." The following quote defines "precision:"

> Precision is the closeness of agreement between test results obtained under prescribed conditions. A statement on precision allows potential users of the test method to assess in general terms its usefulness in proposed applications. A statement on precision is not intended to contain values that can be duplicated in every user's laboratory. Instead the statement provides guidelines as to the kind of variability that can be expected between test results when the test method is used in one or more reasonably competent laboratories. (11)

The precision statement for AASHTO T89:

> 17. PRECISION STATEMENT
> 17.1. This precision statement applies to soils having a liquid limit range from 21 to 67.
> 17.2. Repeatability (Single Operator) – Two results obtained by the same operator on the same sample in the same laboratory using the same apparatus, and on different days, should be considered suspect if they differ by more than 7 percent of their mean.
> 17.3. Reproducibility (Multilaboratory) – Two results obtained by different operators in different laboratories should be considered suspect if they differ from each other by more than 13 percent of their mean. (12)

The values 7% and 13% of the respective means for allowable ranges in LL test results were derived from analyzing sets of LL test data, such as those considered in rounds of proficiency sampling and testing.

A precision statement only applies if the two laboratories are measuring a given parameter the same way. If they are, the precision statement provides the contractor, MDOT, and an RSC a numerical characterization of the quality of those two results based on an industry accepted difference between them for the given test procedure. If the LL test is performed in accordance with AASHTO T89, then the RSC can be confident that 95% of the time a particular LL test result from one laboratory is reproducible in another laboratory within a spread of 13% of the average of the two results. In other words, the LL test standard precision statement conveys to the user

of the test data that the indicated spreads in allowable values will not be exceeded by 19 out of 20 laboratories (13).

In summary, the precision statement provides an RSC with a quantifiable level of quality he/she can expect in the test results from a given test procedure. That quantifiable level of quality is the allowable spread between two test results, each derived from using the same test procedure on a split sample of a given material. Assuming AASHTO accredited laboratories are performing the tests, an RSC can be confident that 95% of the time two test results will be within the applicable precision statement allowable spread.

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