Original

NCHRP

PROJECT NO. 14-41

Permanent Vegetation Control Treatments for Roadsides

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Transportation Research Board
NAS-NRC

Texas A&M Transportation Institute

SECTION 2
SUMMARY PAGE

NCHRP Project 14-41
Permanent Vegetation Control Treatments for Roadsides

Proposing Agency:	Texas A&M Transportation Institute (TTI) The Texas A&M University System 400 Harvey Mitchell Parkway South, Suite 300 College Station, TX 77845-4375 (979) 862-6777 • (979) 862-3250 fax REF: SRS #1803319
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Proposal Written by:	Jett McFalls, Assistant Research Scientist Beverly Storey, Associate Research Scientist
Proposal Date:	January 17, 2018
Principal Investigator:	Jett McFalls, Assistant Research Scientist Texas A&M Transportation Institute 3135 TAMU, College Station, TX 77843-3135 (979) 847-8709 Email: j-mcfalls@tti.tamu.edu
Co-Principal Investigator:	Beverly Storey, Associate Research Scientist Texas A&M Transportation Institute 3135 TAMU, College Station, TX 77843-3135 (979) 845-7217 Email: b-storey@tti.tamu.edu
Administrative Officer:	Chris Slape, Senior Contract Negotiator II Sponsored Research Services 400 Harvey Mitchell Parkway South, Suite 300 College Station, TX 77845-4375 (979) 845-6280 Email: awards@tamu.edu
Proposed Contract Period:	24 months
Total Contract Amount:	$200,000
Proposed Contract Type:	Fixed Price

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SECTION 4
RESEARCH PLAN

Introduction

The Department of Transportations (DOTs) have historically incorporated a range of roadside vegetation management operations (e.g., mowing, herbicide treatments, and permanent vegetation control treatments) in the Right of Way (ROW) from boundary to boundary for fire prevention, safety, cost, and aesthetic reasons. The American Association of State Highway and Transportation Officials (AASHTO) published *Guidelines for Vegetation Management* in 2011 to assist DOTs with their vegetation management programs. Specifically, DOTs seek to minimize ROW maintenance without compromising safety and roadway infrastructure. The vision for the final products for National Cooperative Highway Research Program (NCHRP) 14-41 is user-friendly guidance aimed at providing practitioners information that will be valuable when considering different permanent vegetation control treatments. The NCHRP 14-41 project will translate academic research and practical experience into user-friendly guidance.

Research Objective

The NCHRP 14-41 project aims to produce up-to-date and user-friendly guidance for transportation agencies to select appropriate permanent vegetation controls that will be effective in preventing or significantly retarding the growth of unwanted vegetation around roadside appurtenances and along roadsides.

This section of the proposal summarizes the research team's work plan and deliverables to achieve the NCHRP 14-41 project's objective. The proposed plan also reflects the team's familiarity and current knowledge of roadside vegetation management practices.

The research team will:

- Gather information on permanent vegetation controls through a detailed review of the literature, targeted interviews with technical experts, a web-based survey of transportation practitioners, and in-depth interviews with practitioners that have piloted or implemented additional methods, technologies, or applications.

- Develop guidance and an informed project selection process for effective permanent vegetation controls that also address traveler and highway worker safety and costs of construction and maintenance, as well as minimize adverse environmental impacts.

- Develop practical guidance that are broadly applicable to a wide range of conditions and appropriate for new construction and for existing facilities.

Specific details of the task efforts are discussed in the following sections.

Overview of Team Structure and Qualifications

Through their extensive years of experience, members of the Research Team have demonstrated a wide range of capabilities related to roadside design, safety, and management. Needed is

expertise in pulling the technical material into a comprehensive, usable format. The Principal Investigator (PI) for the Texas A&M Transportation Institute's (TTI) Research Team will be Jett McFalls.

We recognize that technical expertise alone is not enough for this project. The Research Team understands the issues with regard to roadside safety and vegetation management. Members of the Research Team have extensive experience in sustainable roadside development, and development of guidance material to include guidelines, construction specifications, standard details, and decision matrices. They have produced the following (more information regarding projects available in Section 6):

- Texas Department of Transportation (TxDOT) 0-4949-1, *Successional Establishment, Mowing Response, and Erosion Control Characteristics of Roadside Vegetation in Texas*, 2004 – 2007 (Jett McFalls). Available at http://d2dtl5nnlpfr0r.cloudfront.net/tti.tamu.edu/documents/0-4949-1.pdf.
- NCHRP 25-25 Task 53, *Stormwater Treatment with Vegetated Buffers,* 2009 (Beverly Storey- PI, Jett McFalls). Available at http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP25-25(53)_FR.pdf
- TxDOT 0-6733-1, *Evaluation of Generic and Branded Herbicides: Technical Report*, 2012 (Jett McFalls –PI, Beverly Storey). Available at: http://d2dtl5nnlpfr0r.cloudfront.net/tti.tamu.edu/documents/0-6733-1.pdf.
- TxDOT IAC, *Erosion and Sediment Control Testing Program*, 1989 – present. (Jett McFalls- PI, Beverly Storey). Available at http://www.txdot.gov/inside-txdot/division/maintenance/erosion-control.html.
- TxDOT 0-6638, *Performance Testing of Coagulants to Reduce Stormwater Runoff Turbidity*, 2010-2013 (Jett McFalls-PI, Beverly Storey). Available at http://tti.tamu.edu/documents/0-6638-1.pdf .
- The Institute of Transportation Engineers' (ITE's) *Designing Walkable Urban Thoroughfares: A Context Sensitive Approach,* 2010 (Beverly Storey, contributing author) *and Phase III Outreach Materials,* 2011 (Beverly Storey, coauthor). Available at http://www.ite.org/css/.
- TxDOT Report 0-5731-1*, Synthesis and Study of the Roadside Vegetation Establishment Process,* May 2011 (Beverly Storey-PI, Jett McFalls). Available at http://tti.tamu.edu/documents/0-5731-1.pdf
- TxDOT 0-5748-*1, Water Retention Techniques for Vegetation Establishment in TxDOT West Texas Districts,* Mach 2010, (Jett McFalls-PI; Beverly Storey). Available at http://tti.tamu.edu/documents/0-5748-1.pdf.
- TxDOT 0-4548, *Recommendations, Procedures, and Guidelines for the Protection of Trees and Sensitive Landforms,* 2001-2003 (Beverly Storey). Available at http://tti.tamu.edu/documents/0-4548-1.pdf .

Deliverables

Section 9 provides a timeline for the project, and Table 1 Deliverables lists the anticipated deliverables. The task descriptions presented in the following section will be revised based on the panel's review to form the Revised Work Plan, which the study team will submit to NCHRP within 15 days once comments have been received.

Table 1. Deliverables.

Task	Deliverables per Request for Proposal	Month
—	Revised work plan	1
1	Project Management	1
2	Conduct Literature Review	1
3	Conduct Web-based Survey and Practitioner Interviews	9
4	Develop Interactive Selection Tool	17
5	Prepare Final Deliverables	19

Research Approach

The Research Team's approach to developing comprehensive, user-friendly guidance for permanent vegetation control treatments for roadsides includes active project management and a detailed work plan. Active project management will ensure effective communication between the research team and the project panel. The work plan summarizes the individual tasks deemed essential for successful completion of this project.

Work Plan

Task 1: Project Management

Objective

The objectives of this task are to ensure that the research is conducted as defined in the detailed work plan within the agreed upon time and resources, and to effectively communicate with the NCHRP technical representative regarding the direction of the project along with the progress updates.

Approach

TTI will serve as the contractor for this project and will be the sole point of contact for contractual, administrative, and technical issues. The research team anticipates producing criteria ready for implementation and practice. The following management approach has been established to ensure the project stays on time and within budget:

- The PI, Jett McFalls (TTI), will be responsible for project management and will guide all technical activities of the research. The PI will also maintain frequent communication through all stages of the project with the NCHRP technical representative. When appropriate and approved by the NCHRP technical representative, the PI may also communicate with panel members through email, telephone, and in-person meetings.

Deliverables

- Kick-off teleconference meeting within one month of the contract's execution.
- Monthly progress reports at the end of each calendar month.

- Quarterly progress reports at the end of each calendar quarter.

Task 2: Conduct Literature Review

Objective

The objective of this task is to document the state-of-practice through a review of online documents and a review of the literature on the effectiveness, longevity, initial construction costs, maintenance requirements, site conditions, ecological and climate conditions, aesthetic value of permanent vegetation control treatments and their effect on the safety performance of highway appurtenances, such as guardrails, cable barriers, and signs. Literature review will be supplemented with targeted interviews with technical experts in the field.

Approach

Identifying the state of the practice requires familiarity beyond the national guidelines and standards. Agency manuals, research reports, pilot study results, and guidance documents are important as well. The research team will conduct a literature search to identify recent reports or articles, and other resources that previous studies may not have considered. Computerized searches will also be conducted in the Transportation Research Information Service (TRIS) and Transport databases. TRIS includes the capability to search several databases including the Highway Research Information Service database for domestic literature, the Highway Research in Progress database for ongoing research studies, and the International Road Research Database for relevant international literature.

In addition, this task will include consideration of key reference documents—such as the American Association of State Highway and Transportation Officials (AASHTO) *Guidelines for Vegetation Management (Guidelines)* —to identify how the developed guidelines will fit (and should fit) with respect to these key documents.

The Research Team will conduct a review of existing relevant research, design guidelines and documented practices focusing at a minimum on the following broad areas:

- Cost:
  - Initial cost and constructability (including labor, equipment, materials, and management/planning costs).
  - Ongoing maintenance requirements.
  - Maintenance-related delays to the traveling public.
- Effectiveness:
  - Longevity.
  - Appropriate site conditions (e.g., soils, traffic volumes, aesthetic factors).
  - Appropriate ecological and climate conditions (e.g., frostlines, precipitation, winter maintenance requirements).
  - New construction or existing facilities.
  - Type of vegetation effectively suppressed.
  - DOT performance metrics.
- Safety
  - Highway worker exposure to traffic.
  - Suitability for use in conjunction with the installation, repair, and replacement of common types of roadside appurtenances.

- Infrastructure
  - Impacts to the integrity of highway surfaces by controlling erosion and damage to the pavement structure from encroaching roots and water intrusion.
  - Adjacent land use concerns.
- Aesthetic Value
  - Roadway context, e.g., urban versus rural, roadway classification, roadway geometry.
  - Public perception/outreach/stakeholder involvement.

The Research Team will apply the knowledge framework to efficiently mine the available information from the literature and to extract referenced information on the various areas for each identified permanent vegetation control option.

Literature review will be supplemented with targeted interviews with technical experts in the field.

- Identify missing applications (e.g., controls for use with cable barriers)

- Additional methods and technologies that technical experts are piloting or experimenting with.

Deliverable
The developed ***draft literature review*** will summarize the results of Task 1, including any missing information that will be gathered in Task 2.

NCHRP Panel Input/Checkpoint
Upon NCHRP panel review of the study team's draft literature review, the study team will participate in a web-enabled teleconference to discuss panel's members comments.

Task 3. Conduct Web-Based Survey and Practitioner Interviews

Objective
The objective of this task is to supplement the information gathered in Task 2. Specifically, the research team aims to collect information on current practices, institutional obstacles, issues and concerns agencies have regarding permanent vegetation control treatments. The research team will also identify additional methods and technologies that DOTs are piloting or experimenting with, additional guidance required, and how DOTs would utilize the findings from this research.

Approach
The web based survey and the interviews will be designed to optimize responses by balancing the length and the level of detail requested of the respondents. The draft survey and interview questionnaire will be shared with the NCHRP panel for review and comment before being finalized. The research team will follow all Institutional Review Board (IRB) for Human Subject Protocols for the interview process as appropriate.

The research team will develop a web based survey that will be administered to the maintenance directors at all state DOTs and a representative sample of local agencies. The objectives of the web-based survey are to:

- Gather information on current practices, institutional obstacles, issues and concerns agencies have regarding permanent vegetation control treatments,

- Gather information on the selection process implemented by DOTs,
- Identify any missing applications that require further guidance (e.g., controls for use with cable barriers),
- Identify any innovative methods or technologies that DOTs have been experimented with and
- Gather information on additional guidance required.

The research team will analyze the web-based survey results to identify agencies that will be targeted for in-depth phone interviews. The objectives of the in-depth phone interviews are to obtain detailed information on innovate selection processes implemented, experiences with implementing innovative methods or technologies, additional guidance required, and how DOTs would utilize the findings from this research. The information gathered as part of the in-depth interviews will assist the research team in finalizing the updated guidance on the selection of appropriate permanent vegetation controls, as well as inform the development of the Interactive Selection Tool (Task 4).

Deliverable

Develop technical memorandum with draft recommendations for permanent vegetation control treatments and relevant supporting evidence, including recommendations for additional needed updates to the Guidelines. This document will offer updated guidance on the selection of appropriate Permanent Vegetation Controls in AASHTO's ***Guidelines for Vegetation Management – Chapter 12 Permanent Vegetation Controls (Barriers).*** Finally, a graphic or tabular presentation of permanent vegetation controls will be developed.

NCHRP Panel Input/Checkpoint

Members of the Research Team will meet with the NCHRP panel upon review of the draft technical memorandum at a time and location to be determined by NCHRP. During this meeting, the group will discuss the draft technical memorandum. The meeting will set the direction for the remaining tasks of the study. The research team will not proceed with the remaining tasks until NCHRP has provided approval.

Task 4: Develop Interactive Selection Tool

Objective

The objective of Task 4 is to develop an Interactive Selection Tool – a practical and user-friendly web-based tool – that will provide step-by-step guidance to transportation agencies to identify and select permanent vegetation controls. The development of the Interactive Selection Tool will be informed and based on the information collected in Tasks 2 and 3.

Approach

Based on the information gathered in Tasks 2 and 3, the research team will develop an Excel®-based smart interactive tool or web-based interactive tool to assist analysts in application of the Guidelines developed in Task 3. To accommodate various input data needs, this tool will have inputs for required data elements and optional data elements. The Interactive Tool will be configured so the users can use default values for some inputs such as direct labor, equipment, materials, and management/planning costs, or provide values for these inputs if desired. Finally, the tool will include examples and case studies as identified in Task 3.

This research project will also build on existing best practices and ensure maximum flexibility and usefulness. The Interactive Tool development will learn from comparable tools developed in other areas, such as highway safety and operation project analysis. Examples of tools that will be evaluated include, for example:

- FHWA desktop tools like FHWA-TOPS (Source: http://www.ops.fhwa.dot.gov/) which provides supporting guidance for operations.
- FHWA web-based BCA.Net tool.
- NCHRP 03-110 *Estimating the Life-Cycle Cost of Intersection Designs*.

User Testing

A draft version of the Interactive Tool will be distributed to practitioners. The research team will request the assistance of the NCHRP panel team to identify practitioners that can evaluate the tool. The research team will develop and present a webinar to demonstrate use of the draft Tool to the practitioners and request their feedback. Participants will have the opportunity to ask questions about the use of the Tool and provide feedback.

To further facilitate the provision of informative feedback, the research team will develop a questionnaire with questions, such as:

- Is the Tool user friendly?
- Can you collect the required input data with a reasonable level of effort?
- Are the default values provided for some of the input variables plausible for your area?
- What are the most valuable calculations that the Tool provides to assist you in comparing permanent vegetation controls?
- What additional calculations or features should be added to the Tool?
- What calculations or features should be removed or modified?

The research team will review the feedback received from participants and revise the Interactive Tool accordingly.

Deliverable

Draft final Tool, including a User Guide for the Tool.

NCHRP Panel Input/Checkpoint

Upon NCHRP panel review of the draft Tool, the research team will participate in a web-enabled teleconference to discuss panel's members comments.

Task 5. Prepare Final Deliverables

Objective

The objective of this task is to prepare the final project documentation, which will include a final research report documenting the conduct of research, web-based Interactive Selection Tool, and written/graphic presentation of permanent vegetation controls.

Approach

In Task, the research team will develop:

- a comprehensive final report detailing all procedures, results, recommendations from this research project.
- A Interactive Selection Tool designed to assist end-user in the selection for the most cost-effective permanent vegetation control based on desired effect, site, ecological, and climate conditions.
- a Graphic Presentation of Permanent Vegetation Controls with the most pertinent information as deemed important by the NCHRP panel. Information from the report that can be synthesized in the graphic presentation include the permanent vegetation controls, effectiveness, initial cost, constructability, maintenance requirements, and longevity in a wide range of roadside conditions.

Deliverable

The research team will deliver the final report, Interactive Selection Tool, and graphic presentation of permanent vegetation controls.

In addition to the deliverables identified above, the Research Team expects to make presentations at conferences and other meetings to disseminate the research findings, along with the submission of journal papers and other scholarly works. Because these activities will likely occur following the completion of the project, they are not included as formal deliverables during the research project.

Anticipated Research Results

The Research Team has significant experience in conducting research that leads to practical and implementable results. The team members' knowledge of the technical issues, agency practices, and institutional issues make them well suited to conduct research that will provide the types of results and implementation products that the sponsor desires.

Applicability to Improving Current Practice

The results from this research will further the state of the practice on permanent vegetation control treatments that best serve the goals of sustainable roadside management. The findings from this research can improve and result in a more consistent and efficient manner of selecting treatments. It will produce practical and immediately usable results for implementation by planning, design, and operations staff in state and local agencies. The NCHRP program is targeted to provide results-oriented research focused on improving roadway performance and safety. This proposal for the NCHRP 14-41 project meets that objective. This research project will produce results that agencies can use to select the most appropriate vegetation management technique that best suits the agency's specific needs.

Anticipated Products

The products from this research as detailed in the request for proposal (RFP) include the NCHRP-designated products of the interim report, a final report that documents the conducts of the research, provides guidelines for determining the best approach for permanent vegetation control treatments, and enables practitioners to ready assess varying roadside conditions for a best management practice via the graphic presentation.

As part of the information dissemination, we expect to produce technical papers and presentation material (i.e., PowerPoint presentations) that will target potential users. We may submit papers presenting details of various portions of the research efforts to the Transportation Research Board (TRB) for consideration of publication and presentation and AASHTO Standing Committee on the Environment for presentation at their conference. Frequently, when these organizations accept papers and/or abstracts, the research team makes an accompanying presentation at the organization's conference. These presentations provide an opportunity for the research team to present the findings from the research.

Audience or "Market" for this Product

The key audiences for the research findings are state and local transportation decisions makers and transportation practitioners (both public and private) with interests in roadside safety, vegetation and environmental management, roadside maintenance and operations, and highway corridor development. The research results aim to demonstrate to state agencies the benefits of permanent vegetation control treatments. While the general public is not one of the intended audiences for the expected products from the research, their interest as expressed in attitude (acceptance or opposition of these controls) need to be considered. At a minimum, the products developed in this research study should equip transportation agencies to explain the selection process and factors considered in selecting permanent vegetation controls.

Assessment of Impediments to Successful Implementation

No major impediments to implementation is anticipated, but successful implementation could be impeded by a lack of awareness of the research findings, organizational culture that resist change, or the need for the research findings and the research results to be included in the more established design guides.

Leadership in Deploying the Research Product

The Research Team believes that successful implementation requires a continuous process of disseminating results. Dissemination of the Final Report and presentations to key organizations and professional societies will be another important activity. And lastly, leaders in the field will need to work beyond the life of the research project to help mainstream research findings and/or recognition of the NCHRP 14-41 report into existing reference documents. The successful application and implementation of the research findings and research products requires champions. First, the NCHRP panel is in a position to advance the findings from this project. Finally, organizations such as AASHTO, TRB, ITE, and others have outlets to include the research findings in published technical documents and newsletters.

SECTION 5
QUALIFICATIONS OF THE RESEARCH TEAM

Principal Investigator

Jett McFalls

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Jett McFalls is an Assistant Research Scientist and has been with the TTI's Environment and Planning Program since 1990. He is the manager of the Sediment and Erosion Control Laboratory (SEC Lab). The SEC Lab is a 19 acre, international facility that conducts vegetation management and stormwater research including full-scale performance evaluations of erosion and sediment control products. He has served as principal investigator or co-principal investigator for numerous vegetation and water quality research studies, including projects working with various DOTs, Texas Commission on Environmental Quality, the Environmental Protection Agency, and other local/federal regulatory agencies. Mr. McFalls also co-authored several vegetation establishment, erosion/sediment control training and certification courses for highway construction for various state DOTs. Mr. McFalls is a registered Landscape Architect with a Bachelor of Science in Landscape Architecture from Texas A&M University. He is a member of AASHTO National Transportation Product Evaluation Program Technical Committee on Erosion Control Products. He is also a member ASTM D18 Soil and Rock Standards Subcommittee. He is an active member of the International Erosion Control Association where he serves on three Subcommittees: Storm water Management, Erosion and Sediment Control, and University Partners.

Co-Principal Investigator

Beverly J. Storey, P.L.A.

Associate Research Scientist
System Reliability Division, TTI
3135 TAMU, College Station, TX 77843-3135
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Beverly Storey is an Associate Research Scientist with the System Reliability Division with over 23 years of diverse experience in corridor management for visual and environmental quality, sustainable roadside development, green infrastructure, stormwater management for regulatory compliance, and context sensitive solutions with a great interest in better understanding and managing the effects of design and implementation upon the natural systems within transportation corridors.

Ms. Storey has served as principal investigator or key researcher on numerous research studies sponsored by NCHRP, FHWA, EPA, and various state transportation agencies. She has developed numerous national/international surveys and compiled collected data to provide compendiums of best transportation agency practices. Ms. Storey has co-authored and taught

numerous short courses regarding stormwater management for regulatory compliance and green infrastructure/low impact development for various sponsors such as the Lower Rio Grande Valley Texas Pollutant Discharge Elimination System (TPDES) Stormwater Task Force with Texas A&M University at Kingsville, TxDOT, Texas General Land Office, and the South Dakota Department of Transportation's Water Quality Enhancement Program for Construction. Ms. Storey has also provided on-site training and workshops throughout Texas for CSS with FHWA, and the Livable, Sustainable Communities workshops with EPA-HUD-DOT. She co-developed outreach materials and webinars for the Institute of Transportation Engineers' *Designing Walkable Urban Thoroughfares: A Context Sensitive Approach, A Recommended Practice*.

She has extensive experience in roadside landscape development including TxDOT's landscape and aesthetic highway corridor master plans. These documents identified and prioritized landscape and aesthetic goals for the various TxDOT Districts and the representative cities using a context sensitive philosophy toward development, establishment of design guidelines, and creation of a mechanism for short term establishment and long term maintenance of landscape and aesthetic components. Ms. Storey led teams of multi-discipline professionals and community leaders through the process of analysis, conceptualization, design, and planning to create documents which provide guidance for future development. Ms. Storey is professional landscape architect. She is a member of the TRB Committees AHD50 Roadside Maintenance and Operations, and AFB50T Task Force on Context Sensitive Design/Solutions, and the Smart Growth Network. She is a past member of AFB40 Landscape and Environmental Design and also past president of the Institute of Transportation Engineers Brazos Valley Section. Ms. Storey's research background in roadside use, preservation and management will be extremely valuable in this research effort.

Researchers

John A. Habermann, P.E.

Research Engineer
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John Habermann is a Research Engineer at the Texas A&M Transportation Institute. Mr. Habermann is currently the Principal Investigator and Lead Mobility Coordinator for a 21-mile corridor reconstruction effort on Interstate 35 through Central Texas scheduled to be completed in the Spring of 2019. As part of his efforts on I-35, he serves the critical role of a project ombudsman between the various stakeholders and the contractor and TxDOT. He also coordinates communication and outreach efforts with TxDOT Waco and surrounding districts. Recently, Mr. Habermann has joined the efforts of the I-35 expansion, in the TxDOT Austin District, to transfer lessons learned and best practices from the Waco District. This work is successful due to Mr. Habermann bringing together different stakeholders to learn of citizens', business', and community/elected leaders' concerns, questions, and feedback including those issues surrounding roadside vegetation. Mr. Habermann knows the importance of collaboration, working together, and strong partnerships. When communication takes place and when ideas are shared then one group doesn't have to suffer at the expense of another. It is team building at work when stakeholders get together to discuss issues and problems.

Outside of his work zone traffic management and mobility coordination efforts, Mr. Habermann has led a task, for the TxDOT Freight Division, on collecting, and reviewing the relevant literature, specifications, and current practices for Roadside Truck Parking along interstates and freeways. Mr. Habermann helped develop and conduct structured interviews to determine current practices in Preparing Work Zones for Automated and Connected Vehicles. Previously, while at Purdue University, as the Program Manager of the Indian Local Technical Assistance Program, he managed nine employees and led several technology transfer and research initiatives to bring the latest updates and research findings of the Indiana DOT to local governments. Mr. Habermann chaired LTAP's annual Stormwater Drainage conference. Vegetation Management was a reoccurring topic on the conference agenda. Mr. Habermann served on the 2008 committee to revise and update the Indiana Stormwater Drainage Manual to include green infrastructure and the importance of roadside vegetation within highway and road projects. Mr. Habermann has spent the last 24 years working with and alongside state DOTs and helping them solve relevant problems through stakeholder involvement and teamwork. Mr. Habermann has chaired or co-chaired a number of technology transfer workshops and conferences. Mr. Habermann is a member of the Institute of Transportation Engineers.

Subasish Das, Ph.D.

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Dr. Subasish Das is an associate transportation researcher with the Texas A&M Transportation Institute (TTI). He received his Ph.D. in Civil Engineering from University of Louisiana at Lafayette in 2015, and holds a Master of Science in Civil Engineering from the same university in 2012. He has more than seven years of national and international experience associated with transportation safety engineering research projects. These projects include:

- Safety Impacts of Reduced Visibility in Inclement Weather. (Atlas TTI Competitive Research Project 2016)
- Collection and Estimation of Annual Average Daily Traffic (AADT) on Lower-Volume Roads (FHWA Office of Safety Project 2016)
- Analysis of the Shoulder Widening Need on the State Highway System (TxDOT 0-6840).
- Access Management in the Vicinity of Interchanges (NCHRP 07-23).
- Developing a method for estimating traffic volumes in Louisiana local roads (LTRC 14-3SA)
- A Comprehensive Study on Pavement Edge Line Implementation (LTRC 13-2P). This project won 2014 AASHTO High Value Research 'Sweet Sixteen' Award.

Dr. Das is the author or co-author of over 20 technical papers or research reports. He is an active member of ITE, and ASCE. He recently served as vice-chair of membership of Young Professionals in Transportation (YPT) Houston chapter. He is an active member of the TRB Committee for Library and Information Science for Transportation (ABG40). He is an active friend of TRB committees: Highway Safety Performance (ANB25), Safety Data, Analysis, and Evaluation (ANB20), Statistical Methods (ABJ80), and Vehicle User Characteristics (AND10).

Disclosure

The TTI team can confidently state that it will approach this research project with absolute objectivity in its endeavor to satisfy the research objective. All TTI staff members are employed as full-time faculty, researchers, or both with The Texas A&M University System. The subcontractors working with TTI on this project are also fully objective in their approach to this research.

None of the research team members have ownership in any legal entities nor do they receive remuneration of any kind from organizations that would constitute (or be perceived as constituting) a conflict of interest to this research project. Similarly, the research team members do not have properties, patents, or interests that would benefit in any way from the findings of this research.

The Texas A&M University System has policies (TAMUS Policies 15.01.03, 31.05, and 31.05.01) that require the full and complete disclosure of substantial interest (financial or otherwise) in any situation or entity that may (1) conduct business with any component of the A&M System or (2) require the employee to make decisions in conflict to the best interests of the A&M System.

Federal, State, Transit Agency, or Airport Employees

The Texas A&M Transportation Institute is an agency of the State of Texas and an educational institution of the Texas A&M University System. Attached is the letter of commitment.

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January 10, 2018

Mr. Christopher Hedges
Director, Cooperative Research Programs
Transportation Research Board
500 Fifth Street, NW
Washington, DC 20001

Re: NCHRP Project 14-41, *Permanent Vegetation Control Treatments for Roadsides*
TTI Proposal #P2018115/ Maestro No. 1803319

Dear Mr. Hedges:

Please accept this proposal from the Texas A&M Transportation Institute to perform NCHRP Project 14-41, *Permanent Vegetation Control Treatments for Roadsides*.

For additional technical details, please contact the Principal Investigator, Mr. Jett McFalls. The technical and administrative point of contact information is provided below:

Contract Administrator:
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The Texas A&M Transportation Institute heartily endorses Mr. McFalls and his research team in this proposal. I am confident their abilities will help accomplish this project in a timely, thorough, and capable manner. We greatly appreciate your attention and consideration and look forward to producing useful and informative results for you.

Sincerely,

Gregory D. Winfree
Agency Director

TTI | Office of the Director

SECTION 6
ACCOMPLISHMENTS OF THE RESEARCH TEAM

In this section of the proposal, the qualifications of the TTI team are outlined with descriptions of representative relevant projects and specific examples regarding the research team's ability to meet the objectives of this project. The TTI team's experiences in the development of guidance documents and research is extensive and are described in the projects listed below.

Texas A&M Transportation Institute

Successional Establishment, Mowing Response, and Erosion Control Characteristics of Roadside Vegetation in Texas

Sponsor: Texas Department of Transportation (TxDOT)
Project No.: 0-4949
Period of Performance: September 2004 to August 2007
Personnel: Jett McFalls (PI), Beverly Storey
Total Award Amount: $291,198

This project investigated whether TxDOT's standard seed mix needs modifications to better address the issue of invasive species while meeting regulatory compliance for erosion control. The research objectives investigated: (1) the successional process of roadside grasses using TxDOT's seed mix and seeding procedure on field laboratory test plots and actual roadsides, (2) erosion control properties of vegetation on 12 new plots seeded with TxDOT's standard seed mix and 10 existing plots originally seeded with a non-TxDOT seed mix, and (3) the impacts of mowing on establishing and established grass communities. To achieve these objectives, the researchers conducted field laboratory experiments and actual highway roadside surveys. The results indicate that roadsides as maintained and mowed environments cannot be easily adapted by tall grass species (native or introduced). Short, sod-forming grasses, however, could grow better on roadsides. It was found that grass species in TxDOT's standard seed mixes did not show invasiveness on investigated laboratory plots and actual roadsides. The researchers also found little connection between original seeded grass species and observed grass species several years after seeding. This implies that volunteer species either from adjacent lands or from seed banks in the soil tend to dominate roadsides in the long term. All field laboratory plots controlled erosion very well. Yielded sediments were much below the TxDOT's minimum performance standards. Little literature was found on cost and benefit analysis about roadside management as a result of a lack of consistent cost database data held by state DOTs, which suggests future research on creating a database for comparing cost-benefit between the uses of natives and introduced grasses.

Synthesis and Study of the Establishment and Management of Roadside Vegetation

Sponsor: Texas Department of Transportation (TxDOT)
Period of Performance: September 2006 to August 2010
Project No.: 0-5731
Personnel: Beverly Storey (PI), Jett McFalls
Total Award Amount: $510,000

The objective of this study was to provide a more diverse set of tools and options for TxDOT personnel that will help ensure timely vegetation establishment to meet the Texas Pollutant Discharge Elimination System (TPDES) regulatory requirements, minimize project delays, and help reduce long-term costs in vegetation development and management. To achieve these objectives, the researchers: (1) compared TxDOT's practices to that of other state DOTs and related fields, (2) identified methods for more rapid vegetation establishment for meeting the TPDES requirements using field demonstration plots seeded according to current TxDOT practices, (3) developed a tool to assist design personnel not familiar with the vegetation establishment process-*Vegetation Establishment Guidance for Decisions Assistance Tool* (VEGDAT), (4) developed the Roadside Vegetation Establishment Quick Reference Field Guide, and (5) developed example district standard sheets for vegetation establishment. Available at: http://tti.tamu.edu/documents/0-5731-1.pdf.

I-35 Corridor Pollinator Project

Sponsor: Texas Department of Transportation (TxDOT)
Period of Performance: Ongoing Project
Personnel: Jett McFalls
Total Award Amount: $79,962

The objective of this project is to inform the public of the TxDOT's efforts in promoting pollinators along Texas rights-of-way. Five 1 to 2 minute videos and two brochures will be developed and produced to highlight the TxDOT's past and current ROW management programs and their positive impacts on monarch butterflies and pollinators in general. These videos and brochures will be made available to the public at eight I-35 travel rest areas via existing informational kiosks; and online (via the World Wide Web). The rest areas are located in Hill, Bell, Medina, and La Salle counties. At each of these rest areas, plans are currently underway to establish monarch waystations maintained by the TxDOT in collaboration with local citizen science programs (e.g., The North Central Chapter of the Native Plant Society of Texas). The content of the informational materials will be designed for a 'captive' travelling audience; but will also provide broader information that can be accessed through the WWW.

Urban Tree and Landscape Safety

Sponsor: Federal Highway Administration (FHWA)
Performance Period: June 2008 to June 2009
Personnel: Beverly Storey (PI)
Total Award Amount: $45,000

This project provided guidance for urban roadside trees and other fixed-objects regarding roadside safety that balances the urban context, community needs, other stakeholder concerns, and environmental constraints to achieve an appropriate context sensitive solution. This project examined all DOT and numerous municipal guidelines for tree and other fixed object placement within the right of way.

Preparing for EPA Effluent Limitation Guidelines

Sponsor: Texas Department of Transportation (TxDOT)
Project No.: 0-6638
Period of Performance: September 2010 to August 2013
Personnel: Jett McFalls (PI), Beverly Storey
Total Award Amount: $736,243

This project was initiated in 2010 to prepare TxDOT for changes to the CGP regarding the monitoring and sampling of their construction site effluent to meet the anticipated numeric effluent limitation guideline requirements. The scope of the project was modified due to EPA's actions. However, in light of anticipated future numeric limits, the project's monitoring and testing experiments proceeded to 1) determine "typical turbidity" representative of TxDOT's construction site discharges, 2) collect performance data on innovative erosion and sediment control measures that might be expected to achieve the discharge standard, and 3) provide update to TxDOT's *Stormwater Managements Guidelines for Construction Activities.* Available at: http://tti.tamu.edu/documents/0-6638-1.pdf.

Bioretention for Stormwater Quality Improvement in Texas

Sponsor: Texas Department of Transportation (TxDOT)
Project No.: 0-5949
Period of Performance: September 2007 to October 2013
Personnel: Jett McFalls, Beverly Storey
Total Award Amount: $564,364

This project summarizes five years of evaluating the applicability and performance of bioretention used as a best management practice (BMP) for highway environments in Texas. The project includes a literature review, pilot experiments, and roadside in situ demonstration. The demonstration site consisted of two different designs: (1) dry (or non-internal water storage) and (2) internal water storage types. The report includes drawing examples, designs and maintenance guidelines, a special specification, a planting plan guide, a summary of the site selection process, and performance data. Available at: http://tti.tamu.edu/documents/0-5949-4.pdf.

Stormwater Treatment with Vegetated Buffers

Sponsor: National Cooperative Highway Research Program (NCHRP)
Period of Performance: June 2008 to October 2009
Project No.: 25-25 Task 53
Personnel: Beverly Storey (PI), Jett McFalls
Total Award Amount: $50,000

NCHRP 25-25 project provided data demonstrating the proven performance capabilities of vegetated buffers, filter strips, and grass swales as post-construction, primary stormwater treatments. The results of this project enable a sharing of suggested practices, provide a synthesis of recommended practice examples by transportation, environmental, and regulatory agencies regarding the utilization of vegetated buffers, filter strips, and grass swales as a primary stormwater treatment for post-construction rural roadside applications that will facilitate support for gaining more widespread acceptance by state regulatory agencies. Available at: http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP25-25(53)_FR.pdf

Designing Walkable Urban Thoroughfares: A Context Sensitive Approach, Phase III Outreach Materials

Sponsor: Institute of Transportation Engineers (ITE)/Federal Highway Administration (FHWA)
Period of Performance: April 2008 to October 2011
Personnel: Beverly Storey
Total Award Amount: $58,865

This project built upon the ITE/FHWA *Designing Walkable Urban Thoroughfares: A Context Sensitive Approach Recommended Practice* and other context sensitive solutions (CSS) resources to expand understanding of CSS principles and practices within the transportation community as a whole related to designing walkable urban thoroughfares. The outreach materials included two case studies, web briefings, an ITE Journal article, presentations at various conferences, update to existing Fact Sheets and the development of two additional Fact Sheets, and a report on CSS Performance Measures. The outreach materials are intended to raise the bar for CSS implementation nationally by increasing awareness and by identifying tools and techniques that can be used to successfully implement CSS in design of walkable urban thoroughfares. Available at: http://www.ite.org/css/.

Design and Management Planning for Landscape, Aesthetics, and Environmental Development

Sponsor: Texas Department of Transportation (TxDOT)
Period of Performance: 1995 to 2008
Personnel: Beverly Storey
Total Award Amount: $880,000 bi-annual contract

The objective of this inter-agency agreement was to provide design support to TxDOT district personnel such as landscape architects, engineers, maintenance personnel, and vegetation managers. Many projects are planting designs; however, others include retaining walls, riprap, structural aesthetic treatments, landscape pavers, colored concrete, handicap accessibility renovations, erosion control solutions, embankment treatments, and storm water management features. All projects were taken from design development through completed construction documents with estimates. This project also included the development of Landscape and Aesthetic Corridor Master Plans. These master plans identified and prioritized landscape and aesthetic goals for the various TxDOT Districts and the representative cities, developed a philosophy toward landscape and aesthetic development sensitive to the environment, established design guidelines, and created a mechanism for short term establishment and long term maintenance of landscape and aesthetic components. Researchers led teams of multi-discipline professionals and community leaders through the process of analysis, conceptualization, design, and planning to create documents which provide guidance for future development within the highway corridors for the respective districts.

SDDOT Water Quality Enhancement Program for Construction

Sponsor: South Dakota Department of Transportation Water Quality Enhancement Program
Period of Performance: 2005
Personnel: Beverly Storey, Jett McFalls
Total Award Amount: $98,000

This project for the South Dakota Department of Transportation produced design and construction manuals for erosion and sediment control, inspection checklist, and training course and manuals.

Minimizing Impacts to Existing Vegetation and Sensitive Landforms during Roadway Construction

Sponsor: Texas Department of Transportation (TxDOT)
Project No.: 0-4548
Period of Performance: September 2002 to August 2003
Personnel: Beverly Storey
Total Award Amount: $68,700

This project surveyed existing techniques for tree and landform preservation/protection and weighed their suitability for application to the highway environment. It provides guidelines that include criteria for decision-makers to use in identification of safety as well as social concerns affecting the decision, determining what can be saved, why it might be saved, and the cost for different measures available. This report identifies the issues that affect tree and landform preservation and protection, recommends standards and a new specification procedure as part of a tree protection program for TxDOT, and includes guidelines that explain the standards. Available at: http://tti.tamu.edu/documents/0-4548-1.pdf.

Mobility Coordination During I-35 Corridor Reconstruction

Sponsor: Texas Department of Transportation (TxDOT)
Contract No.: 09-5XXIA002
Period of Performance: August 2015 – 2017
Personnel: John Habermann, Principal Investigator
Total Award Amount: $700,000

TTI utilizes a team of mobility coordinators to serve the mobility coordinator function for the I-35 corridor reconstruction through the TxDOT Waco District. The mobility coordinator's role is to provide TxDOT with technical and communications support for this project. The mobility coordinator also assists in keeping the traveling public and corridor stakeholders informed of mobility, access, and construction issues for the duration of the corridor reconstruction. The effort requires weekly travel to attend construction meetings for each of the active construction projects. TTI coordinates and facilitates a highly responsive traffic management effort to safely provide an acceptable level of mobility for persons traveling through the area. TTI convenes a monthly traffic management team meeting with key stakeholders and governmental entities to discuss reconstruction impacts on mobility and access. These meetings are divided among the different segments along the corridor. TTI provides the technical support needed to assist in the analysis of problems and identification of solutions to meet both the expected and unexpected events impacting traffic during construction. TTI reviews placed and planned traffic control plans and provide feedback to TxDOT's points of contact. TTI facilitates open lines of

communication between key stakeholders and attends project-related meetings with different municipal and county governmental entities. This activity includes assistance with potential mobility and traffic maintenance issues in the limits of the I-35 corridor reconstruction project and potentially along major alternate routes around the I-35 corridor reconstruction projects.

The Indiana Local Technical Assistance Program

Sponsor: Indiana Department of Transportation (INDOT)
Period of Performance: 2007 – 2012 (yearly renewal $900,000-$1,200,000)
Personnel: John Habermann, Program Manager/Co-Principal Investigator

Mr. Habermann led, managed and encouraged a team of nine employees to accomplish the mission of the Indiana Local Technical Assistance Program (LTAP) which is to foster a safe, efficient, environmentally sound transportation system by improving the skills and knowledge of local transportation providers through training, technical assistance, and technology transfer. Indiana LTAP provides technical assistance and training to the highway, road, and street departments of all 92 counties, 117 cities, and over 450 towns in Indiana. These local agencies are responsible for over 80,000 miles of roads and streets across Indiana. Technical assistance is provided through training programs conducted at Purdue University and throughout the state, as well as topical workshops and seminars on subjects pertaining to roads and streets, regular newsletters, and periodic publications. Indiana LTAP also provides assistance via the telephone and website. The intent of the Center is to provide the necessary information to help local government offices find the latest tools to analyze their highway and road problems. Indiana LTAP strives to help those responsible, for local transportation networks, perform their responsibilities correctly and efficiently.

SECTION 7
OTHER COMMITMENTS OF THE RESEARCH TEAM

The TTI team is prepared to commit the necessary personnel to achieve the goals and objectives of this project in a timely and efficient manner. The following tables summarize the known commitments of each key staff member who is estimated to provide at least 10 percent of their time for this project.

The research team has the time available to conduct this research project in a manner consistent with the schedule and budget provided in this proposal as illustrated in Table 1.

Table 2. Commitments of the Research Team.

Percent Time Over Contract Period (%)				
Commitments	**McFalls**	**Storey**	**Das**	**Haberman**
NCHRP 14-41	12	18	8	8
Other CRP* Projects	0	40	0	10
State/Local Projects	80	42	20	80
Federal Projects	0	0	25	0
Other Projects	8	0	15	0
Academic/Advisory	0	0	0	0
Total Committed	100	100	68	98
Uncommitted	0	0	32	2
Total % Time	100	100	100	100

*Cooperative Research Program

SECTION 8
EQUIPMENT AND FACILITIES

About TTI

Since 1950, experts at the Texas A&M Transportation Institute (TTI) have developed solutions to the problems and challenges facing all modes of transportation. A member of The Texas A&M University System, TTI has a breadth and depth of programs, facilities and capabilities unsurpassed by any other higher-education affiliated transportation research organization in the United States.

The Institute's research and development program has resulted in significant breakthroughs across all facets of transportation. TTI research is widely known as an excellent value with a proven impact of saving lives, time and resources.

The Institute conducts about 600 research projects annually with over 200 sponsors at all levels of government and the private sector. In 2015, TTI had research expenditures totaling $58 million.

The strategies and products developed through TTI's research have saved Texas and the United States billions of dollars and thousands of lives.

At any one time, the Institute has research projects under way in about 30 states and has conducted research in all 50 states. TTI researchers have worked in more than 40 foreign countries to enhance transportation infrastructure and promote a vibrant global economy.

TTI staff comes from more than 50 different countries and are known for their credibility and technical expertise. Many are recognized national and international leaders in their fields. The Institute also plays a key role in educating the next generation of transportation professionals. Over 40 TTI researchers hold joint academic appointments at Texas A&M University. In the laboratory and the classroom, through the Dwight Look College of Engineering and other colleges at Texas A&M University, TTI researchers help prepare students for transportation careers.

With expertise in areas such as engineering, planning, economics, policy, public engagement, landscape architecture, environmental sciences, computer science, and the social sciences, TTI researchers serve as objective transportation experts. They provide a resource to local, state, and national agencies and groups, helping them solve transportation challenges and make informed decisions.

TTI is home to nine state and national research centers, all approved by The Texas A&M University System Board of Regents. These centers help illustrate the depth and breadth of the Institute's capabilities. Center research emphasis areas range from transportation safety and economics, to railway, border mobility, and ports and waterways research.

With headquarters and laboratories on the Texas A&M campus in College Station, TTI also operates several facilities in Bryan, including roadside safety, visibility, pavements, environmental and emissions testing facilities at the university's Riverside Campus.

TTI has offices in Arlington, Austin, Dallas, El Paso, Galveston, Houston, San Antonio and Waco. Internationally, TTI has locations at the Texas A&M University Center in Mexico City and in Doha, Qatar, on the campus of Texas A&M University at Qatar.

For more information about TTI, visit the Institute's website at tti.tamu.edu.

Research Facilities

Research is how we will know more tomorrow than we do today; laboratories—on campus and in the field—are where we will make and validate those discoveries. TTI researchers have access to more than 300 full-scale laboratories and field-testing devices, from the High-Bay Structural Testing Facility to an instrumented vehicle designed to measure driver behavior behind the wheel.

TTI maintains state-of-the-art laboratories, buildings and outdoor test beds. The 67,000-square-foot Gibb Gilchrist Building, located in the Texas A&M University Research Park, was designed and built specifically to house TTI's transportation research programs. The CE/TTI Building, an 85,640-square-foot building on the main campus of Texas A&M University, houses a portion of TTI staff, many of whom are also faculty in Texas A&M's Dwight Look College of Engineering. The CE/TTI Building connects to several laboratories in the areas of pavements and materials, soils and aggregates, and structures. The new three-story, 66,700-square-foot TTI State Headquarters and Research Building houses additional TTI research programs and TTI's administrative offices. Other highlights of the building include the Visibility Research Laboratory, which features a 125-foot-long corridor and is used to measure highway visibility products including signs, pavement markings, and traditional and new lighting technologies, such as LEDs. The lab also measures specialized visibility-related materials, including photoluminescent devices, and is equipped with state-of-the art photometric equipment used to develop new test methods and specifications to meet the needs of nighttime drivers.

TTI's expansive field-testing facilities are essential in providing real-world findings to state, national and international sponsors. TTI's Proving Grounds at the Texas A&M RELLIS Campus, a 2,000-acre complex about 10 miles from the main campus, is home to many TTI testing facilities. At the Proving Grounds, more than 4,000 full-scale crash tests have been conducted on the 3.5-mile test track since TTI began such testing in 1965. Vehicles ranging from subcompacts to 80,000-lb tractor-trailer rigs have been used to test the effectiveness of roadside safety devices, crash cushions, and barrier systems.

The RELLIS Campus facilities also include a drive-in Environmental and Emissions Research Facility used for research and testing designed to help lower vehicle emissions, improve air quality, and provide reliable information for state and national policy makers. This 7,500-square-foot facility can house tests using a full tractor-trailer rig or municipal bus. The Sedimentation and Erosion Control Laboratory is a 19-acre indoor/outdoor facility also located at RELLIS that provides testing capabilities for technology, products, and devices used for erosion and sediment control, vegetation management, and stormwater-quality improvement.

The Proving Grounds test track is also used for human factors studies using an instrumented vehicle with an eye-tracking system to assess driver look behavior on the open road both in the daytime and at night. The same eye-tracking equipment is used within TTI's driving simulator, which provides a safe and controlled environment to further explore comprehension and

compliance in response to traffic control devices. In the simulated environment, it is possible to inexpensively test multiple variations of the design and placement of a new device.

TTI operates real-world research implementation testing sites in seven cities across the state and has locations on the campus of Texas A&M University at Qatar and at the Texas A&M University Center in Mexico City, Mexico. As a member of The Texas A&M University System, researchers have access to other Texas A&M facilities, including the prestigious Sterling C. Evans Library and world-class computing resources to support them in their research endeavors.

Divisional Facilities

The **Sediment and Erosion Control Laboratory** (SEC Lab) has an overall goal to provide the transportation industry with a research and performance evaluation program for roadside environmental management that includes stormwater quality improvement, erosion and sediment control, and vegetation establishment and management. The Texas A&M Transportation Institute's Environment and Planning Program operates this 19-acre, full scale, indoor/outdoor facility. Through a research program with the Texas Department of Transportation (TxDOT), the SEC Lab produces and maintains the TxDOT Approved Products List (APL) for all sediment and erosion control products used by TxDOT. The SEC Lab also conducts NTPEP performance tests for GA Test Method 11340, *Standard Test Method for Determination of Sediment Retention Device (SRDs) Performance in Reducing Sediment Loss from Rainfall-Induced Erosion during Perimeter Control Applications*.

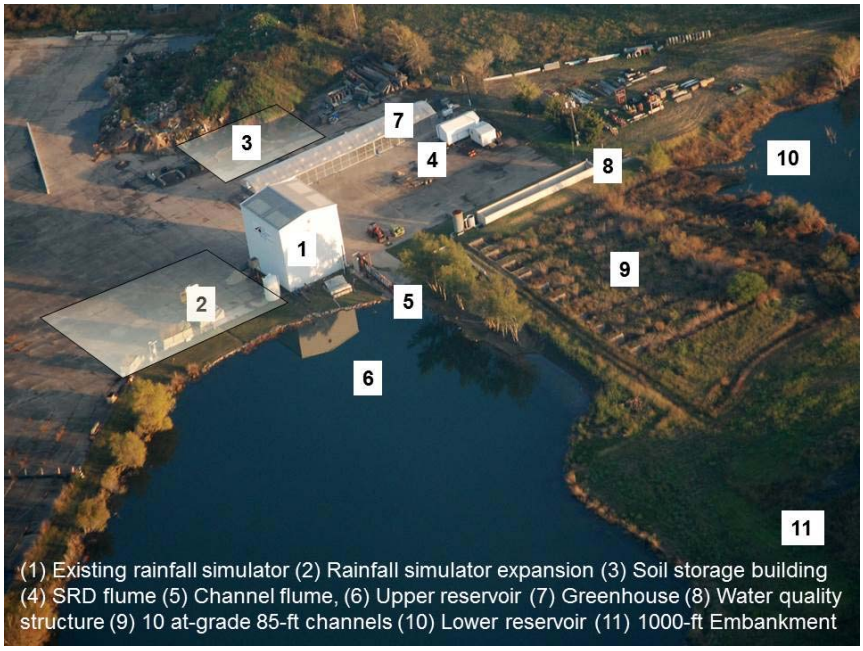

Figure 1. SEC Lab Aerial View.

The indoor rainfall simulator consists of five adjustable soil-filled test beds to match any desired slope up to 1.5:1 and provides water drop size distribution and impact velocity typical of storms common to Texas and the Gulf Coast regions of the country. The rainfall simulator is designed to subject test beds to the greatest, most destructive rainfall characteristics. Almost all of the water droplets reach terminal velocity before soil impact. Rain is dropped from a height of 14

feet causing the speed and erosive force of the water to approximate some of the most severe rainfall properties.

Figure 2. SEC Lab Rainfall Simulator.

In addition to the indoor rainfall simulator, the SEC Lab also houses:

- 25-foot-tall, L-shaped embankment of 1,000 linear feet has both clay and sand soil sections built with 2:1 and 3:1 slopes per highway specifications.
- Sediment retention device (SRD) flume with a 12 ft upper flume, 2 ft lower flume and a 4 ft wide soil-filled area is used to install the material according to manufacturer's specifications. A reservoir continually mixes a slurry of well-graded artificial sediment. Turbidity meters monitor influent and effluent concentrations. Flowmeters are also used to monitor influent and effluent flow rates.
- 30 ft outdoor, variable slope channel flume is used for testing the performance capabilities of flexible channel liner materials at a range of stress flows up to a maximum stress flow of 12 psf (575 Pa).
- 2,800-square-foot climate controlled greenhouse.
- 10 at-grade soil channels that are 85 feet long with a trapezoidal shape and 1:1 side slopes - four with a centerline gradient of 3% and six with a 7% gradient.
- Mobile rainfall simulator used to simulate natural rainfall and control rainfall rates at any remote location.
- 5,000-gallon portable water tank.
- Water quality testing structure designed to hold one-acre inch of water and capture and treat sediment laden water for various time periods. Samplers and flowmeters used in conjunction with this device, monitor settlement rates of sediment and also allow water to be slowly released, skimmed off the surface, or held for a designated time period and then released. One key feature of this device is a solar powered electronic butterfly valve that allows for precise capture and release of water in the structure.

In-House Writing and Editorial Services

TTI writers and editors work with researcher/authors and their support staff to develop high-quality documents on a timely basis. Communicating complex ideas to the public, sponsors, news media and colleagues is a specialty of the writing and editing team at TTI Communications.

Writers offer a wide range of content development services and creative support specific to transportation-related subject matter. Editors are familiar with Federal Highway Administration (FHWA) and Cooperative Research Program (CRP) editorial requirements and review documents for grammar, mechanics, clarity, consistency and style based on the specified guidelines or using standard editorial practices. Editors also suggest editorial changes that help convey messages clearly and concisely to readers. As well as standard edits, we offer advanced services such as electronic in-file editing and formatting, editorial review for electronic accessibility, and responses to sponsor needs.

The team has extensive experience producing:

- Research reports and project summaries.
- Educational materials (online and print).
- Video scripts.
- Manuals, handbooks, guidebooks, and other technical publications.
- Presentation materials and papers for presentation/publication.
- Webpage content.
- News and information articles.
- Brochures and pamphlets.
- Speeches.
- Newsletters.

Summary

In summary, TTI and Texas A&M present an extensive array of personnel, facilities, equipment, networked computing hardware and software, and research services to support research projects covering the spectrum. Our present commitment and our historic record assure sponsors of responsible, productive research of outstanding quality.

SECTION 9
TIME REQUIREMENTS

Tasks	Months																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Monthly Progress Reports																								
Quarterly Progress Reports																								
Kick-Off Teleconference Meeting																								
1. Project Management																								
2. Conduct Literature Review																								
3. Conduct Web-Based Survey and Practitioner Interviews																								
4. Develop Interactive Selection Tool																					D			
5. Prepare Final Deliverables																				C	D	R	R	F
Panel Review																					R	R	R	

Legend:
C = Panel Meeting via Phone.
D = Draft Report.
F = Final Report.
M = Panel Meeting at location selected by NCHRP.
R = Review Period.

Fixed Price Proposed Schedule of Project Milestones, Deliverables, and Progress Payments

Milestones	Deliverables	Due Date	Progress Payments
Revised Work Plan	Monthly Progress Report (PDF format)	Due within 15 days of contract execution	
Task 1. **Kick-Off Teleconference Meeting Monthly Progress Report (MPR)**	MPR (PDF format)	Due by end of 1st month	**$1,992**
Monthly Progress Report	MPR (PDF format)	Due by end of 2nd month	
Task 2. Conduct Literature Review **Quarterly Progress Report (QPR)**	QPR includes MPR	Due by end of 3th Month	**$10,764**
Monthly Progress Report	MPR (PDF format)	Due by end of 4th month	
Monthly Progress Report	MPR (PDF format)	Due by end of 5th month	
Quarterly Progress Report; Literature Review results	QPR includes MPR; Submit Draft Literature Review	Due by end of 6th Month	**$26,316**
Monthly Progress Report	MPR (PDF format)	Due by end of 7th month	
Monthly Progress Report	MPR (PDF format)	Due by end of 8th month	
Quarterly Progress Report Task 3. Conduct Web-Based Survey and Practitioner Interviews	QPR includes MPR	Due by end of 9th month	**$26,938**
Monthly Progress Report	MPR (PDF format)	Due by end of 10th month	
Monthly Progress Report	MPR (PDF format)	Due by end of 11th month	
Quarterly Progress Report Task 4. Develop Interactive Selection Tool	QPR includes MPR	Due by end of 12th month	**$29,675**
Monthly Progress Report	MPR (PDF format)	Due by end of 13th month	
Monthly Progress Report	MPR (PDF format)	Due by end of 14th month	
Quarterly Progress Report	QPR includes MPR	Due by end of 15th month	**$29,106**
Monthly Progress Report	MPR (PDF format)	Due by end of 16th month	
Monthly Progress Report Task 5. Prepare Final Deliverables.	MPR (PDF format)	Due by end of 17th month	
Quarterly Progress Report / Develop Technical Memo with draft recommendations.	QPR includes MPR; Submit Technical Memo with draft Recommendations	Due by end of 18th month	**$38,305**
Monthly Progress Report	MPR (PDF format)	Due by end of 19th month	

Monthly Progress Report	MPR (PDF format)	Due by end of 20th month	
Quarterly Progress Report / Draft Tool, including a User Guide	QPR; Submit Draft Tool that includes User Guide for panel review.	Due by end of 21st month	**$23,107**
Monthly Progress Report	MPR (PDF format)	Due by end of 22nd month	
Monthly Progress Report	MPR (PDF format)	Due by end of 23rd month	
Submit Final Deliverables: **1) Final Report for publication.** **2) Interactive Selection Tool.** **3) Graphic Presentation of Permanent Vegetation Controls.**	Submit Final report for print and electronic publication; Interactive Selection Tool; Graphic Presentation.	Due by end of 24th month	**$13,797**

SECTION 12
DISADVANTAGED BUSINESS ENTERPRISE PLAN

Proposer: **Texas A&M Transportation Institute** Date: **January 17, 2018**

Program and Project Number: **NCHRP 14-41**

Company Name	Relation to Prime (Check One)		DBE Type (Check One)		Budgeted Amount ($)
	Prime	Subcon-tractor	Minority Owned	Woman Owned	
N/A					$0

TTI's HUB Program

TTI and The Texas A&M University System (TAMUS) are committed to making a good faith effort to use Historically Underutilized Businesses (HUBs) through a fair, open, and competitive bidding and procurement process. All employees are encouraged to solicit bids from HUB vendors and, resources and guidance are made available to enable principal investigators and support staff to locate qualified vendors and special interest groups that can assist.

TTI has an internal HUB program that satisfies the State of Texas and TAMUS requirements. This plan has been active for over 15 years and contains elements as described below.

Statement of Commitment

TTI is dedicated and committed to the State of Texas HUB Program to actively involve minority-owned, woman-owned, qualified disabled veteran-owned and small businesses in the procurement process for goods and services and ensure they receive equal opportunities for a fair share of state business. Use of a diverse HUB vendor base for all levels of expenditures is an emphasis of the program.

The Institute is further committed to the State Use Works Wonders Program for Texans with disabilities. TTI departmental purchasers are encouraged to consider the Texas Industries for the Blind and Handicapped and various Community Rehab Programs when acquiring items sold by the State Use Works Wonders Program.

The Texas A&M University Procurement Services Department, responsible for the procurement of goods and services in excess of $10,000 for the Institute, encourages the use of and participation by HUBs in all procurement decisions. TTI division, program, and center staff process all delegated purchases, those less than or equal to $10,000. On these purchases, department personnel are encouraged to fulfill good faith efforts by seeking bids from HUB vendors by phone, e-mail, and/or vendor websites.

Goal of TTI's HUB Program

The intent of TTI leadership is to establish and implement HUB program policies that foster fair and competitive business opportunities that maximize the inclusion of HUB owned and small businesses in agency procurement contracts.

Administration of TTI's HUB Program

TTI administers the HUB program as specified by State of Texas Government and Administrative Codes, TAMUS Policies, Agency Rules and Federal Guidelines when applicable. Plan strategies include both in-reach and outreach activities focused on executive management support, communication, vendor solicitation and recruitment, monitoring of program performance, and employee training. Continued management communication regarding the importance of the HUB program, vendor diversity, and employee training are essential in-reach activities required for the attainment of agency HUB performance goals. Performance goals are set at a minimum of 18.06 percent of expenditures for fiscal year 2017. A copy of TTI's HUB plan is available upon request from Donna Harrell at the Texas A&M Transportation Institute (d-harrell@tti.tamu.edu).

SECTION 14
APPENDICES

Appendix A: Resumes – Texas A&M Transportation Institute

This section provides the TTI staff resumes for the research team members named below:

Jett McFalls (PI)

Beverly Storey (Co-PI)

Subasish Das (Researcher)

John Habermann (Researcher)

Michelle Benoit (Research Editor)

Jett McFalls, P.L.A.

Assistant Research Scientist
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EDUCATION

B.L.A., Landscape Architecture, Texas A&M University, May 1990.

EXPERIENCE

Assistant Research Scientist, Environmental Management Program, Texas A&M Transportation Institute, Texas A&M University, College Station, Texas, 2007-present.
Associate Transportation Researcher, Environmental Management Program, Texas Transportation Institute, Texas A&M University, College Station, Texas, 1999-2007.
Research Associate, Environmental Management Program, Texas Transportation Institute, Texas A&M University, College Station, Texas, 1990-1999.

MEMBERSHIPS/APPOINTMENTS

American Society of Testing Materials (ASTM)
D 18.25 Soil/Rock Subcommittee Member
International Erosion Control Association
Member, 1992-present.
President South Central Chapter, 2005-2008
Stormwater Management Subcommittee Member
Erosion & Sediment Control Subcommittee Member
University Partners Subcommittee Member
Texas Transportation Institute
H.B. Zachary Researcher of the Year – 1997
Most Distinguished Technical Paper Award (IECA) - 1998

PROFESSIONAL LICENSES

Registered Landscape Architect, Texas No. 1955.

SELECTED PRESENTATIONS

Professional Society Meetings
"Proposed Test Protocol for Evaluating the Sediment Control Removal Efficiency of SRDs" International Stormwater Conference (StormCon), Long Beach, CA, August 2010
"Proposed Test Protocol for Evaluating the Performance of Sediment Control Devices for Roadside Stormwater Runoff" Transportation Research Board Annual Meeting, January 2010
"Erosion Control for Construction Sites." Texas Vegetation Management Association Annual Conference, College Station, Texas. October 2010.
"Revised Universal Soil Loss Equation 2" California Stormwater Quality Association, San Diego, CA, October, 2009

"TxDOT/TTI Hydraulics, Sedimentation & Erosion Control Laboratory" National Roadside Vegetation Managers Association (NRVMA), San Antonio, TX, September, 2009

"Roadside Sediment Control Device Evaluation Program" AASHTO National Stormwater Conference, San Diego, CA, June 2008

"Stormwater BMP Issues for Erosion and Sediment Control." Texas Department of Transportation Design and Bridge Conference. Corpus Christi, Texas. 2007.

"Revisions to the Protocol for Performance Testing of Erosion Control Products and Flexible Channel Liners" International Erosion Control Association, Orlando, FL, 2002

"Performance Testing of Erosion Control Products – What Have We Learned After Five Complete Evaluation Cycles?" - Winner of the 1998 Most Distinguished Paper Award - International Erosion Control Association, Reno, NV, 1998

"The 1996 Performance Results for Slope Protection Products, Hydraulic Mulches, and Flexible Channel Liners" Transportation Research Board Annual Meeting, Washington D.C., 1997

"Flexible Channel Liner Study at the TxDOT/TTI Hydraulics and Erosion Control Laboratory" International Geosynthetics Conference, Long Beach California, October, 1997

"Control at Highway Construction Sites: Guidelines for Texas" Transportation Research Board Annual Meeting, Washington, D.C., October 1996

"Development of Standard Specifications for TxDOT" International Erosion Control Association, Reno, NV, 1994

"Texas Department of Transportation and Texas Transportation Institute Field Testing Program" International Erosion Control Association, Reno, NV, February, 1992

RESEARCH REPORTS

Synthesis and Study of the Roadside Vegetation Establishment Process. B.J. Storey, J.R. Schutt, J.A. McFalls, K.D. Jones, A.P. Garza, W.J. Rogers, C. Robinson, T.A. Gaus, G. Marek, and K. Heflin. FHWA/TX-11/0-5731-1. Texas Transportation Institute. College Station, Texas. 2011.

Stormwater Treatment with Vegetated Buffers. B.J. Storey, M. Li, J.A. McFalls, and Y. Yi. Project 25-25 Task 53, National Cooperative Highway Research Program. October 2009.

Water Retention Techniques for Roadside Vegetation Establishment in Arid Regions of Texas. J.A. McFalls, W. Rogers, C. Robinson, B.J. Storey, B.A. Stewart, M. Li, J. Schutt, and V. Saxena. FHWA/TX-09/0-5748-1. Texas Transportation Institute. College Station, Texas. 2009.

Successional Establishment, Mowing Response, and Erosion Control Characteristics of Roadside Vegetation in Texas. M. Li, J.R. Schutt, J.A. McFalls, E.K. Bardenhagen, C. Sung, L.A. Wheelock. Texas Transportation Institute. TxDOT 0-4949-1. 2008

SDDOT Water Quality Enhancement Program for Construction. H. Landphair, J. McFalls, B. Storey, and M. Li. Report No. SD04-05-F. South Dakota Department of Transportation. 2006.

Estimating Pollutant Loads for Stormwater Quality. H.C. Landphair, J.A. McFalls, D. Thompson. Texas Transportation Institute/Texas Tech University. TxDOT 0-1837. August 2003

Erosion Control and Engineering Properties of Native Vegetation Compared to Bermudagrass. J.A. McFalls, J.R. Schutt, H.C. Landphair. Texas Transportation Institute. TxDOT 0-1504-2. August 2002.

Design Methods, Selection, and Cost Effectiveness of Stormwater Quality Structures. J.A. McFalls, H.C. Landphair, D. Thompson. Texas Transportation Institute/Texas Tech University. TxDOT 0-1837-1. 2001

Recommendation for an Integrated Weed Management Program for Ornamental Plantings on Texas Highways. J.R. Schutt, J.A. McFalls. Texas Transportation Institute. TxDOT 7-2979. November 1996

Use of Compost and Shredded Brush on Rights-of-Way for Erosion Control: Final Report. B. Storey, J.A. McFalls, and S.H. Godfrey. Texas Transportation Institute. TxDOT 1352-2F. 1996.

Performance of Flexible Erosion Control Materials and Hydraulic Mulches. J.A. McFalls, H.C. Landphair, S.H. Godfrey. Texas Transportation Institute. TxDOT 1914-1. April 1993

COURSES DEVELOPED AND TAUGHT

Training Course on Developing and Implementing Soil Erosion Management Plan at Construction Sites. J.A. McFalls, B.J. Storey. South Texas Environmental Institute at Texas A&M University Kingsville with the Lower Rio Grande Valley Stormwater Task Force. 2009-present.

Training Course on How to Inspect Construction Sites and How to Enforce a TPDES Program. B.J. Storey and J.A. McFalls. South Texas Environmental Institute at Texas A&M University Kingsville with the Lower Rio Grande Valley Stormwater Task Force. 2009-present.

Training Course on Erosion and Sediment Control, ENV 102. J.A. McFalls, H. Landphair, B.J. Storey, M. Li,. TxDOT. 2003-2007.

Training Course on Erosion and Sediment Control and Associated Train-the-Trainer and Certification Program. H. Landphair, , M. Li, J.A. McFalls, and B.J. Storey . South Dakota Department of Transportation's Water Quality Enhancement Program. 2005-2006.

Beverly J. Storey, P.L.A.

Associate Research Scientist
System Reliability Division
Texas A&M Transportation Institute
Texas A&M University System
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EDUCATION

M.L.A., Landscape Architecture, Texas A&M University.
B.S., Forestry, Texas A&M University.

EXPERIENCE

Associate Research Scientist, System Reliability Division, Texas A&M Transportation Institute, 2016 - present
Associate Research Scientist, Environment and Planning Program, Texas A&M Transportation Institute, 2012-2016
Program Manager, Environmental Management Program, Texas Transportation Institute, 2007-2012.
Associate Research Scientist, Environmental Management Program, Texas Transportation Institute, 2007-2012.
Assistant Research Scientist, Environmental Management Program, Texas Transportation Institute, 2004-2007
Associate Transportation Researcher, Environmental Management Program, Texas Transportation Institute, 2000-2004.
Assistant Transportation Researcher, Environmental Management Program, Texas Transportation Institute, 1999-2000.
Assistant Research Specialist, Environmental Management Program, Texas Transportation Institute, 1996-1999.
Graduate Assistant Researcher, Environmental Management Program, Texas Transportation Institute, 1993-1996.

PROFESSIONAL REGISTRATION

Registered Professional Landscape Architect in Texas, Registration No. 1996.

AFFILIATIONS

Member, Transportation Research Board (TRB) CSS Task Force.
Member, TRB Roadside Maintenance Operations Committee.
Past Member, TRB Landscape and Environmental Design Committee.
Member, Smart Growth Network.
Member, Institute of Transportation Engineers, Texas Section.

ACADEMIC COURSES DEVELOPED

Making Mobility Improvements a Community Asset, Graduate level course in CSS, University Transportation Center for Mobility, Texas A&M University.

WEBINARS

Case Study Successes in Designing Walkable Thoroughfares: Lancaster Avenue, Ft. Worth, Texas, Institute of Transportation Engineers.

SHORT COURSES DEVELOPED AND TAUGHT

Construction Site Erosion and Sediment Control. Texas Department of Transportation.

Introduction to Low Impact Development. Southwest Region University Transportation Center.

Developing and Implementing Soil Erosion Management Plan at Construction Sites. South Texas Environmental Institute at Texas A&M University Kingsville with the Lower Rio Grande Valley TPDES Stormwater Task Force.

How to Inspect Construction Sites and How to Enforce a TPDES Program. South Texas Environmental Institute at Texas A&M University Kingsville with the Lower Rio Grande Valley TPDES Stormwater Task Force.

Low Impact Development Best Management Practices and Stormwater Management. South Texas Environmental Institute at Texas A&M University Kingsville with the Lower Rio Grande Valley TPDES Stormwater Task Force.

Context Sensitive Solutions Workshops and *EPA/DOT/HUD Sustainability/Livability Workshops*. Federal Highway Administration.

Erosion and Sediment Control Course ENV 102, Texas Department of Transportation.

Erosion and Sediment Control Course ENV 103. Texas Department of Transportation.

Erosion and Sediment Control Course with Train-the-trainer and Certification Program. South Dakota Department of Transportation's Water Quality Enhancement Program.

SELECTED PUBLICATION

R. Baker, L. Cochran, N. Norboge, M. Moran, J. Wagner and B. Storey. *Alternative Fuel Vehicle Forecasts*. PRC 14-28F. Transportation Policy Research Center, Texas A&M Transportation Institute. 2015.

J. Overman, B. Storey, E. Kraus, K. Miller, and Z. Elgart. *Introductory Guide to Integrated Ecological Framework*. FHWA/TX-13-0-6762-P1, Texas A&M Transportation Institute. 2014.

J. Overman, B. Storey, E. Kraus, K. Miller, and Z. Elgart. *Maximizing Mitigation Benefits–Making a Difference with Strategic Inter-Resource Agency Planning: Year Two Technical Report*. FHWA/TX-13-0-6762-2, Texas A&M Transportation Institute. 2014.

J. McFalls and B. Storey. *Sediment and Erosion Control Laboratory Facility Expansion*. FHWA/TX-13/5-9048-01. Texas A&M Transportation Institute. 2013.

M. Li, P. Li, J. McFalls, B. Storey and G. Newman. *Developing the Sediment and Erosion Control Laboratory to Become a Hand-on Training and Education Center: Project Report.* Southwest Region University Transportation Center. 2013.

J. McFalls, Y. Yi, B. Storey, M. Barrett, D. Lawler, B. Eck, D. Rounce, T. Cleveland, H. Murphy, D. Dalton, A. Morse, G. Herrmann. *Performance Testing of Coagulants to Reduce Stormwater Runoff Turbidity*. FHWA/TX-14/0-6638-1. Texas A&M Transportation Institute. 2013.

J. McFalls, Y. Yi, M. Li, S. Senseman, and B. Storey. *Evaluation of Generic and Branded Herbicides: Technical Report.* FHWA/TX-13/0-6733-1. Texas A&M Transportation Institute. College Station, Texas. 2013.

B. Storey, D. Foster, J. Johnson, and J. McFalls. *Development and Validation of a Testing Protocol for Carbon Sequestration Using a Controlled Environment.* Southwest Region University Transportation Center. 2012.

B.J. Storey, J.R. Schutt, J.A. McFalls, K.D. Jones, A.P. Garza, W.J. Rogers, C. Robinson, T.A. Gaus, G. Marek, and K. Heflin. *Synthesis and Study of the Roadside Vegetation Establishment Process.* FHWA/TX-11/0-5731-1. Texas Transportation Institute. College Station, Texas. 2011.

B.S. Bochner and B.J. Storey. *Designing Walkable Urban Thoroughfares: A Context Sensitive Approach – Phase III Outreach Materials.* 2011.

Institute of Transportation Engineers. *Designing Walkable Urban Thoroughfares: A Context Sensitive Approach.* ITE Publication No. PR-036A, Washington, D.C., 2010.

B.J. Storey, M. Li, J.A. McFalls, and Y. Yi. *Stormwater Treatment with Vegetated Buffers.* Project 25-25 Task 53, National Cooperative Highway Research Program. October 2009.

J.A. McFalls, W. Rogers, C. Robinson, B.J. Storey, B.A. Stewart, M. Li, J. Schutt, and V. Saxena. *Water Retention Techniques for Roadside Vegetation Establishment in Arid Regions of Texas.* FHWA/TX-09/0-5748-1. Texas Transportation Institute. College Station, Texas. 2009.

K.D. Jones, B.J. Storey, D. Jasek, and J. Sai. *Synthesis of New Methods for Sustainable Roadside Landscapes.* FHWA/TX-07/0-5330-1. Texas Transportation Institute, College Station, Texas. 2007.

H. Landphair, J. McFalls, B. Storey, and M. Li. *SDDOT Water Quality Enhancement Program for Construction.* Report No. SD04-05-F. South Dakota Department of Transportation. 2006.

B. Storey, A.B. Raut Desai, M. Li, H. Landphair and T. Kramer. *Water Quality and Performance of Compost Filter Berms,* FHWA/TX-06/0-4572-1. Texas Transportation Institute, College Station, Texas. 2006.

D.L. Bullard, N.M. Sheikh, R.P. Bligh, R.R. Haug, J.R. Schutt, B.J. Storey. *Aesthetic Concrete Barrier Design.* National Cooperative Highway Research Program Report 554. Transportation Research Board, Washington, D.C. 2006.

D.L. Bullard, N.M. Sheikh, R.P. Bligh, R.R. Haug, J.R. Schutt, B.J. Storey. *Aesthetic Concrete Barrier and Bridge Rail Design*. 474630-5. Texas Transportation Institute, College Station, Texas. September 2005.

B. Storey*, Lubbock Landscape and Aesthetic Master Plan, Lubbock District, Texas Department of Transportation*, Texas Transportation Institute, College Station, Texas. 2004.

J. Schutt, B. Storey, R. Rabinowitz. *Recommendations, Procedures, and Guidelines for the Protection of Trees and Sensitive Landforms*. FHWA/TX-04/0-4548-1. Texas Transportation Institute, College Station, Texas. 2003.

P.L. Ellis, C.W. Gilliland, J.H. Overman, B.J. Storey, N. Volkman. *Preliminary Review Environmental Process Guidebook*, Product 4001-P1. Texas Transportation Institute, College Station, Texas. 2003.

B. Storey, J.A. McFalls, S.H. Godfrey. *Use of Compost and Shredded Brush on Rights-of-Way for Erosion Control: Final Report*. Texas Transportation Institute. TxDOT 1352-2F. 1996.

B. Storey and S. Godfrey. "Highway noise barriers: 1994 survey of practice". *Transportation Research Record 1523*. Transportation Research Board. 1997.

B. Storey, S.H. Godfrey. *Highway Noise Abatement Measures: 1994 Survey of Practice*. Texas Department of Transportation. TX-95/1994-4. 1995.

Subasish Das

Associate Transportation Researcher
Roadway Safety
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EDUCATION

Ph.D. Degree in Civil Engineering (Transportation), University of Louisiana at Lafayette, 2015.
M.S. Degree in Civil Engineering (Transportation), University of Louisiana at Lafayette, 2012.
B.S. Degree in Civil Engineering, Bangladesh University of Engineering and Technology, 2007.

EXPERIENCE

Texas A&M Transportation Institute, Associate Transportation Researcher, 2015 – present.
University of Louisiana at Lafayette, Research Assistant, 2010 – 2015.
Hennessey LLC, Dubai, UAE, Quality Surveyor on Roadway Projects, 2008 – 2009.
Mak International, Dhaka, Bangladesh, Project Engineer, 2007 – 2008.

PROFESSIONAL AFFILIATIONS

Member, Institute of Transportation Engineers.
Member, American Society of Professional Engineers.
Former Vice President of Young Professionals in Transportation, Houston Chapter.
Member, TRB Committee for Library and Information Science for Transportation (ABG-40).

AWARDS

2015- Eno Fellow
2014 - AASHTO RAC "Sweet Sixteen" High Value Research award.

SELECTED PUBLICATIONS

Das, S., R. Avelar, K. Dixon, and X. Sun. Investigation on the Wrong Way Driving Crash Patterns using Multiple Correspondence Analysis. Accident Analysis and Prevention, Vol. 111, pp. 43-55, 2018.

Das, S., A. Dutta, K. Dixon, L. Minjares-Kyle, and G. Gillette. Using Deep Learning in Severity Analysis of At-Fault Motorcycle Rider Crashes. Transportation Research Record: Journal of the Transportation Research Board, 2018 (accepted).

Das, S., B. Brimley, T. Lindheimer, and M. Zupancich. Association of Reduced Visibility with Crash Outcomes. IATSS Research, 2017.

Sun, X., S. Das, Z. Zhang, F. Wang, and C. Leboeuf. Investigating Safety Impact of Edgelines on Narrow, Rural Two-Lane Highways by Empirical Bayes Method. Transportation Research Record: Journal of the Transportation Research Board, Volume 2433, 2014, pp. 121-128.

PRESENTATIONS

Das, S., M. Le, M. Pratt, and C. Morgan. Safety Performance of Truck Lane Restrictions in Texas: Empirical Bayes Observational Before-After Analysis. The 97th Transportation Research Board Annual Meeting, Washington D.C., January 7-11, 2018.

Das, S. Exploring SHRP2 NDS for the perspective of Self-Driving Cars in Difficult Driving Condition. Autonomous Vehicle Symposium, San Francisco, CA, July 10-14, 2017.

Das, S., X. Sun, and K. Dixon. Converting Four lane roadways into Five lane roadways on Urban structure: Study on Safety Effectiveness. Urban Street Symposium 5, Raleigh, North Carolina, May 21-24, 2017 (*2017 Urban Street Symposium Best Paper Award*).

Das, S., L. Minjares-Kyle, R. Avelar, K. Dixon, and B. Bommanayakanahalli. Improper Passing-Related Crashes on Rural Roadways: Using Association Rules Negative Binomial Miner. The 96th Transportation Research Board Annual Meeting, Washington D.C., January 8-12, 2017.

Avelar, R., T. Lindheimer, K. Dixon, J. Miles, and S. Das. Safety Evaluation of the Seasonality of Crashes with Tire Debris on Highways and Freeways. The 96th Transportation Research Board Annual Meeting, Washington D.C., January 8-12, 2017.

RELEVANT PROJECTS

NCHRP 14-40: Comparison of Cost, Safety, and Environmental Benefits of Routine Mowing and Managed Succession of Roadside Vegetation. 2017-2019. (Role: Co-Principal Investigator)

NCHRP 17-76: Guidance for the Setting of Speed Limits. 2016-2018. (Role: Key Researcher)

Safety Impacts of Reduced Visibility in Inclement Weather. Atlas TTI Competitive Research Project, 2016. (Role: Principal Investigator).

A Comprehensive Study on Pavement Edge Line Implementation. Louisiana DOT. 2013-2014. *2014 AASHTO High Value Research Sweet Sixteen Award.* (Role: Key Researcher)

John Habermann

Research Engineer
TTI-Dallas
Research and Implementation Division
Texas A&M Transportation Institute
Texas A&M University System
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John Habermann is a Research Engineer at the Texas A&M Transportation Institute. Mr. Habermann is currently the Principal Investigator and Lead Mobility Coordinator for a 21-mile corridor reconstruction effort on Interstate 35 through Central Texas scheduled to be completed in the Spring of 2019. As part of his efforts on I-35, he serves the critical role of a project ombudsman between the various stakeholders and the contractor and TxDOT. He also coordinates communication and outreach efforts with TxDOT Waco and surrounding districts. Recently, Mr. Habermann has joined the efforts of the I-35 expansion, in the TxDOT Austin District, to transfer lessons learned and best practices from the Waco District. This work is successful due to Mr. Habermann bringing together different stakeholders to learn of citizens', business', and community/elected leaders' concerns, questions, and feedback including those issues surrounding roadside vegetation. Mr. Habermann knows the importance of collaboration, working together, and strong partnerships. When communication takes place and when ideas are shared then one group doesn't have to suffer at the expense of another. It is team building at work when stakeholders get together to discuss issues and problems.

Outside of his work zone traffic management and mobility coordination efforts, Mr. Habermann has led a task, for the TxDOT Freight Division, on collecting, and reviewing the relevant literature, specifications, and current practices for Roadside Truck Parking along interstates and freeways. Mr. Habermann helped develop and conduct structured interviews to determine current practices in Preparing Work Zones for Automated and Connected Vehicles. Previously, while at Purdue University, as the Program Manager of the Indian Local Technical Assistance Program, he managed nine employees and led several technology transfer and research initiatives to bring the latest updates and research findings of the Indiana DOT to local governments. Mr. Habermann chaired LTAP's Annual Stormwater Drainage Conference. Vegetation Management was a reoccurring topic on the conference agenda. Mr. Habermann served on the 2008 committee to revise and update the Indiana Stormwater Drainage Manual to include green infrastructure and the importance of iroadside vegetation within highway and road projects. Mr. Habermann has spent the last 24 years working with and alongside state DOTs and helping them solve relevant problems through stakeholder involvement and teamwork. Mr. Habermann has chaired or co-chaired a number of technology transfer workshops and conferences. Mr. Habermann is a member of the Institute of Transportation Engineers.

EDUCATION

- M.S., Civil Engineering, Purdue University, 1994.
- B.S., Civil Engineering, Texas A&M University, 1992.

RELEVANCE TO STATEMENT OF WORK

- *Mobility Coordination*, TxDOT, 2013-present, Principle Investigator 2015-present
- *Traveler Information During Construction*, TxDOT, 2015-present
- *Collection and Estimation of AADT on Lower-Volume Roads,* FHWA, 2016-2017
- *Assessment of Innovative and Automated Freight Systems and Development of Evaluation Tools-Phase II-Subtask 3-7,* TXDOT, 2017
- *Technical Assistance for the Early Operational Improvements to Support Integrated Corridor Management (ICM) Initiatives for the Austin District-Task 1b-1a,* TxDOT, 2017
- *Evaluation of TxDOT Variable Speed Limit Pilot Projects*, TxDOT, 2014
- *Hazard Elimination Project for Existing Roads and Streets-Low Cost Safety Improvements*, Indiana DOT, 2009-2012
- *Very Short Duration Work Zone Safety for Maintenance and Other Activities*, NCHRP Synthesis 20-05/Topic 49-04, 2017
- *Design and Maintenance Practices for Urban Freeway Roadside Vegetation,* NCHRP Synthesis 20-05/Topic 49-06, 2017
- *N*ou *H*ope, Board of Directors (2015-2017), Vice-President (2017-2018), http://www.nouhopehaiti.org/

RELEVANT EMPLOYEMENT HISTORY

Dates	Position(s)	Organization
2013-Present	Research Engineer	Texas A&M Transportation Institute
2007-2013	Program Manager	Indiana Local Technical Assistance Program-Purdue University
1999-2007	Research Engineer	Indiana Local Technical Assistance Program-Purdue University
1994-1999	Roadway Construction Engineer	Private Consulting

SELECTED PUBLICATIONS AND TECHNICAL REPORTS

"A Simple Guide on Low Volume Road Design", A. Warith, P. Anastasopoulos, J. Seidel, N. Carboneau, J. Habermann, J. Haddock. 2012. 53rd Transportation Research Forum, Tampa, FL

"Construction of Sustainable Energy Facilities: Policy Considerations for Local Agencies", A. Tanaka, P. Anastasopoulos, N. Carboneau, J. Fricker, J. Habermann, J. Haddock, 2012. 53rd Transportation Research Forum, Tampa, FL

"Impacts of Sustainable Energy Facility Construction on Local Roads', A. Warith, W. Richardson, P. Anastasopoulos, N. Carboneau, J. Fricker, J. Habermann, J. Haddock, 2012. 53rd Transportation Research Forum, Tampa, FL

Michelle Benoit

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Michelle Benoit is a research editor with TTI Communications and supervises one full-time editor and five contract editors as head of the editing and desktop publishing group. In 2014, she was certified by Microsoft Corporation as a specialist in Microsoft Word 2010. She works as a copy editor, proofreader, and writer for TTI, with 20 years of experience with technical reports and other documents for the Texas Department of Transportation's cooperative research program at TTI. Ms. Benoit's group performs editorial and formatting services for close to 200 research documents a year for both federal and state sponsors. She is knowledgeable about text file accessibility requirements, including compliance with Section 508 at the federal level and TAC 206/213 at the state level. She writes alternative text for accessibility compliance, articles for the *Texas Transportation Researcher*, and various brochures, guidebooks, manuals, and reports. She is experienced in and knowledgeable about a wide variety of sponsor guidelines and editorial styles, as well as word-processing and graphic design software programs.

Ms. Benoit joined TTI in 1996. She has served as the managing editor and writer for two newsletters, one for the Association of American Railroads and one for the International Center for Aggregates Research. She was the primary editor for the American Association of State Highway and Transportation Officials document metrication project and the International Right of Way Association's interactive course manual. Ms. Benoit was also the manager of TTI Communications' graphic design group and was responsible for supervising six graphic designers, preparing budgets and specifications, and interacting with clients.

Before joining TTI, Ms. Benoit was a copy editor and graphic designer for a New York Times newspaper in Louisiana. She holds a B.A. honors degree in English, French, and history from Nicholls State University. She is a member of Mensa International.

Education

- B.A., English, French, and history, Nicholls State University, 1991, summa cum laude.

Certifications and Affiliations

- Member, Mensa Society, 2010–Present.
- Microsoft Word 2010 Specialist, Certification, Microsoft Corporation, 2014.

Selected Publications

P.A. Turner, K.D. West, R.W. Brinkmann, and M.M. Benoit. *Texas School Bus Driver Training and Driver Recertification Course Revision*. 405690-1.

Relevant Employment History

Dates	Position(s)	Organization
June 2011–Present	Research Editor	Texas A&M Transportation Institute
December 2000–June 2011	Associate Research Editor	Texas Transportation Institute
September 1998–November 2000	Assistant Research Editor	Texas Transportation Institute
June 1997–August 1998	Research Associate	Texas Transportation Institute
February 1996–May 1997	Research Assistant	Texas Transportation Institute
August 1995–February 1996	Copy Editor/Graphic Designer	The Courier, a New York Times Newspaper, Houma, Louisiana
April 1994–September 1995	Graphic Artist	The Courier, a New York Times Newspaper, Houma, Louisiana

Appendix B: Signed Liability Statement

Cooperative Research Programs

Liability Statement

Revised May 2006

Project NCHRP 14-41 Fiscal Year 2018

The signature of an authorized representative of the responding agency is required on the following unaltered statement in order for the TRB to accept the agency's response for consideration. **Responses submitted without this executed and unaltered statement by the response deadline will be summarily rejected.** An executed, unaltered statement indicates the agency's intent and ability to execute a contract that includes the provisions below.

Proposing Agency: Texas A&M Transportation Institute

Name: Julie Bishop Title: Associate Executive Director

Signature: Dan Hubbard Date: 1/5/18

CONTRACTOR LIABILITY

(a) The parties agree that the contractor and its employees and agents ("Contractor") will be primarily responsible for performing the work required under the contract, and shall therefore be legally responsible for, and shall indemnify and hold the Academy harmless for all claims asserted against the Academy, its committee members, officers, employees, and agents, by any third parties, whether or not represented by a final judgment, if such claims arise out of or result from Contractor's negligent or wrongful acts in performing such work, including all claims for bodily injury (including death), personal injury, property damage, and other losses, liabilities, costs, and expenses (including but not limited to attorneys fees).

(b) With respect to entities of State government that are subject to State law restrictions on their ability to indemnify and hold harmless third parties ("Restricted State Entities"), the obligation to indemnify and hold harmless the Academy in Paragraph (a) shall apply to the full extent permitted by applicable State law. In addition, each Restricted State Entity executing this contract represents and warrants that no part of any research product or other material delivered by such Restricted State Entity to the Academy ("Work Product") shall include anything of an obscene, libelous, defamatory, disparaging, or injurious nature; that neither the Work Product nor the title to the Work Product will infringe upon any copyright, patent, property right, personal right, or other right; and that all statements in the Contractor's proposal to the Academy and in the Work Product are true to the Contractor's actual knowledge and belief, or based upon reasonable research for accuracy.

(c) The term "wrongful act" as used herein shall include any tortious act or omission, willful misconduct, failure to comply with Federal or state governmental requirements, copyright or patent infringement, libel, slander or other defamatory or disparaging statement in any written deliverable required under the contract, or any false or negligent statement or omission made by Contractor in its proposal to the Academy.

(d) The obligations in paragraph (a) of this clause to indemnify and hold harmless the Academy shall not extend to claims, damages, losses, liabilities, costs, and expenses to the extent they arise out of the negligent or wrongful acts or omissions of the Academy, its committee members, officers, employees, and agents.

(e) Both the Academy and Contractor shall give prompt notice to each other upon learning of the assertion of any claim, or the commencement of any action or proceeding, in respect of which a claim under this paragraph may be sought, specifying, if known, the facts pertaining thereto and an estimate of the amount of the liability arising therefrom, but no failure to give such notice shall relieve the Academy or Contractor of any liability hereunder except to the extent actual prejudice is suffered thereby.

(f) The Academy and Contractor agree to cooperate with each other in the defense of any claim, action, or legal proceeding arising out of or resulting from Contractor's performance of the work required under this contract, but each party shall control its own defense. The Academy shall also have the option in its sole discretion to permit Contractor or its insurance carrier to assume the defense of any such claims against the Academy.

(g) The obligations under this clause survive the termination, expiration, or completion of performance under this contract.