WisDOT Transportation Pooled Fund Program

TPF-5(432): Bridge Element Deterioration for Midwest States

LIMITED USE DOCUMENT

This proposal is for use of the recipient in selection of a research agency to conduct work for WisDOT. Proposals are regarded as fully privileged, and dissemination of the information included therein must be approved by WisDOT.

Wood Environment & Infrastructure Solutions, Inc.
August 5, 2019

Summary Page

Project Title: TPF-5(432) Bridge Element Deterioration for Midwest States

Proposing Agency and Contact Information:

Wood Environment & Infrastructure Solutions, Inc.
4795 Meadow Wood Lane
Suite 310 East
Chantilly, VA 20151
(703) 488-3700

Person Submitting the Proposal: Jonathan Groeger, Principal

Proposal Written By: Jonathan Groeger, Paul Thompson, Richard Boadi, Ph.D., Dena Khatami, Ph.D.

Proposal Date: August 5, 2019

Principal Investigator:

Jonathan Groeger, Principal
Wood Environment & Infrastructure Solutions, Inc.
4795 Meadow Wood Lane
Suite 310 East
Chantilly, VA 20151
(703) 488-3700
jonathan.groeger@woodplc.com

Administrative Officer:

Richard Boadi, Ph.D., Senior Consultant
Wood Environment & Infrastructure Solutions, Inc.
4795 Meadow Wood Lane
Suite 310 East
Chantilly, VA 20151
(703) 488-3700
richard.boadi@woodplc.com

Proposed Contract Period: 24 months

Total Contract Amount: $399,317

Overhead/Indirect Cost Portion at 142.68% = $115,261

Table of Contents

Background

In this section of the proposal, we will demonstrate a clear understanding of the problem statement, address how the project relates to state DOT practices, and how it will benefit state DOTs and demonstrate our awareness of recent research and current practice on the topic.

Problem Statement and Research Objectives

Wood Environment & Infrastructure Solutions, Inc. (Wood) is pleased to provide this response to the Wisconsin DOT's Request for Proposal (RFP) for Bridge Element Deterioration for Midwest States TPF-5(432). For a background of our firm and a list of project resources, please see the Qualifications of the Research Team section of this proposal. This project is part of the Transportation Pooled Fund (TPF) program in which several States pool their resources in order to answer specific questions pertaining to the member States. The TPF participating States are highlighted in green in Figure 1.

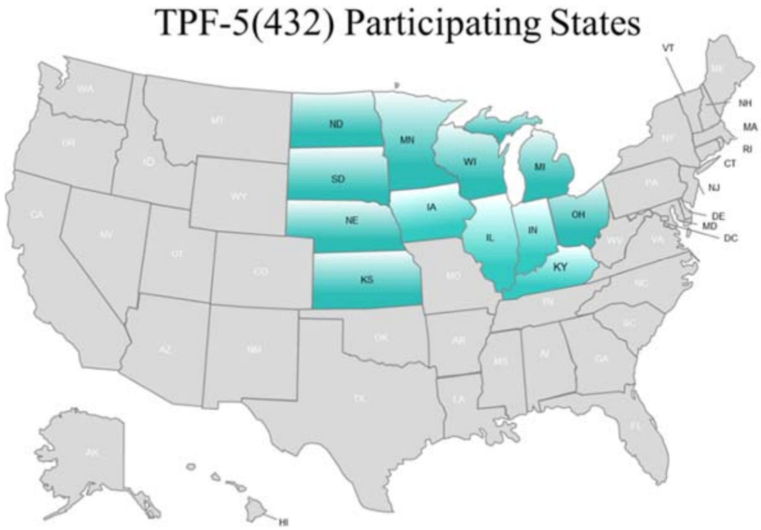


Figure 1. TPF-5(432) Participating States

The objective of this pooled fund research is to develop element-level deterioration models for specific bridges using multiple Midwest resources and historic Midwest bridge data. A select number of deterioration curves will provide the needed utility for the time-dependent deterioration of bridge elements to be used in making estimates of future conditions and work actions.

The deterioration curves will be developed through data analysis and research that are reflective of the Midwest environment (winter/summer), operations practices (application of deicing chemicals and representative rates of application), maintenance practices, and design/construction details. In addition, these deterioration curves need to be specific and focused, addressing key transition points in the life of bridge structures to facilitate the accurate determination of timing of work actions. These deterioration models must be compatible and complement the effectiveness of various Bridge Management Systems (BMS) used by agencies (BrM, Agile Assets, and others).

This proposal is responsive to the stated research objectives. We understand that we will:

- Pool data and information from all of the participating States,
- Develop deterioration curves for a prioritized list of Tier 1 and Tier 2 elements,
- Develop other information for Tier 3 (identify agency-defined elements, determine NDE translation, and provide a summary of policy, guidance, and practices), and
- Ensure compatibility with various BMSs.

Current Practices

Since the 1970s, states have been required to gather a standardized dataset of bridge inventory and biennial inspection data, for submittal to FHWA each April. These are compiled into a National Bridge Inventory (NBI).[3] Until recently, the NBI had only four data items describing bridge condition:

- 58 – Deck condition rating
- 59 – Superstructure condition rating
- 60 – Substructure condition rating
- 62 – Culvert condition rating

These four items represent separate parts of a structure, with a focus on the primary load-bearing components. Since the NBI Coding Guide is focused on safety rather than on maintenance needs, certain components with significant maintenance costs (such as expansion joints and paint) receive little or no consideration when assigning a condition rating. Each item is recorded using a coding scheme with 9 representing excellent condition and 0 indicating failed condition and beyond corrective action. When any of the NBI components is assigned a condition rating of 4 or below, the bridge is considered “structurally deficient.”

Although the FHWA Coding Guide is still mandatory, bridge owners have found that the four condition ratings are insufficient for asset management purposes. These ratings do not provide enough information on the cause of deterioration, to forecast future condition or select appropriate maintenance and preservation actions, and they do not provide enough information on the extent of deterioration for cost estimation.

As a result, nearly all bridge management systems worldwide use a more extensive condition description organized according to elements and condition states.[7] In the United States, most of these systems have, until recently, been based on the AASHTO Commonly-Recognized (CoRe) Element Guide.[1] The guide defines 106 common structural elements and provides objective visual language for recognizing 3-5 condition states for each element. Inspectors record the quantity or percentage of each element found to be in each condition state.

Previous versions of the National Bridge Investment Analysis System (NBIAS) used 72 of the 106 elements, focusing on the ones believed by FHWA to have some relationship to the criteria used in assessing the four NBI condition ratings. Since the collection of element-level data was optional at the time of NBIAS development, and because there was no process for states to submit such data to FHWA, it was necessary to develop a model to synthesize element data from NBI data. Only the 72 elements were capable of being imputed in this way.

One of the criticisms of the AASHTO CoRe Elements was the lack of detail on bridge decks, and the fact that deterioration processes were often commingled. It was difficult, for example, to separate deterioration of paint systems from deterioration of the underlying steel, or cracking from corrosion. As a result, the AASHTO manual moved toward a standard that makes a separate assessment of each major deterioration process, in order to provide the clearest and most relevant possible distinctions among condition states. This practice was formalized in the 2013 AASHTO Manual for Bridge Element Inspection.[2] Federal rules now mandate the collection and reporting of a subset of the elements defined in the new manual. Designated “NBI Elements,” these are shown in the table below.[4]

National Bridge Inventory (NBI) Elements

12	Reinforced Conc (R/C) Deck	207	Steel Tower
13	Prestressed (PS) Conc. Deck	208	Timber Trestle
15	PS Concrete Top Flange	210	R/C Pier Wall
16	R/C Top Flange	211	Other Pier Wall
28	Steel Deck - Open Grid	212	Timber Pier Wall
29	Steel Deck - Filled Grid	213	Masonry Pier Wall
30	Steel Deck - Orthotropic	215	R/C Abutment
31	Timber Deck	216	Timber Abutment
38	R/C Slab	217	Masonry Abutment
54	Timber Slab	218	Other Abutments
60	Other Deck	219	Steel Abutment
65	Other Slab	220	R/C Sub Pile Cap

102	Steel Box Girder	225	Steel Pile
104	PS Box Girder	226	PS Concrete Pile
105	R/C Box Girder	227	R/C Pile
106	Other Box Girder	228	Timber Pile
107	Steel Open Girder/Beam	229	Other Pile
109	PS Open Girder/Beam	231	Steel Pier Cap
110	R/C Open Girder/Beam	233	PS Concrete Cap
111	Timber Open Girder	234	R/C Pier Cap
112	Other Girder/Beam	235	Timber Pier Cap
113	Steel Stringer	236	Other Pier Cap
115	PS Concrete Stringer	240	Steel Culvert
116	R/C Stringer	241	R/C Culvert
117	Timber Stringer	242	Timber Culvert
118	Other Stringer	243	Other Culvert
120	Steel Truss	244	Masonry Culvert
135	Timber Truss	245	PS Concrete Culvert
136	Other Truss	300	Strip seal joint
141	Steel Arch	301	Pourable joint
142	Other Arch	302	Compression joint
143	PS Concrete Arch	303	Assy. joint w/ seal
144	R/C Arch	304	Open joint
145	Masonry Arch	305	Assy. joint no seal
146	Timber Arch	306	Other joint
147	Steel Main Cables	310	Elastomeric Bearing
148	Sec Steel Cables	311	Moveable Bearing
149	Other Secondary Cable	312	Enclosed Bearing
152	Steel Floor Beam	313	Fixed Bearing
154	PS Floor Beam	314	Pot Bearing
155	R/C Floor Beam	315	Disk Bearing
156	Timber Floor Beam	316	Other Bearing
157	Other Floor Beam	330	Metal Railing
161	Steel Pin & Hanger	331	R/C Railing
162	Steel Gusset Plate	332	Timber Railing
202	Steel Column	333	Other Railing
203	Other Column	334	Masonry railing
204	PS Concrete Column	510	Wearing surfaces
205	R/C Column	515	Steel coating
206	Timber Column	521	Concrete coating

The advent of this dataset provides new opportunities and challenges with respect to bridge performance modeling and deterioration curves development. A major challenge is the fact that the definitions of NBI elements and condition states are relatively new, so very few studies had yet been undertaken to develop compatible deterioration models. As late as 2016, only the Florida Department of Transportation had completed such models.[(8)] However, many of the States had long histories, some going as far back as 1995, of bridge inspection using the older CoRe Element manual, and some had developed deterioration models using the older format.

A 50-state survey identified 15 State Departments of Transportation that had developed bridge element deterioration models. Most of these models were based on expert judgment, although some of the agencies had used the linear regression procedure within AASHTO’s Pontis (now BrM) software to update their judgment-based models to incorporate bridge inspection data.

In 2010 to 2012, the Departments of Transportation of Florida and Virginia developed bridge element deterioration models using large databases of CoRe Element inspections over 12 years or more. The methodology was developed initially for Florida DOT.[(9)] These states addressed only three of the nine climate zones, and only the Florida model, at the time, had been migrated to fit the 2013 AASHTO elements. Nonetheless, the earlier studies provided some important lessons:

- There can be important differences between agencies in how the condition state language of the CoRe elements is interpreted. It was found, for example, that Virginia inspectors were reluctant to use the worst defined condition state of each element because they understood this to imply a requirement for a structural analysis. The Florida inspectors did not share that view and were more willing to use all of the defined condition states.
- The Florida research compared the models based on inspection history against earlier models based only on expert judgment. They found that expert judgment was not very accurate, that transition times were underestimated by a factor of about 2.(9)

These lessons implied that it would be desirable to base each model on more than one agency's data, and actual inspection history should be relied upon as much as possible, in preference to expert judgment. Thus the proposed project pooling States data is a very good approach.

The LTBP program is currently performing national deterioration model research of its own that will be available with the TRB 2020 release of InfoBridge. In addition to that, the LTBP data which contains all of the available NBI and NBE data can be extracted and made available to the project team.

Benefits to the Participating States

By drawing on the research and datasets of the participating state DOTs, this study will be able to produce bridge element deterioration models for the participating States. Using historical inspection data, these models will avoid some of the problems that have been noted with earlier judgment-based models, particularly underestimation of transition times noted in Sobanjo and Thompson.(8)

These models will be especially useful to agencies that are getting started with bridge management and have not yet developed their own models. It may also be useful to researchers who need a model for life cycle cost analysis or investment analysis but might not have the resources to develop one of their own.

Some of the benefits to the States that will accrue as a result of this project are as follow:

- Generation of select deterioration models that are Midwest-specific.
- One project instead of 12 different State projects.
- Development of agency-defined elements that would be of use for other Midwest DOTs to consider adopting.
- Determine NDE data the States have and how it is used, which translates into information on element-level defects.
- Provide a summary of policy, guidance, and practices from other States that can be applied to member States.
- Other States (outside of participating States) may benefit as well with a starting point for their own models.

Preliminary Literature Review

For this proposal, we performed a brief literature review to inform us on the latest techniques and applications of bridge performance modeling. The results are presented herein as a precursor to the full literature review, survey instrument, and targeted interviews to be conducted under task 2 of this project.

The literature reveals two approaches to developing deterioration models for bridges: 1) a Delphi method in which expert judgment and knowledge are used for predicting future conditions of bridges, 2) a data-driven method in which analyzing and processing historical data will inform the models. According to the NCHRP 14-20 report, the state of practice is best represented by the modeling approach used by the National Bridge Investment Analysis System (NBIAS) and Pontis/BrM. NBIAS is an element-level bridge management software used by FHWA and partially developed by a member of the proposed project team. AASHTOWare BrM, originally Pontis, is also a management software that optimizes maintenance actions at the element level. Existing bridge management software use deterministic or statistically methods such as Markov chain or semi-Markov to predict the future performance of bridges. Many states have developed deterioration models for their inventory. For example, the following States were explored as part of the preliminary literature review.

Alabama

Bridge condition data were processed to develop element-level deterioration models that can be used in BrM. Development of Alabama-specific models, which have been adjusted by expert review and comments, provides future predictions with high accuracy. Mr. Thompson, a member of the proposed team, was involved in this study.

Colorado

The Colorado DOT (CODT) has produced several reports related to bridge modeling. According to the Report No. CDOT-2012-4, CDOT uses element-level Markovian transition probabilities to estimate the loss of safety in bridges.(12) The transition probabilities are calculated for bridge NBI components. Report No. CDOT-2017-05 investigated the application of mechanistic models from the literature to express physical processes causing deterioration, to predict the future condition of bridges and assist with maintenance and repair planning.(13) In this report it was suggested that mechanistic models can be used as a supplement to statistical methods for modeling the physical deterioration process at element and bridge level as a function of influential parameters.

Florida

In this report, an improved deterioration model was developed for Pontis and the Florida project-level analysis tool (PLAT).(14) PLAT is an Excel-based model which can be used with Pontis for decision making. A simplified methodology was conducted to estimate Markovian transition probabilities (one-step method) with smaller sample sizes than traditional regression. Also, a methodology was developed to estimate the action effectiveness models using the historical activity and condition data. Moreover, an improved Excel spreadsheet version of NBI translator is developed that can be incorporated into PLAT.

Indiana

Due to the fact that the deterioration models which were developed for Indiana bridges were old and not capable of capturing some external stressors such as truck traffic and climate condition, a set of deterioration models for bridge decks, superstructure, and substructure were developed in this study.(15) These models were categorized based on influential parameters such as functional class, material type, traffic, and climate condition. The models were developed based on the national bridge inventory database.

Michigan

To forecast the network conditions of bridges, Michigan uses a spreadsheet called the Bridge Condition Forecast System (BCFS). In BCFS, the performance of bridges at the network level is estimated using Markov chain deterioration models for the NBI condition rating.(16) In a separate study, the efficiency of preventive maintenance actions on the deterioration process of bridge NBI components was investigated.(17)

Minnesota

Through this study, a deterioration curve was generated for bridge decks which were overlaid with low-slump concrete using historical NBI data over twenty years.(18) The significance of internal and external parameters such as traffic, material, and span length on deterioration rate of bridges was also studied.

Nebraska

In order to perform life cycle cost analysis and compare different maintenance strategies, development of deterioration models was required. The deterioration process of bridges was modeled through two strategies - deterministic and stochastic. Using the deterministic deterioration strategy, a nonlinear formula was generated to relate the condition rating of bridges to their age considering different categories like type of wearing surface, average daily traffic, and average daily truck traffic. A stochastic model was defined using a Markov chain model and percentage prediction method to estimate transition probabilities for the bridge deck, superstructure, and substructure components.(19,20)

North Carolina

A set of updated deterministic and statistical deterioration models was developed for use in bridge management software (BMS) in this study.[21] To this end, 45 years of existing data in NCDOT's BMS were analyzed. Material type, design type, geographic location, and average daily traffic were the categories used in the deterministic models to classify bridge components and culverts into families. Survival analysis techniques and proportional hazard assumptions were applied for the development of transition probabilities in the statistical approach. Similar to deterministic modeling, transition statistical modeling accounts for the effects of design, geographic, and functional characteristics on deterioration rates. Although the advanced statistical model had a good accuracy for the prediction of bridge performance, it was discovered that a simplified version of the probabilistic deterioration model was able to achieve similar performance without considering the effects of external factors on deterioration rates.

New York

To calculate the deterioration rate of bridges, it is required to filter data to remove data affected by treatment actions, inspector subjectivity, and errors. The filtered inspection data are then used to estimate the rate of deterioration for bridge elements that have been classified based on truck traffic, climate, DOT regions, ownership, design types, etc. A Markov chain model and Weibull-based approaches were applied to develop a computer program to calculate deterioration rates of bridge elements in this study.[22]

Pennsylvania

A Weibull distribution (semi-Markov process) was used as a statistical analysis to model the deterioration process of a bridge's deck parameters for each condition rating. By fitting the Weibull distribution to the data, the Weibull parameters were estimated. The estimated Weibull distribution was then implemented into an excel deterioration model called PSU Bridge Deck life. The expected condition rating of the deck over time was predicted from the model to help in identifying the most cost-effective treatment action and optimum time to remediate it.[23]

Washington

This study developed a statistically-driven model to express deterioration process of bridge substructure elements for both Eastern and Western Washington climates.[24] The outcome of this study is a probability transition matrix and age of transition for dry and submerged concrete pile/column elements.

Wyoming

Deterministic and probabilistic deterioration models were developed for Wyoming bridges based on historical data. The NBI condition rating has been recorded since 1983 while element level inspection data is available since 1996.[25]

AASHTOWare Bridge Management (BrM)

Information regarding the deterioration models implemented in the software can be found in the manual, AASHTO training and webinar links such as:[26]

https://www.youtube.com/watch?v=43JsZJ-M1OA
https://www.youtube.com/watch?v=nXHZVX8godc
https://www.eiseverywhere.com/file_uploads/2eae1423856df463b22e50feab2dfcb1_5BrMWorkshop.pdf

The element-level deterioration model in BrM software (version 6) is a combination of Weibull survival function and Markovian process. Weibull function expresses the deterioration process of bridge elements in good condition (condition state 1) since it can capture more a realistic (slower) trend compared to the Markov process.

Methodology of Homogeneous and Non-Homogeneous Markov Chains for Modelling Bridge Element Deterioration

The deterioration model used in the Pontis bridge management system is Markov Chain, with a statistical regression to estimate the transition probabilities. In this report, the applied deterioration model in Pontis was reviewed to identify areas for improvement and consequently a non-homogenous Markov chain model was developed.[27]

Culvert Asset Management Practices and Deterioration Modeling

The researcher investigated the factors that affect culvert performance to present a deterioration model. In this study, a binary logistic regression with a forward stepwise variable selection method is employed to generate a deterioration model for the data obtained from the Ohio DOT.(28)

Modeling Bridge Deterioration Using Case-based Reasoning

A new case-based reasoning approach has been used to describe the deterioration of bridges. The advantages of this method compared to the Markov chain process are: a) capturing interactive effects between deterioration mechanisms of bridge components, and b) updating using new inspection data.(29)

Artificial Neural Network Model of Bridge Deterioration

This study developed an artificial neural network model to predict deterioration of bridges.(30) To this end, significant parameters in this process are recognized by statistical analysis and by using historical maintenance and inspection data. The model was developed and provides predictions of bridge condition with good accuracy.

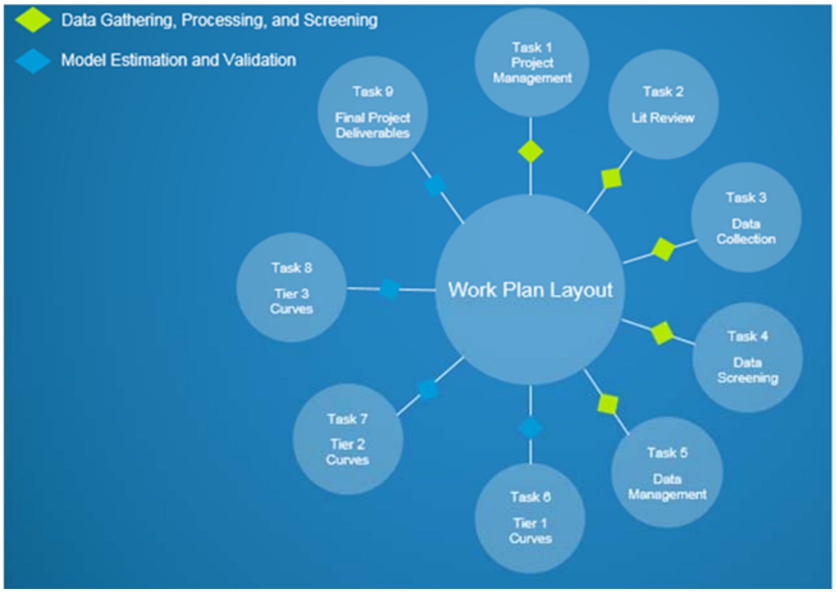
Keys to Success

Because of the cooperative nature of this project, there are specific keys to success the project team will emphasize throughout execution of the project. These will be discussed and agreed to during the kickoff meeting.

1. Constant communication – We will provide frequent and consistent communication between the project team, the WisDOT Project Manager, and the TPF TAC. This is considered critical with the many players and interests involved in this project.
2. Use of an online, documented, open source MySQL database and an open source statistical package – This is needed for update of the models after the project has ended by participating States (more on this in the Work Plan).
3. Disciplined and committed review of deliverables in terms of comments and review periods – Because there are multiple participating agencies, it will be critical to stick to agreed review periods and provide comments in the format requested.
4. Working together effectively to support each participating State DOT will be very critical to achieve the collective goals of the participating State DOTs.

Work Plan

The planned approach to the study will be executed within the scope provided in the solicitation, which we have elected to break down into nine tasks. They are:



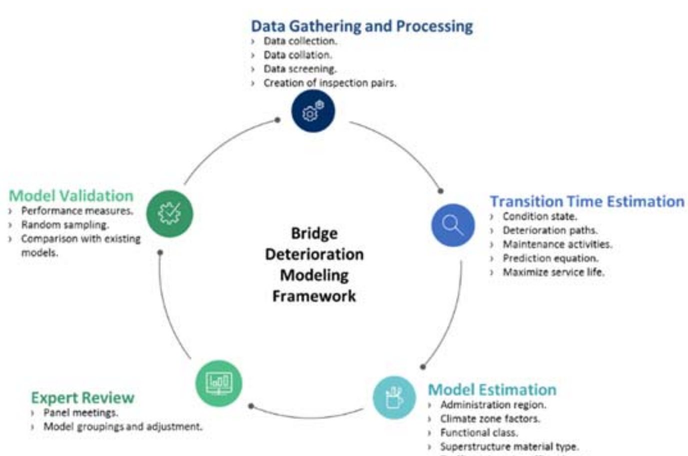
The above tasks will be carried out in accordance with the details of the solicitation.

Overall Approach to Modeling

At this point in the proposal, we will take a minute to discuss our general approach to modeling, which will be used for each analysis undertaking in the subsequent tasks.

The modeling approach documented here will serve as the foundation in developing specific deterioration models for the families of deterioration curves for the different bridge components (deck, superstructure, and substructure) and bridges material types that will be identified in the research approach. The critical components of our modeling development approach include data gathering and processing, transition time estimation, model estimation, expert review, and model validation. The figure shows the essential elements that go into each component of our approach.

Data Gathering, Processing, and Screening – This will be primarily conducted under tasks 3 to 5. The data screening process will allow the team to filter the inspection data and create inspection pairs of the same element on the same bridge such that we can generate reliable information from the collated data to inform the deterioration models. Using a structured query language, the team will process the data to create a table of inspection pairs. These inspection pairs will consist of two element inspections. This process all depends on the completeness of the available inspection data. It is expected that data mismatch, erroneous ratings, and missing data will occur throughout the process.



We will also work with the TAC to collect Agency Defined Elements (ADE) and that we will work with the TAC to isolate a select number to pursue to develop the deterioration curves.

The remaining components of the framework covers the activities that will be performed under tasks 6 through 9.

Transition Time Estimation – Markov transition modeling is one of the basic processes used in modeling bridge deterioration over time. In fact, the most widely used AASHTO BrM forecasts bridge deterioration using the Markov model. This approach uses one-year transition probabilities that are developed based on the dataset of inspection—i.e., initial condition—with no consideration for age, past conditions, or any other information. The Markov model expresses the probabilities as a simple matrix indicating the percentage of elements transitioning from one condition state to the next condition. Since no other factor except initial condition is used, it is expected that bridge components or elements will get worse in the future. This model will serve as the base model, while other models are considered by incorporating past maintenance and preservation activities, age of the bridge, and other significant variables.

Model Estimation – This component is the overarching outcome of this research. As stated in the request for proposal (RFP), the team will estimate specific models for the two tiers identified, as a minimum. Several modeling techniques exist for model estimation, each possessing its own merits and inherent limitations. The most common among them are the regression-based models and Markov chain. The team will investigate the benefits and weaknesses of the available modeling approaches and select a group of methods that addresses the needs of the research questions. During this process, the team will estimate models that are representative of the independent variables—administrative regions in which bridges are located as well as other factors such climate zones, functional class, bridge deck area and material types, and the amount of general traffic and truck traffic volumes. We will investigate different models, taking into consideration important variabilities and uncertainty, to verify if any inconsistencies in the response variables are statistically significant based on the independent variables data available to the team. The team will develop adjustment factors for the significant variables based on the bridge location and other attributes. We will examine defect progression as part of this task for each model developed.

Expert Review – Expert oversight will be critical to this project to ensure that the underlying assumptions made are correctly reflected in the models. This verification process will be executed with a keen understanding that the final models sufficiently reflect the needs and priorities of the participating DOTs. As stated earlier, mathematical models have their inherent limitations associated with their inability to capture some of the business operations that are not reflected in inspection reports. These shortcomings can result in underestimating or overestimating model parameters. These limitations are best addressed by supplementing the mathematical models with assumptions based on expert understanding of the actual work completed on particular bridges. With assistance from the project team, we will identify a group of experienced bridge inspectors and maintenance leaders from the participating DOTs to serve as a technical advisory committee to verify assumptions and model outputs. This group will be involved throughout the processes until the final models are agreed upon. Upon estimation of the initial models, we will provide the models to the team of experts for review and evaluation. We will gather comments to refine the models where needed. This process will include a series of presentations and workshops to achieve consensus on assumptions, model types, independent variables selections, and model forms. The information gathered through this review process will be used to group the models and refine them such that the group can agree upon the final models for future planning and use in bridge management systems.

Note: During the proposal review process the following concern was expressed – "We would like to avoid forcing probability functions to match our perceived reality, using arbitrary modification factors. Any factors used to modify the probability functions should have a specific purpose and a repeatable means to determine their value (e.g. Weibull or Bayesian). We would prefer an investigation of the original data to determine if the original data assumptions were correct (both the based probability functions and the modification factors will rely on this observed data, and obviously the deterministic models as well). There may be many database errors or inconsistencies within the state records. Please allow sufficient time to revisit the original dataset when models do not deteriorate as expected." This is noted herein so that the project team can reference the concern during project execution.

Model Validation – To validate the developed deterioration models for the identified tiers, we will use data and information from the participating DOTs to demonstrate if the models are a good representation of the systems groupings—indicating the flexibility and robustness of the models. The next step after verifying the model will be to validate the goodness of the model. It is important to note the difference between the model verification (through expert review) and the model validation process, although the two steps can be blended in practice. During this process, the team will develop and select performance measures to establish the goodness of the models. We will ensure that the performance measures are based on important elements within the system. We will employ various validation techniques to validate the models. Examples of available techniques in the literature include expert intuition, real system measurements, and theoretical results/analysis. As stated earlier, verification and validation overlap in practice, and expert intuition analysis will be covered through the expert review process. In practice, real system measurements tend to be the most suitable validation technique. However, data gaps may not allow this technique to be instituted. The team will create samples of the data to help validate the models in a more practical and intuitive approach. The team will produce deterministic deterioration curves to validate all probabilistic deterioration models.

Task 1 – Project Management

Sound project management forms the backbone of any research project. This is especially true when considering a TPF study in which there are many stakeholders. Included in this task is conduct of a face-to-face project launch meeting, development of a detailed work plan, development of quarterly progress reports, and performance of monthly (or more frequent) status conference calls.

The leader for this task will be Mr. Groeger and the primary support staff will be Dr. Boadi and Ms. McKlveen.

Task 1.1 – Project Launch Meeting

The Wood team will schedule and hold a project launch meeting within 10 days of contract award. This meeting will be the first step in a collaborative process. The team will lay out a plan for working hand-in-hand with the WisDOT Project Manager (PM) and the TPF TAC to build consensus on project objectives, contract methodologies, and results. Prior to this meeting, the team will coordinate with the WisDOT Project Manager. We will meet in person and the PI and Technical Manager (TM) will attend. Other project team members and participating States may attend via webinar, which the project team will coordinate and host.

The discussions will ensure all participants agree on the work to be performed and the expected outcomes. This also will provide an opportunity for the project team to receive further guidance from WisDOT on the overall project and provide input on the detailed work plan to be developed after the meeting. A detailed meeting agenda will be prepared by the project team five days prior to the meeting. The preliminary list of topics includes: identification and introduction of key staff members, review work order scope of work, requirements and conceptual work plan, review project timeline, TPF TAC input to detailed work plan, keys to success, review strategy and review duration for deliverables, risks and mitigation strategies, communications and reporting processes, and issue resolution.

Within 5 working days following the kick-off meeting, the PI will submit meeting minutes to the WisDOT PM that will document discussion points, resolutions, and action items.

Task 1.2 – Develop Detailed Work Plan

The objective of this task is to finalize a detailed work plan using the work plan contained in this proposal and including input from the TPF TAC at the project launch meeting. This work plan will contain priorities of the deliverable products, data collection plan, and approach, including what types of data the Contractor believes are significant, contact list (names) within participating DOTs and FHWA, analytical methods, overall work plan, schedule, and Contractor resources. The detailed work plan will be delivered 10 working days after the project launch meeting. A two-week review period is expected from the TPF TAC with finalization of the work plan occurring 5 working days after receipt of final comments from the TPF TAC.

Task 1.3 – Develop Quarterly Progress Reports

We will deliver a quarterly progress reports (QPR) in the TPF required format and a supporting invoice to the WisDOT and the TPF TAC by the 15th of the month following the period in question. The QPRs will contain all required elements of the TPF format. We are currently working on another TPF project and are well versed in the importance of the QPR process as a communication vehicle for the managing agency and for the TPF TAC.

Task 1.4 – Coordination: Monthly Status Calls

Communication with WisDOT, the TPF States, and other stakeholders is key to Wood's ability to manage, administer, and coordinate a contract. In addition to the QPRs, we propose monthly teleconferences to further coordinate our work and provide a status report to interested parties. We want you to be involved in the status and pursuit of this project in a collaborative and transparent manner. In these one-hour calls (we will adjust the time as necessary), the PI will discuss project status, work to be conducted over the next month, issues that need resolution, questions, and technical discussion of issues. The implementation of monthly status calls is a key to success so that WisDOT, TPF members, and other stakeholders are kept up-to-date and issues are resolved efficiently and effectively. If more frequent calls are needed during periods of high intensity work, we will perform these as well. We will provide agendas for the meetings three days in advance, participate, take notes, and issue minutes.

Task 1 deliverables are:

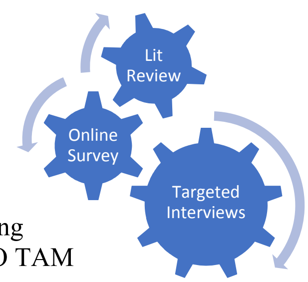
- Project launch agenda, meeting materials, and meeting notes.
- Detailed work plan.
- Quarterly progress reports and invoices.
- Monthly progress update phone calls and minutes.

Task 2 – Literature Review

The literature review is a critical part of the project. Through this process we will discover the state of the practice related to deterioration models, polices used to manage bridges, and NDE technologies used worldwide. This will also partially inform task 8, Develop Tier 3 Inputs, in terms of identifying agency-defined elements, determining NDE translations, and providing a summary of policy, guidance, and practices for the Midwest States. We have performed a cursory review in preparation for this proposal and it is included in the preceding section.

The leader for this task will be Mr. Thompson with primary support by Dr. Bektaş, Dr. Khatami, and Dr. Boadi.

Task 2.1 – Conduct Literature Review



The objective of this task is to gather relevant information on domestic and international practices in developing bridge deterioration curves. The Wood team will accomplish this task using three approaches; a literature review, an online survey, and targeted interviews with agencies identified through the survey.

The research team will build on our existing knowledge regarding the state-of-practice through a traditional literature review to identify agencies and their approach to developing deterioration curves. The team will utilize different search avenues, such as the AASHTO TAM (Transportation Asset Management) Portal, which hosts a wide range of TAM materials on implementation, the Transportation Research Board (TRB) Research in Progress databases, the TRIS Research Information Services database, the FHWA Office of TAM information resources, and online libraries using keywords. The final Transportation Asset Management Plans should provide a great wealth of information in this regard. Deterioration curves and element-level modeling were both a "pain point" among many DOTs developing their TAMPs, including the ones in which Wood was involved. Therefore, this is a known need among DOTs and it should have a rapid evolution cycle.

To pursue current and accurate information on recent developments in bridge deterioration modeling, the Wood team will utilize an online survey to gather up-to-date information from Federal, State, and International agencies, as well as research institutes. Hence, subject to TPF TAC approval, the online survey will target all 50 states, federal park owners, and international agencies. The information gathered through this task will enable the Wood team to assess the maturity level of bridge deterioration among DOTs, identify best practices, and seek various views on bridge deterioration implementation challenges. The survey is anticipated to be succinct but comprehensive to encourage maximum participation. The Wood team will develop an initial set of questions for the TPF TAC panel to review and approve before commencing its administration. The Wood team has conducted similar online surveys for NCHRP, TPF, FHWA, and State DOT projects with successful outcomes.

The final leg of this task is targeted interviews with participants identified as case studies to gather additional insights on approaches that were not captured in the survey. These interviews will be conducted through web-based audio-visual technology with key individuals involved with the case studies. Our goal is to identify at least five of these cases and showcase their efforts as part of the final deliverable.

Task 2.2 – Develop Literature Synthesis Document

The literature review document will be drafted to include the results of the aforementioned activities, e.g. the literature review, questionnaire, and targeted interviews. The document will form conclusions as to how the literature review can be leveraged to assist with this research. We will draft the document for TPF TAC review (assuming a two week review period) and then finalize it based on comments received.

Task 2 deliverables are:

- Technical memorandum documenting results from the literature review, surveys, and targeted interviews.

Task 3 – Data Collection

The data collection task is perhaps the most critical of the project. This data will form the backbone of the remaining tasks and fuel the analysis. During this task we will gather the following information:

- Inspection practices and coding methods of the DOTs related to element inspection and recording.
- State definitions of elements and coding practices for consistency and applicability.
- All available National Highway System (NHS) and Non-NHS Component and Element-Level information from the DOTs. This may also include historic CoRE Element information as well as available and pertinent Non-destructive Evaluation (NDE) information to be considered or employed in the data analysis process.
- Construction history data from DOTs as related to the analysis needs (original/maintenance/preservation) to address items like wearing surface.
- Relevant DOT policies and practices related to bridge construction, preservation and maintenance as appropriate.
- The current deterioration curves that the States have generated.

We will also conduct a systematic evaluation of FHWA NBI component and element-level bridge condition data. The research team will utilize the FHWA, Long Term Bridge Performance "InfoBridge" for collection of national bridge demographic and condition information.

This relates to the overall research objectives through collection of the information and population of an analysis database from which the tier 1, tier 2, and tier 3 models can be developed.

The leader for this task will be Dr. Boadi with primary support by Mr. Thompson and Dr. Khatami.

We will conduct the following tasks:

Task 3.1 – Develop Familiarity with Participating States Inspection and Coding Methods

This subtask will be concerned with determining each State's inspection practices and coding the NBI and NBE databases. Gathering this information will be included in the literature review task, so we will not be starting from scratch.

Task 3.2 – Compare State Inspection and Coding Practices

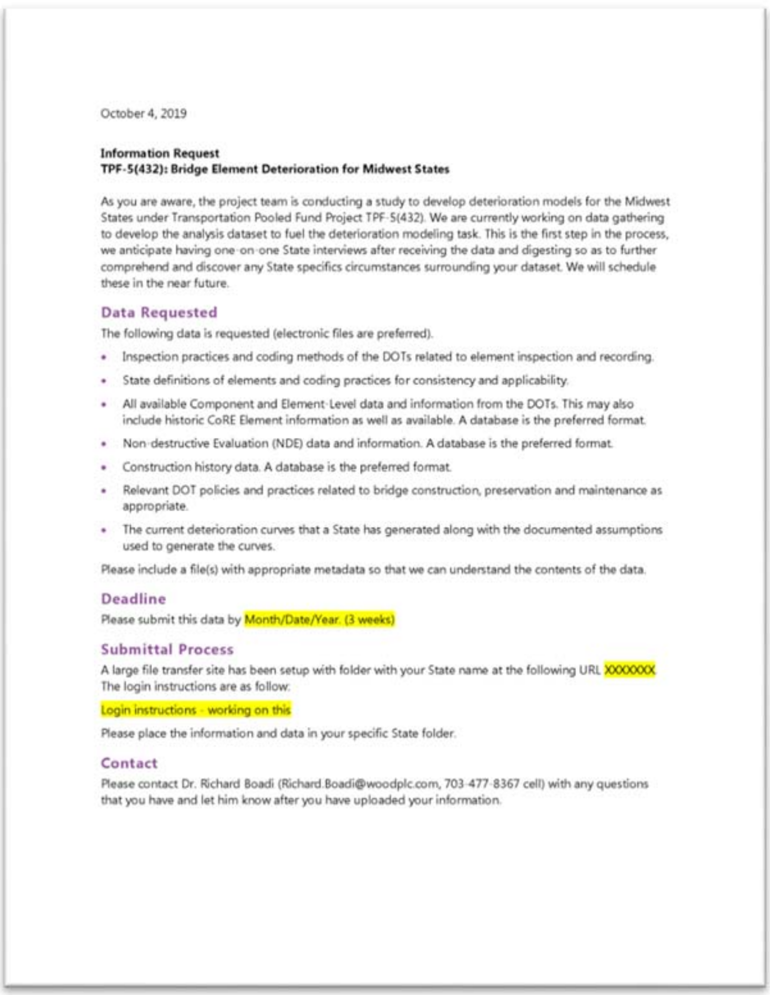
It is anticipated that the inspection and coding methods will be fairly uniform, as these processes are fairly mature. However, we will compare and contrast the data to determine if there are any outliers or special cases that must be accounted for when developing the analysis dataset.

Note: During review of the proposal the following concerns were raised—these may not be as uniform as anticipated, and we would strongly suggest a recalibration of hours to account for these variances. For example, in one of the participating state DOTs, between 2016 and 2019, some inspectors were coding delamination's found by IR as Condition State 3 defect 3210, others were coding the same condition as Condition State 2 defect 3210. This variance can be associated to certain regions within a state and can be largely corrected if cross-referenced with IR data and regional association, but this would only be revealed through a thorough investigation of inspection practice as required in RFP Task 3a [pg. 5]. Also, in this same DOT, between 2014–2016, some inspectors were coding IR delamination's as defect 1080 in the deck/slab element. Through the 2016 change of inspection practice, the data shows that many deck and slab elements "healed themselves" while many wearing surface elements "rapidly deteriorated" even though the actual structure condition remained largely unchanged. The project team agrees with this statement and will take it into consideration when conducting the project.

Task 3.3 – Collect Data from DOTs

We will collect data from the DOTs. To do this, we will provide specific instructions to be followed by the participating DOTs so as not to waste the State Bridge Engineers' time and effort providing us with this data. This will include the data elements, format, and bridges to include in the dataset. It will also include the current deterioration curves that the States use.

An example of this request is shown in Figure 2. This request will be refined in collaboration with the participating States.


October 4, 2019

Information Request
TPF-5(432): Bridge Element Deterioration for Midwest States

As you are aware, the project team is conducting a study to develop deterioration models for the Midwest States under Transportation Pooled Fund Project TPF-5(432). We are currently working on data gathering to develop the analysis dataset to fuel the deterioration modeling task. This is the first step in the process, we anticipate having one-on-one State interviews after receiving the data and digesting so as to further comprehend and discover any State specifics circumstances surrounding your dataset. We will schedule these in the near future.

Data Requested

The following data is requested (electronic files are preferred).

- Inspection practices and coding methods of the DOTs related to element inspection and recording.
- State definitions of elements and coding practices for consistency and applicability.
- All available Component and Element-Level data and information from the DOTs. This may also include historic CoRE Element information as well as available. A database is the preferred format.
- Non-destructive Evaluation (NDE) data and information. A database is the preferred format.
- Construction history data. A database is the preferred format.
- Relevant DOT policies and practices related to bridge construction, preservation and maintenance as appropriate.
- The current deterioration curves that a State has generated along with the documented assumptions used to generate the curves.

Please include a file(s) with appropriate metadata so that we can understand the contents of the data.

Deadline

Please submit this data by Month/Date/Year. (3 weeks)

Submittal Process

A large file transfer site has been setup with folder with your State name at the following URL XXXXXXX.
The login instructions are as follow:

Login instructions - working on this

Please place the information and data in your specific State folder.

Contact

Please contact Dr. Richard Boadi (Richard.Boadi@woodplc.com, 703-477-8367 cell) with any questions that you have and let him know after you have uploaded your information.

Figure 2. Data Request

Note: During review of the proposal the following concern was raised—please do not exclude collection of any elements or bridges. We would like a repository of all NBI and Element Level data for all bridges within each participating state. Data may be cleaned or excluded to create a "refined" dataset for analysis, but the raw dataset must be preserved. Processes used to refine the raw data should be documented and automated whenever possible. Both the raw data set and the refinement processes should allow for future updates based on new inspection data and new inspection practices, respectively. The project team agrees with this statement and will work to develop a holistic dataset that can be used for future modeling based on new information and inspections.

Task 3.4 – Determine Method to Collect Construction History Data

This subtask will be concerned with determining each State's construction history practices and available data. It is expected that these processes will vary widely among the DOTs. Like the previous tasks, gathering this information will be included in the literature review task, so we will not be starting from scratch. We will evaluate the data gathered and decide, along with the TPF TAC, on how to proceed with gathering and integrating all of this data into a cohesive dataset.

Task 3.5 – Collect State DOTs Construction/Preservation/Maintenance Practices

We will collect data from the DOTs. To do this, we will again provide specific instructions to be followed by the participating DOTs so as to collect this data efficiently and effectively. This includes examining state DOT preservation policies and inspection policies for bridges, as they may relate to this project. This would also include reviewing existing guidance State DOTs have correlating non-destructive test inspection data to NBI Component and Element-Level conditions. We will put this data into the project-specific database mentioned earlier.

Note: During review of the proposal the following concern was raised—the researcher should not rely completely on the instructions they develop and needs to talk with and reviews the DOT websites, so they have an idea of what data is readily available. This needs to be done in case a state does not supply them with data, they know to follow-up and keep trying to get the data instead of giving up on it. The project team agrees with this statement and will keep it in mind during project execution.

Task 3.6 – Evaluate National NBI/NBE Data

To conduct this task, we will extract the NBI and NBE data from the LTBP database. As mentioned previously, our team (specifically Wood) is the prime contractor for the FHWA LTBP InfoBridge development and deployment and as such (with FHWA permission) we have access to the entire dataset and the knowledge on how to extract this dataset from FHWA LTBP InfoBridge.

Task 3.7 – Deliverable: Memorandum Data Collection Processes and Outcomes

The final deliverable of this task will be the populated online project database and a technical memorandum which contains a brief description of the data discovery methods used, the data received, and a description of the project database.

We will place this data into a specially designed MySQL project database. This type of database is open source. Microsoft Access is not a viable alternative for this project because the NBI and NBE datasets are a larger size than Access can handle (NBI is 1.2Gb per year and the NDE dataset is 1.9Gb). This database will be online and available to the TPF TAC on an ongoing basis throughout the project.

Task 3 deliverables are:

- First version of populated project database.
- Technical memorandum.

Note: During the review of the proposal there were concerns raised that more time needed to be allocated to data collection. The level of effort will be evaluated during this task and hours adjusted if necessary to adequately collect the necessary data. This is a foundational aspect of this project and all efforts will be concerned with developing a robust dataset.

Task 4 – Develop Data Screening Procedure

It will be necessary to cleanse the data received from the participating State DOTs such that it is analysis ready. This is an important task as the statement "garbage in garbage out" applies to the generation of deterioration models. At the end of this task, the dataset will be "analysis ready" and will be prepared for deterioration modeling. This is an imperative step to reach the research objectives of this project and not keep circling back to issues in the data when performing the deterioration modeling. The goal is not to produce a perfect data set but to process the data into a useful format to support the analysis.

The leader for this task will be Mr. Thompson with primary support by Dr. Bektaş, Dr. Khatami, and Dr. Boadi.

Task 4.1 – Develop Data Screening Method

Our team has developed data screening methods for previous projects so as to develop an analysis dataset from multiple States. This same process will be used for this project with additional refinements and input from the TPF TAC.

The State DOTs have often used their PONTIS/BrM/Agile Asset/Deighton, etc. databases for more than just bridges. As just one example, one State we have worked with included drainage culverts, sign structures, high-mast light poles, and traffic signal mast arms in their datasets. For the purpose of this analysis, it will be necessary to remove certain objects:

- All agency-defined and customized elements.
- Approach slabs, slope protection elements, and any other elements not found in the list of 100 NBI Bridge Elements (FHWA 2014).
- All bridge deck elements that used the temporary 2001 interim revisions to the AASHTO CoRe Elements.
- Other items deemed not relevant by the TPF TAC.

These redactions will ensure that the deterioration models will faithfully represent the structures that will be analyzed.

It is expected that many agencies vary considerably in their ability to maintain uniform quality control on element data. In particular, the first element inspection cycle attempted by each agency, usually in the mid-1990s, was often treated as a practice run for inspectors in training and for field manuals under development, and was not considered reliable by many of the agencies. In addition, the first and last years of inspections often cover only a part of the inventory: the first year may cover one or more pilot districts within the state, and the final year could reasonably be expected to be still underway and partially complete at the time the database was obtained from the agency. Since these partial cycles are not likely to be random samples of the inventory, they may be deleted.

For element inspections remaining, a variety of quality assurance tests will be performed, which may result in additional deletions. For example, it may be required that the quantities of each element inspection in each condition state sum, over all condition states, to the total quantity indicated for the element.

Note: During review of the proposal the following concern was raised—Exclusion of ADE's or supplemental DOT data may not be the best practice. Instead, this data may need to be cleaned/refined for use. RFP Tier 2 requires deterioration curves for each type of wearing surface. Some DOT's use ADE's to track the specific condition of our wearing surfaces. Other states use the generic 510 wearing surface element will need to be supplemented with NBI item 108A and/or cross-referenced with available construction history. NBI item 108A #6 "Bituminous" may be used for a wide range of wearing surfaces from polymer modified asphalt PMA to regular hot mix asphalt without a membrane. These have very different deterioration curves. A deterioration curve that blindly lumps these wearing surfaces together simply because the data seems to indicate they are the same will produce deterioration curves that are unfit for use. The project team is in agreement with this statement and understand the issues raised. The project team will work with each State to understand their data and how it was collected.

Task 4.2 – Deliverable: Screening Method

We will develop a written screening method based on our experience performing this for other projects in consultation and collaboration with the TPF TAC. Once the screening procedure is agreed to and approved in writing we will implement it in the database we have developed for the project as mentioned in the preceding task. The project team does not intend to delete data as it may have a future use.

At the conclusion of this task, we will have an analysis ready database.

Task 4 deliverables are:

- Draft written screening procedure.
- Final written screening procedure.
- Analysis ready dataset.

Note: During the review of the proposal the following note was made – "We would like to salvage as much data as possible. Please allow for sufficient time to modify/enhance this data by inquiring of state practices, or additional data sources." The project team agrees with this statement and will take it into consideration when conducting the project.

Task 5 – Develop Data Management Policy

For this task, the project team will develop a data management policy beginning with the end in mind—that this dataset can be used by the participating States to develop their own models in future efforts. This method will identify, relate, and preserve key data for bridges used in analysis of generating deterioration curves. Not only that, it will allow States to generate models on their own without impacting the resulting dataset. This is imperative to the overall research effort in that it will empower the States to explore the data themselves and develop their own models without impacting the underlying dataset after this project is over as new or better data (i.e. NDE data) becomes available.

The leader for this task will be Dr. Boadi with primary support by Mr. Thompson and Dr. Khatami.

Task 5.1 – Develop Data Management Policy

The first step in the data management policy is to have a well-defined database. In other words, the database should be self-describing so that any State can examine and understand the database without intervention by the project team. To do that we will have a table description (TD) and a database description (DD) which describe every element in the database, its precision, ranges, etc. We have done this for the LTBP InfoBridge portal (as well as other portals and databases) so that users understand what the database contains.

The next step is determining who has administrative rights to the database. In other words, there will be an online login process and based on the login users will have either administrative rights to change data or read-only rights to examine data. We will need to establish a process on how data gets deleted and added to the system as well. We will need to establish a data-checking process and QC and QA for the database. The data will be scrubbed in a previous task, but this will apply to new data that is added.

The next step in the process will be to design a data manipulation interface. We intend to use an open source program such as "R" to perform the data manipulation analysis. R has many benefits—it is a free program, it is open source, and it can perform a wide variety of functions, such as data manipulation, statistical modeling, and graphics. One particular advantage of R, however, is its extensibility. Developers can easily write their own software and distribute it in the form of add-on packages. Thus, this tool can perform the statistical modeling for this application and it can be easily modified by the States to perform additional analysis.

The last step is to design an interface of the outputs that can be merged seamlessly into BrM, InfoBridge, or another asset management program deployed by the States. As mentioned previously, our team is the prime contractor for the FHWA LTBP InfoBridge deployment and we designed the system interface for input of bridge deterioration models into the portal.

The program can be hosted on an Amazon web services platform for access by any State. In fact, it may be beneficial and add value if this tool was hosted on the FHWA LTBP InfoBridge Amazon Cloud Services platform. This service exists already, will be managed for decades into the future, and does not require any new investment from the participating States. With the authentication process identified earlier, you can limit access to the site as well. Since the project team is the prime contractor for the FHWA LTBP InfoBridge deployment, and the FHWA liaison for this project is also a member of the project panel, we can leverage the relationship to benefit the project.

Task 5.2 – Deliverable: Draft Data Management Policy

At the conclusion of this task we will develop a written draft data management policy for review by the TPF TAC. At the conclusion of the review we will modify the document and issue it as final.

Task 5 deliverables are:

- Draft data management policy.
- Final data management policy.

Task 6 – Develop Tier 1 Deterioration Curves

Once provided approval by the TPF TAC, we will begin the model development task following the modeling approach described immediately preceding the work plan. Because at this point the database will be screened, robust, checked, and ready for analysis, the modeling should be straightforward. In all cases, we will involve the TPF TAC in the deterioration modeling so that they are informed of the inputs, processes, and results as they occur so there are no surprises at the conclusion of the analysis. It is anticipated that multiple webinars will be held during this process to seek feedback on these inputs, processes, and results.

The leader for this task will be Mr. Thompson with primary support by Dr. Bektaş, Dr. Khatami, Dr. Serigos, Dr. Boadi, and Dr. Halfawy.

We will develop the following deterioration curves:

Task 6.1 – Element-Level Deterioration Curves for Reinforced Concrete Deck (RCD)

Task 6.2 – Element-Level Deterioration Curves for Reinforced Concrete Slab

Task 6.3 – Deterioration Curves for NBI Component Items

Task 6.4 – Element-Level Deterioration Curves for RCD after Major Preservation

Task 6.5 – Predicted Improvement in Condition for RCD after Major Preservation

The team will produce deterministic deterioration curves to validate all probabilistic deterioration models.

Task 6.6 – Deliverable: Tier 1 Report

Based on the results of the preceding tasks, we will develop a draft Tier 1 report as the task proceeds. Once all the modeling is completed, we will issue a Tier 1 report which documents the process and results. This will be a brief report of less than 10 pages. We will hold a webinar to discuss the results, although as mentioned previously we intend on holding multiple webinars as the modeling progresses to involve the TPF TAC, so this final Tier 1 webinar should not hold any surprises. It is recognized that we will need approval on the Tier 1 models prior to progressing with the Tier 2 models.

Task 6 deliverables are:

- Draft Tier 1 report.
- Tier 1 webinar.
- Final Tier 1 report.

Task 7 – Develop Tier 2 Deterioration Curves

Once provided approval by the TPF TAC, we will continue the model development task for Tier 2 analyses. Again, in all cases, we will involve the TPF TAC in the deterioration modeling so that they are informed of the inputs, processes, and results as they occur so there are no surprises at the conclusion of the analysis. Like task 6, it is anticipated that multiple webinars will be held during this process to seek feedback on these inputs, processes, and results.

The leader for this task will be Mr. Thompson with primary support by Dr. Bektaş, Dr. Khatami, Dr. Serigos, Dr. Boadi, and Dr. Halfawy.

We will develop the following deterioration curves:

Task 7.1 – Element-Level Deterioration Curves for Wearing Surfaces

Task 7.2 – Element-Level Deterioration Curves for Deck Joints

Task 7.3 – Deterioration Curves for Defect Development and Progression

Task 7.4 – Deterioration Curves for Paint System Effectiveness

Task 7.5 – Defect Deterioration Curves for Steel Girder Corrosion

Task 7.6 – Element-Level Deterioration Curves for Substructure Elements in Harsh Environments

The team will produce deterministic deterioration curves to validate all probabilistic deterioration models.

Task 7.7 – Deliverable: Tier 2 Report, Including Updated Work Plan for Tier 3

Based on the results of the preceding tasks, we will develop a draft Tier 2 report (also known as the Interim Report) as the task proceeds. Once all the modeling is completed, we will issue an Interim report which documents the process and results for Tier 1 and Tier 2. We will hold a webinar to review the interim report. It is recognized that we will need approval on the Tier 2 models prior to progressing with the Tier 3 models.

Task 7 deliverables are:

- Draft Interim Report discussing Tier 1 and Tier 2 analysis.
- Webinar.
- Final Interim Report.

Task 8 – Develop Tier 3 Inputs

Once provided approval of the work plan by the TPF TAC, we will commence the Tier 3 tasks. Again, in all cases, we will involve the TPF TAC in the task so that they are informed of the inputs, processes, and results as they occur so there are no surprises at the conclusion of the analysis. Like task 6 and 7, it is anticipated that multiple webinars will be held during this process to seek feedback on these inputs, processes, and results.

The leader for this task will be Mr. Thompson with primary support by Dr. Bektaş and Dr. Khatami.

We will perform the following:

Task 8.1 – Identify Agency-Defined Elements

For this task we will identify any agency-defined elements (ADE) that would be of use for other Midwest DOTs to consider adopting. This will first be identified during the literature review, survey, and directed interviews in task 2. However, we will interact with the TPF TAC to determine which elements to advance further and provide detailed instructions for other DOTs on how to collect the data, the data to be captured, and the format of the data.

Task 8.2 – Determine NDE Translation

In this task we will determine what type of inspection information related to Nondestructive Evaluation (NDE) Midwest DOTs have and how it is used that translates into information on element-level defects (Ground Penetrating Radar, Infrared Thermograph, or other). These items will likely be identified during task 2, but we will work with the TPF TAC to boil them down into promising technologies that will translate into information that will have a direct impact on the element-level defects. We will determine which NDE technologies to advance further and provide detailed instructions for other DOTs on how to collect the data, the data to be captured, and the format of the data.

Task 8.3 – Provide Summary of Policy, Guidance, and Practices

For this task we will provide a summary of policy, guidance, and practices that Midwest DOTs employ to relate NDE results to defect reporting (to describe delamination and deterioration) and how DOTs use NDE to make quantifiable inspection and actionable work actions for concrete bridge decks. Most of this information will be obtained during task 2.

Task 8.4 – Deliverable: Tier 3 Report

Based on the results of the preceding tasks, we will develop a draft Tier 3 report as the task proceeds and we will issue a Tier 3 report which documents the results. We will hold a webinar to discuss the results.

Task 8 deliverables are:

- Draft Tier 3 report.
- Tier 3 webinar.
- Final Tier 3 report.

Task 9 – Final Project Deliverables

The final project deliverables will be provided to the TPF TAC two and a half months prior to the end of the project. Sixteen copies and an electronic version will be provided. We will combine all of the previous work into a concise report which will be easily digestible by the TPC TAC and other member States Bridge management staff. As an ancillary benefit, it is also anticipated that it will serve as a guideline for nationwide adoption of bridge deterioration models.

The leader for this task will be Mr. Thompson with primary support by Dr. Boadi and Dr. Khatami.

Task 9.1 – Prepare Draft Project Report

The Wood team will prepare the report using TPF guidelines. As part of this task we will also deliver:

- First generation of select deterioration curves with documented methodology to update these curves and add additional element curves.
- Dataset used to develop deterioration curves and other related products in format that may be used by DOTs for future updates.
- Recommendations to DOTs on what information and format should be collected for future inclusion in deterioration modeling.
- Tools, guidance, and summary of how to make updates to the curves at future dates based on more available information.
- PowerPoint presentation (with speaker notes) to serve as a training tool for DOT Bridge Management staff on the project, development of the models, and how the models can be updated. Consider physical (climate) environmental factors in analytical process.

Task 9.2 – Deliverable: Project Report

The Wood team will submit the final project report at least two and a half months prior to the end of the 24-month project period for the TPF TAC panel to review and provide comments. In addition, the first generation of the deterioration curves, the dataset, and the draft PowerPoint will be submitted.

After the panel has had a chance to review the final report, we will schedule a face-to-face meeting to go over the report and respond to questions and concerns. After a one month review period it is expected to receive comments from the TPF TAC on all of the final deliverables. If a webinar is needed to discuss the review comments the PI will schedule it. All final deliverables will be delivered ten business days later.

Task 9 deliverables are:

- Draft project report including deterioration curves, the dataset, and the PowerPoint presentation.
- Face-to-face meeting to discuss draft deliverables.
- Final project report.
- Final deterioration curves.
- Final dataset.
- Final educational PowerPoint.

Expected Contribution from Partner States and Lead Staff

The expected contribution from those involved in the project is as follows:

Wisconsin DOT (Lead State): WisDOT will serve as the lead agency for this project. As such they will oversee and handle administrative and logistical details of the project with Wood. They will provide direction to Wood. They will also manage the TAC and take progressive actions to obtain deliverable review from the participating States. WisDOT will also provide the Midwest DOT contacts for bridge management data, inspection data, as-built plan data and policy information.

Participating States: The participating States will provide Wood with bridge management data, inspection data, access to as-built plan data (if needed and appropriate) and policy information. Through WisDOT as the lead State, they will interact with the Wood team by answering questions. They will review, comment on, and recommend for approval all project proposals generated through their participation on the TAC and make final decisions of the approval of any project proposal.

In addition, each project partner will review project implementation to make sure project outputs will be useful, review project methodology (including deterioration modeling approach) and provide feedback. It is especially important that they participate in monthly, quarterly or other scheduled teleconferences or any scheduled face-to-face meetings. And lastly they will provide timely review of deliverables - this cannot be overemphasized on a project of this complexity and number of stakeholders.

FHWA – Long Term Bridge Performance (LTBP): Will provide historic NBI and limited element information for the national inventory, and answer questions from Wood.

Wood, as the Prime Contractor: Will provide all of the resources necessary to conduct the project including subcontractors. They will outreach to all participating DOTs to request required bridge data, hold numerous coordination meetings with WisDOT and the participating States to inform them of progress, discuss technical issues, and provide data requests. These meetings will be held in a face-to-face format, by webinar, and by telephone, as appropriate. Mr. Groeger in his role as PI will make sure we are meeting our requirements for deliverables including scope, budget, schedule, and quality. We will prepare quarterly invoices, prepare draft proposals that include work plans and budgets to be presented for review, comment and approval and prepare quarterly and final reports.

Implementation Plan

The following are the expected findings, impacts, and benefits resulting from the project for project stakeholders.

Expected Findings

The project will deliver the following items:

- Literature review which will detail the current state of the practice for bridge deterioration modeling and will include the literature review, a survey, and targeted interviews.
- Data screening procedure. This will allow participating States to help understand the validity of their data and its pros and opportunities for improvement.
- A populated and documented open source database and analysis engine which the States can use to explore and model their data or data from other States in an easy to use interface.
- Tier 1 models.
- Tier 2 models.
- Ties 3 information.

Overall the main thrust of this project is to produce deterioration models to fuel the analysis of bridge performance for selected items.

Stakeholders

All of the participating States will be stakeholders to the outputs of the process. In addition, the knowledge and experience gained through this project will benefit all of the States in the US and provide a starting point for those that do not have deterioration models.

Impact

The activities, tools, practices, policies or methods in partner states that would be impacted by the research findings include:

- Bridge management practices and policies
- Deterioration modeling of bridge components
- Deterioration modeling processes which can be applied to other element level bridge components
- Development of defensible system performance targets
- Development of bridge work plans
- Performance of risk analysis to determine which bridges are more at risk from a condition standpoint
- This project will provide participating States strengths and opportunities of improvement in their data collection polices, procedures, and methods

Expected Benefits

The primary benefit of this project to the participating States is the ability to plug the resultant models into their asset management systems and immediately begin to use the data to make better, data driven decisions. A secondary benefit of this project is the provision of the online database and analysis engine that will be designed for the participating States to run their own analysis at the NBI level or NBE level using their States data, a portion of the participating States data, national data or some other permutation. This will empower the participating States to explore the data and come up with deterioration models as new data are available or new analysis concepts are uncovered.

Timeline

Figure 3 presents the proposed schedule for execution of this project. Our team proposes to complete the project within the 24-month time period specified by the RFP.

The team will use Microsoft Project to track and report project costs and schedules on the project. It is a powerful tool that shows costs and schedule variances to the task level. The use of MS Project reduces project cost and optimizes resource scheduling at Wood because it can be linked to our accounting, costing and billing software. Mr. Groeger is able to download costs and commitments from the system and import into MS Project to provide an accurate and updated status of the project. As project costs are incurred it is possible to determine the earned value progress of a project, a key performance metric. The project schedule contained in this proposal was developed in MS Project and will be used as the starting point for project scheduling. It clearly shows the start and end dates of each task and subtask with dates of project milestones and submittal of deliverables indicated. So that it is readable, it has been formatted to fit two pages.

The schedule is based on an assumed contract start date of September 20, 2019. The schedule also includes a timeframe to allow for TPF TAC review of the final research products. This review period includes a project closeout presentation, TPF TAC review of the draft final report, Wood revisions based on TPF TAC comments, and final submittal of the report.

Figure 3. Project Schedule

ID	Duration	Task Name	Duration	Start	Finish
1					
2	0 days	**Task 0 - Notice to Proceed**	0 days	Mon 12/2/19	Mon 12/2/19
3					
4	**521 days**	**Task 1 - Project Management**	**521 days**	**Mon 12/2/19**	**Mon 11/29/21**
5	8 days	***1.1 Project Launch Meeting - Within this Timeframe (Face-to-Face Meeting)***	8 days	Mon 12/2/19	Wed 12/11/19
6	20 days	1.2 Develop Detailed Work Plan	20 days	Thu 12/12/19	Wed 1/8/20
7	10 days	Develop Draft Work Plan	10 days	Thu 12/12/19	Wed 12/25/19
8	0 days	***Deliverable: Draft Work Plan***	0 days	Wed 12/25/19	Wed 12/25/19
9	10 days	***Pooled Fund Members (PFM) Review (assume 2 week review)***	10 days	Thu 12/26/19	Wed 1/8/20
10	4 days	Finalize Work Plan	4 days	Thu 1/9/20	Tue 1/14/20
11	1 day	***Deliverable: Final Work Plan***	1 day	Wed 1/15/20	Wed 1/15/20
12	521 days	1.3 Develop Quarterly Progress Reports (and invoices)	521 days	Mon 12/2/19	Mon 11/29/21
13	521 days	***1.4 Coordination - Monthly Status Calls***	521 days	Mon 12/2/19	Mon 11/29/21
14	**45 days**	**Task 2 - Literature Review**	**45 days**	**Thu 1/16/20**	**Wed 3/18/20**
15	30 days	2.1 Conduct Literature Review/Survey/Targeted Interviews	30 days	Thu 1/16/20	Wed 2/26/20
16	30 days	2.2 Develop Draft Literature Review/Synthesis Document	30 days	Thu 1/16/20	Wed 2/26/20
17	0 days	***Deliverable: Draft Literature Review Document***	0 days	Wed 2/26/20	Wed 2/26/20
18	10 days	***PFM Review of Draft (assume 2 week review)***	10 days	Thu 2/27/20	Wed 3/11/20
19	5 days	Develop Final Literature Review Document	5 days	Thu 3/12/20	Wed 3/18/20
20	0 days	***Deliverable: Final Literature Review Document***	0 days	Wed 3/18/20	Wed 3/18/20
21	**85 days**	**Task 3 - Data Collection**	**85 days**	**Thu 3/19/20**	**Wed 7/15/20**
22	25 days	3.1 Develop Familiarity with Participating States Inspection and Coding Methods	25 days	Thu 3/19/20	Wed 4/22/20
23	25 days	3.2 Compare State Inspection and Coding Practices	25 days	Thu 3/19/20	Wed 4/22/20
24	20 days	3.3 Collect Data from DOTs	20 days	Thu 4/23/20	Wed 5/20/20
25	50 days	3.4 Determine Method to Collect Construction History Data	50 days	Thu 3/19/20	Wed 5/27/20
26	20 days	3.5 Collect State DOTs Construction/Preservation/Maintenance Practices	20 days	Thu 5/28/20	Wed 6/24/20
27	50 days	3.6 Evaluate National NBI/NBE Data	50 days	Thu 3/19/20	Wed 5/27/20
28	20 days	***3.7 Deliverable: Memorandum Data Collection Processes and Outcomes***	20 days	Thu 5/28/20	Wed 6/24/20
29	10 days	***PFM Review of Draft (assume 2 week review)***	10 days	Thu 6/25/20	Wed 7/8/20
30	5 days	Develop Final Memo	5 days	Thu 7/9/20	Wed 7/15/20
31	0 days	***Deliverable: Final Data Collection Processes and Outcomes Memo***	0 days	Wed 7/15/20	Wed 7/15/20
32	**29 days**	**Task 4 - Develop Data Screening Procedure**	**29 days**	**Thu 7/16/20**	**Tue 8/25/20**
33	15 days	4.1 Develop Data Screening Method	15 days	Thu 7/16/20	Wed 8/5/20
34	0 days	***4.2 Deliverable: Draft Screening Method***	0 days	Wed 8/5/20	Wed 8/5/20
35	10 days	***PFM Review (assume 2 week review)***	10 days	Thu 8/6/20	Wed 8/19/20
36	4 days	Finalize Screening Method	4 days	Thu 8/20/20	Tue 8/25/20
37	0 days	***Deliverable: Final Screening Method***	0 days	Tue 8/25/20	Tue 8/25/20
38	**45 days**	**Task 5 - Develop Data Management Policy**	**45 days**	**Wed 8/26/20**	**Tue 10/27/20**
39	30 days	5.1 Develop Data Management Policy	30 days	Wed 8/26/20	Tue 10/6/20
40	0 days	***5.2 Deliverable: Draft Management Policy***	0 days	Tue 10/6/20	Tue 10/6/20
41	10 days	***PFM Review (assume 2 week review)***	10 days	Wed 10/7/20	Tue 10/20/20
42	1 day	***Meeting to Discuss Data Management Policy and Approach for Tier 1 (Face-to Face Meeting)***	1 day	Wed 10/21/20	Wed 10/21/20
43	4 days	Finalize Data Management Policy	4 days	Thu 10/22/20	Tue 10/27/20

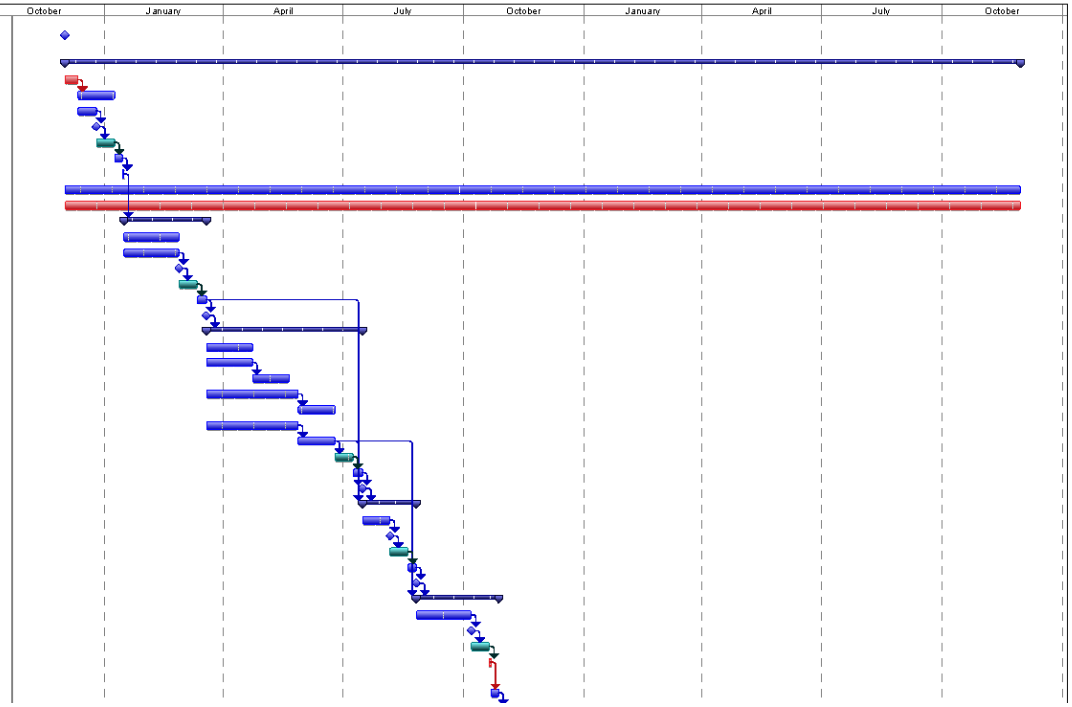
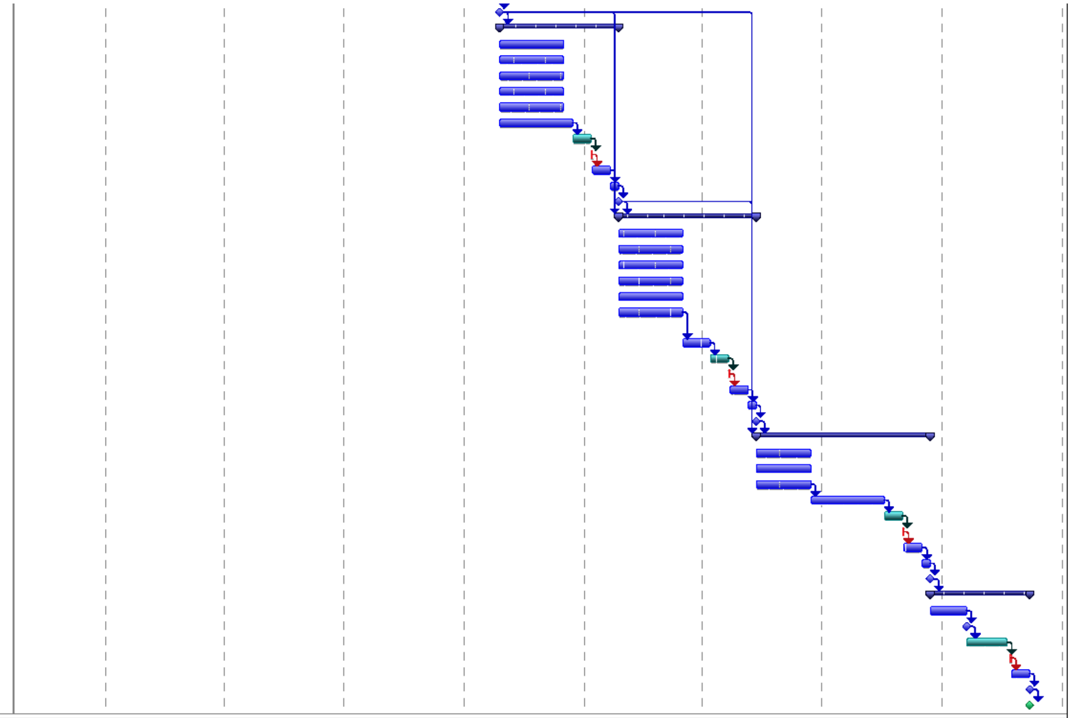


Figure 3. Project Schedule (Continued)

44	0 days	*Deliverable: Final Data Management Policy*	0 days	Tue 10/27/20	Tue 10/27/20
45	**65 days**	**Task 6 - Develop Tier 1 Deterioration Curves**	**65 days**	**Wed 10/28/20**	**Tue 1/26/21**
46	35 days	6.1 Develop Element Level Deterioration Curves for Reinforced Concrete Deck (RFD)	35 days	Wed 10/28/20	Tue 12/15/20
47	35 days	6.2 Develop Element Level Deterioration Curves for Reinforced Concrete Slab	35 days	Wed 10/28/20	Tue 12/15/20
48	35 days	6.3 Develop Deterioration Curves for NBI Component Items	35 days	Wed 10/28/20	Tue 12/15/20
49	35 days	6.4 Develop Element Level Deterioration Curves for RCD after Major Preservation	35 days	Wed 10/28/20	Tue 12/15/20
50	35 days	6.5 Develop Predicted Improvement in Condition for RCD after Major Preservation	35 days	Wed 10/28/20	Tue 12/15/20
51	40 days	*6.6 Deliverable: Draft Tier 1 Report*	40 days	Wed 10/28/20	Tue 12/22/20
52	10 days	*PFM Review (assume 2 week review)*	10 days	Wed 12/23/20	Tue 1/5/21
53	1 day	*Web-based Meeting to Discuss Report*	1 day	Wed 1/6/21	Wed 1/6/21
54	10 days	Rework Analysis If Needed and PFM Review	10 days	Thu 1/7/21	Wed 1/20/21
55	4 days	Finalize Draft Tier 1 Report	4 days	Thu 1/21/21	Tue 1/26/21
56	0 days	*Deliverable: Final Tier 1 Report*	0 days	Tue 1/26/21	Tue 1/26/21
57	**75 days**	**Task 7 - Develop Tier 2 Deterioration Curves**	**75 days**	**Wed 1/27/21**	**Tue 5/11/21**
58	35 days	7.1 Develop Element Level Deterioration Curves for Wearing Surfaces	35 days	Wed 1/27/21	Tue 3/16/21
59	35 days	7.2 Develop Element Level Deterioration Curves for Deck Joints	35 days	Wed 1/27/21	Tue 3/16/21
60	35 days	7.3 Develop Deterioration Curves for Defect Development and Progression	35 days	Wed 1/27/21	Tue 3/16/21
61	35 days	7.4 Develop Deterioration Curves for Paint System Effectiveness	35 days	Wed 1/27/21	Tue 3/16/21
62	35 days	7.5 Develop Defect Deterioration Curves for Steel Girder Corrosion	35 days	Wed 1/27/21	Tue 3/16/21
63	35 days	7.6 Develop Element Level Deterioration Curves for Substructure Elements in Harsh Environments	35 days	Wed 1/27/21	Tue 3/16/21
64	15 days	*7.7 Deliverable: Draft Interim Report including Updated Work Plan for Tier 3*	15 days	Wed 3/17/21	Tue 4/6/21
65	10 days	*PFM Review (assume 2 week review)*	10 days	Wed 4/7/21	Tue 4/20/21
66	1 day	*Web-based Meeting to Discuss Report*	1 day	Wed 4/21/21	Wed 4/21/21
67	10 days	Rework Analysis If Needed and PFM Review	10 days	Thu 4/22/21	Wed 5/5/21
68	4 days	Finalize Draft Tier 2 Report	4 days	Thu 5/6/21	Tue 5/11/21
69	0 days	*Deliverable: Final Interim Report*	0 days	Tue 5/11/21	Tue 5/11/21
70	**95 days**	**Task 8 - Develop Tier 3 Inputs**	**95 days**	**Wed 5/12/21**	**Tue 9/21/21**
71	30 days	8.1 Identify Agency-Defined Elements	30 days	Wed 5/12/21	Tue 6/22/21
72	30 days	8.2 Determine NDE Translation	30 days	Wed 5/12/21	Tue 6/22/21
73	30 days	8.3 Provide Summary of Policy, Guidance, and Practices	30 days	Wed 5/12/21	Tue 6/22/21
74	40 days	*8.4 Deliverable: Draft Tier 3 Report*	40 days	Wed 6/23/21	Tue 8/17/21
75	10 days	*PFM Review (assume 2 week review)*	10 days	Wed 8/18/21	Tue 8/31/21
76	1 day	*Web-based Meeting to Discuss Findings*	1 day	Wed 9/1/21	Wed 9/1/21
77	10 days	Rework Analysis If Needed and PFM Review	10 days	Thu 9/2/21	Wed 9/15/21
78	4 days	Finalize Draft Tier 3 Report	4 days	Thu 9/16/21	Tue 9/21/21
79	0 days	*Deliverable: Final Tier 3 Report*	0 days	Tue 9/21/21	Tue 9/21/21
80	**54 days**	**Task 9 - Final Project Deliverables**	**54 days**	**Wed 9/22/21**	**Mon 12/6/21**
81	20 days	9.1 Prepare Draft Project Report	20 days	Wed 9/22/21	Tue 10/19/21
82	0 days	*9.2 Deliverable: Draft Project Report*	0 days	Tue 10/19/21	Tue 10/19/21
83	23 days	*PFM Review of Draft (assume 4 week review period)*	23 days	Wed 10/20/21	Fri 11/19/21
84	1 day	*Presentation of Draft Final Report (Face-to-Face Meeting)*	1 day	Mon 11/22/21	Mon 11/22/21
85	10 days	Develop Final Project Report	10 days	Tue 11/23/21	Mon 12/6/21
86	0 days	*Deliverable: Final Project Report*	0 days	Mon 12/6/21	Mon 12/6/21
87	0 days	**Milestone: Project Completion**	0 days	Mon 12/6/21	Mon 12/6/21



Utilization of Staff Resources

Table 1 details the number of hours by task committed to the project by each individual member of the research team, including subcontractors, with the Principal Investigator hours indicated.

Table 1. Utilization of Staff / Subcontractor Resources

Individuals	Task 1 - Project Management	Task 2 - Literature Review	Task 3 - Data Collection	Task 4 - Develop Data Screening Procedure	Task 5 - Develop Data Management Policy	Task 6 - Develop Tier 1 Deterioration Curves	Task 7 - Develop Tier 2 Deterioration Curves	Task 8 - Develop Tier 3 Inputs	Task 9 - Final Project Deliverables	Total Hours
Jonathan Groeger - Principal Investigator	80	16	24	16	16	16	16	8	24	216
Pedro Serigos, Ph.D. - Data Scientist	6	0	104	4	4	50	38	0	0	206
Dena Khatami, Ph.D. - Bridge Management Engineer	0	40	120	40	24	110	110	40	80	564
Barbara Ostrom, P.E. - LTBP SME	0	5	0	0	0	8	8	8	0	29
Richard Boadi, Ph.D. - Asset Management Specialist	20	16	100	24	40	40	40	0	80	360
Tess Seidewitz - Technical Editor	0	16	8	8	8	16	16	16	40	128
Jackie McKlveen - Project Controls	70	0	0	0	0	0	0	0	0	70
Paul Thompson - Technical Manager	24	40	64	24	24	80	80	40	40	416
Mahmoud Halfawy, Ph.D., P.E. - Data Engineer	4	0	0	8	8	90	90	0	8	208
Başak Bektaş, Ph.D. - Bridge Management SME	10	44	0	16	8	50	50	40	16	234
Totals	214	177	420	140	132	460	448	152	288	2431

Itemized Budget

Table 2 contains a detailed budget proposed for this project consistent with the Work Plan. The total project budget **is in compliance** with the stated maximum project budget as defined in the RFP. Wood is proposed for 56 percent of the budget. The budget and staffing plan are based on an assumed project start date of September 20, 2019 with 3% escalation applied in 2020 and 2021. Table 3 contains a list of expected travel and travel costs. Table 4, 5 and 6, contain our subconsultants and subcontractors cost detail.

The budget has been organized to reflect the cost associated with each task in the proposal itemized using the template provided by WisDOT including a detailed description of costs related to travel, materials and supplies, and other direct costs.

Wood's indirect cost rate for 2018 has been approved by WisDOT on July 9, 2019 and is 142.68%. A profit of 10% has been applied to Wood salaries. We have included our rate approval letter in Appendix B.

Table 2. Budget Worksheet – Total

Work Effort by Task												
Individuals	**Tasks**									**Total Salaries**	**Fringes**	**Total Salaries and Fringes**
	1 - Project Management	**2 - Literature Review**	**3 - Data Collection**	**4 - Screening Procedure**	**5 - Data Management**	**6 - Develop Tier 1 Curves**	**7 - Develop Tier 2 Curves**	**8 - Develop Tier 3 Inputs**	**9 - Final Project Deliverables**			
Jonathan Groeger - Principal Investigator	$15,871	$3,174	$4,904	$3,269	$3,269	$3,269	$3,368	$1,684	$5,051	$43,861		$43,861
Pedro Serigos, Ph.D. - Data Scientist	$746	$0	$13,317	$512	$512	$6,402	$5,012	$0	$0	$26,502		$26,502
Dena Khatami, Ph.D. - Bridge Management Engineer	$0	$3,733	$11,536	$3,845	$2,307	$10,574	$10,892	$3,961	$7,921	$54,769		$54,769
Barbara Ostrom, P.E. - LTBP SME	$0	$712	$0	$0	$0	$1,173	$1,208	$1,208	$0	$4,302		$4,302
Richard Boadi, Ph.D. - Asset Management Specialist	$2,818	$2,254	$14,511	$3,483	$5,804	$5,804	$5,978	$0	$11,957	$52,609		$52,609
Tess Seidewitz - Technical Editor	$0	$1,010	$520	$520	$520	$1,040	$1,071	$1,071	$2,678	$8,429		$8,429
Jackie McKlveen - Project Controls	$5,572	$0	$0	$0	$0	$0	$0	$0	$0	$5,572		$5,572
TOTALS	$25,007	$10,883	$44,788	$11,629	$12,413	$28,264	$27,529	$7,924	$27,607	$196,043	$0	$196,043
Total Contract Summary												**TOTALS**
Total Salaries and Wages	$25,007	$10,883	$44,788	$11,629	$12,413	$28,264	$27,529	$7,924	$27,607	$196,043	$0	$196,043
Sub-Contracts (Please list each subcontract separately)												
Subcontractor 1 - Paul Thompson (consultant)	$6,000	$10,000	$16,320	$6,120	$6,120	$20,400	$20,800	$10,400	$10,400	$106,560		$106,560
Subcontractor 2 - IDS Consulting	$560	$0	$0	$1,120	$1,120	$12,600	$12,600	$0	$1,120	$29,120		$29,120
Subcontractor 3 - Başak Aldemir Bektaş (consultant)	$1,750	$7,700	$0	$2,800	$1,400	$8,750	$8,750	$7,000	$2,800	$40,950		$40,950
Subtotal	$8,310	$17,700	$16,320	$10,040	$8,640	$41,750	$42,150	$17,400	$14,320	$176,630	$0	$176,630
Other Direct Costs												
N/A										$0		$0
										$0		$0
										$0		$0
Subtotal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Materials & Supplies (List all items over $1000 separately)												
N/A										$0		$0
										$0		$0
Subtotal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Travel (State number of trips and estimated cost/trip)												
Groeger Kickoff Meeting	$ 978.80											$ 978.80
Thompson Kickoff Meeting	$ 976.80											$ 976.80
Groeger Data Management Review Meeting					$ 1,076.80							$ 1,076.80
Boadi Data Management Review Meeting					$ 976.80							$ 976.80
Groeger Draft Final Report Review Meeting									$ 1,076.80			$ 1,076.80
Thompson Draft Final Report Review Meeting									$ 976.80			$ 976.80
Boadi Draft Final Report Review Meeting									$ 976.80			$ 976.80
Subtotal	$ 1,955.60	$ -	$ -	$ -	$ 2,053.60	$ -	$ -	$ -	$ 3,030.40	$ -	$ -	$ 7,039.60
Communications (Printing is required)												
N/A - Printing in included in our overhead										$0		$0
Subtotal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
TOTAL DIRECT COSTS	$35,272	$28,583	$61,108	$21,669	$23,107	$70,014	$69,679	$25,324	$44,957	$0	$0	$379,712
TOTAL INDIRECT COSTS	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		$0
Fixed Fee @ 10%	$2,501	$1,088	$4,479	$1,163	$1,241	$2,826	$2,753	$792	$2,761	$19,604		$19,604
TOTAL CONTRACT COST	$37,773	$29,671	$65,586	$22,832	$24,348	$72,840	$72,432	$26,116	$47,718	$19,604	$0	$399,317

Table 3. Travel Costs

Line #	Destination	Reason for Trip	Employee Name	Travel To/From	Airfare	Hotel Rate Per Day Per FTR	Number of Nights	Total Hotel (Plus 15% Tax)	M/I Per FTR	# of Days M/I Per Diem	Total Per Diem (3/4 for 1st & last day)	Car Rental	Mileage To/From Home Airport	Home Airport Parking	Trans. To/From Dest. Airport	Other	Total
1	Maidson, WI	Project Launch Meeting	Groeger	DC	$600.00	$127.00	1	$146.05	$61.00	1	$45.75	$75.00	$50.00	$12.00	$0.00	$50.00	$ 978.80
2	Maidson, WI	Project Launch Meeting	Thompson	Washington State	$600.00	$127.00	1	$146.05	$61.00	2	$106.75	$0.00	$50.00	$24.00	$0.00	$50.00	$ 976.80
3	Maidson, WI	Data Management Meeting	Groeger	DC	$600.00	$127.00	1	$146.05	$61.00	2	$106.75	$100.00	$50.00	$24.00	$0.00	$50.00	$ 1,076.80
4	Maidson, WI	Data Management Meeting	Boadi	DC	$600.00	$127.00	1	$146.05	$61.00	2	$106.75	$0.00	$50.00	$24.00	$0.00	$50.00	$ 976.80
5	Maidson, WI	Draft Final Report Meeting	Groeger	DC	$600.00	$127.00	1	$146.05	$61.00	2	$106.75	$100.00	$50.00	$24.00	$0.00	$50.00	$ 1,076.80
6	Maidson, WI	Draft Final Report Meeting	Boadi	DC	$600.00	$127.00	1	$146.05	$61.00	2	$106.75	$0.00	$50.00	$24.00	$0.00	$50.00	$ 976.80
7	Maidson, WI	Draft Final Report Meeting	Thompson	Washington State	$600.00	$127.00	1	$146.05	$61.00	2	$106.75	$0.00	$50.00	$24.00	$0.00	$50.00	$ 976.80
																	$ 7,039.60

Table 4. Budget Worksheet – Paul Thompson

Work Effort by Task												
Individuals	Tasks: 1 - Project Management	2 - Literature Review	3 - Data Collection	4 - Screening Procedure	5 - Data Management	6 - Develop Tier 1 Curves	7 - Develop Tier 2 Curves	8 - Develop Tier 3 Inputs	9 - Final Project Deliverables	Total Salaries	Fringes	Total Salaries and Fringes
Subcontractor 1 - Paul Thompson (consultant)	$6,000	$10,000	$16,320	$6,120	$6,120	$20,400	$20,800	$10,400	$10,400	$106,560		$106,560
TOTALS	$6,000	$10,000	$16,320	$6,120	$6,120	$20,400	$20,800	$10,400	$10,400	$106,560	$0	$106,560
Total Contract Summary												**TOTALS**
Total Salaries and Wages	$6,000	$10,000	$16,320	$6,120	$6,120	$20,400	$20,800	$10,400	$10,400	$106,560	$0	$106,560
Sub-Contracts (Please list each subcontract separately)												
												$0
Subtotal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Other Direct Costs												
N/A										$0		$0
										$0		$0
										$0		$0
Subtotal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Materials & Supplies (List all items over $1000 separately)												
N/A										$0		$0
										$0		$0
Subtotal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Travel (State number of trips and estimated cost/trip)												
Thompson Kickoff Meeting	$ 976.80											$ 976.80
Thompson Draft Final Report Review Meeting									$ 976.80			$ 976.80
Subtotal	$ 976.80	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 976.80	$ -	$ -	$ 1,953.60
Communications (Printing is required)												
N/A - Printing in included in our overhead										$0		$0
Subtotal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
TOTAL DIRECT COSTS	$6,977	$10,000	$16,320	$6,120	$6,120	$20,400	$20,800	$10,400	$11,377	$0	$0	$108,514
TOTAL INDIRECT COSTS	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		$0
Fixed Fee @ 10%	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		$0
TOTAL CONTRACT COST	$6,977	$10,000	$16,320	$6,120	$6,120	$20,400	$20,800	$10,400	$11,377	$0	$0	$108,514

Table 5. Budget Worksheet – IDS

Work Effort by Task												
Individuals	Tasks									Total Salaries	Fringes	Total Salaries and Fringes
	1 - Project Management	2 - Literature Review	3 - Data Collection	4 - Screening Procedure	5 - Data Management	6 - Develop Tier 1 Curves	7 - Develop Tier 2 Curves	8 - Develop Tier 3 Inputs	9 - Final Project Deliverables			
Subcontractor 2 - IDS Consulting	$560	$0	$0	$1,120	$1,120	$12,600	$12,600	$0	$1,120	$29,120		$29,120
TOTALS	$560	$0	$0	$1,120	$1,120	$12,600	$12,600	$0	$1,120	$29,120	$0	$29,120
Total Contract Summary												**TOTALS**
Total Salaries and Wages	$560	$0	$0	$1,120	$1,120	$12,600	$12,600	$0	$1,120	$29,120	$0	$29,120
Sub-Contracts (Please list each subcontract separately)												
Subtotal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Other Direct Costs												
N/A										$0		$0
										$0		$0
										$0		$0
Subtotal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Materials & Supplies (List all items over $1000 separately)												
N/A										$0		$0
										$0		$0
Subtotal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Travel (State number of trips and estimated cost/trip)												
Subtotal	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Communications (Printing is required)												
N/A - Printing in included in our overhead										$0		$0
Subtotal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
TOTAL DIRECT COSTS	$560	$0	$0	$1,120	$1,120	$12,600	$12,600	$0	$1,120	$0	$0	$29,120
TOTAL INDIRECT COSTS	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		$0
Fixed Fee @ 10%	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		$0
TOTAL CONTRACT COST	$560	$0	$0	$1,120	$1,120	$12,600	$12,600	$0	$1,120	$0	$0	$29,120

Table 6. Budget Worksheet – Başak Aldemir Bektaş

Work Effort by Task												
Individuals	**Tasks**									**Total Salaries**	**Fringes**	**Total Salaries and Fringes**
	1 - Project Management	**2 - Literature Review**	**3 - Data Collection**	**4 - Screening Procedure**	**5 - Data Management**	**6 - Develop Tier 1 Curves**	**7 - Develop Tier 2 Curves**	**8 - Develop Tier 3 Inputs**	**9 - Final Project Deliverables**			
Subcontractor 3 - Başak Aldemir Bektaş (consultant)	$1,750	$7,700	$0	$2,800	$1,400	$8,750	$8,750	$7,000	$2,800	$40,950		$40,950
TOTALS	$1,750	$7,700	$0	$2,800	$1,400	$8,750	$8,750	$7,000	$2,800	$40,950	$0	$40,950
Total Contract Summary												**TOTALS**
Total Salaries and Wages	$1,750	$7,700	$0	$2,800	$1,400	$8,750	$8,750	$7,000	$2,800	$40,950	$0	$40,950
Sub-Contracts (Please list each subcontract separately)												
Subtotal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Other Direct Costs												
N/A										$0		$0
										$0		$0
										$0		$0
Subtotal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Materials & Supplies (List all items over $1000 separately)												
N/A										$0		$0
										$0		$0
Subtotal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Travel (State number of trips and estimated cost/trip)												
Subtotal	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Communications (Printing is required)												
N/A - Printing in included in our overhead										$0		$0
Subtotal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
TOTAL DIRECT COSTS	$1,750	$7,700	$0	$2,800	$1,400	$8,750	$8,750	$7,000	$2,800	$0	$0	$40,950
TOTAL INDIRECT COSTS	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		$0
Fixed Fee @ 10%	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		$0
TOTAL CONTRACT COST	$1,750	$7,700	$0	$2,800	$1,400	$8,750	$8,750	$7,000	$2,800	$0	$0	$40,950

Qualifications of Research Team

Project Team

Wood is a full-service infrastructure, construction, and environmental firm with more than 90 offices and 3,600 employees nationwide. This geographic coverage means that we have the local presence, facilities, and support staff to conduct projects almost anywhere in the United States. Our firm has a strong transportation business practice with more than 600 transportation professionals, and we currently perform more than $100 million in transportation projects annually. We are ranked number one in the Top 225 International Design firms sector by ENR. We have worked extensively for transportation agencies around the country for the past 60 years, including projects to assess and manage highway and facilities infrastructure (including pavement and bridge management systems) and to improve the overall quality of the nation's transportation infrastructure.

The team will be organized as shown in the organization chart shown in Figure 4. We have included resumes of all staff in Appendix C and these are incorporated by reference herein.

Figure 4. Organizational Chart

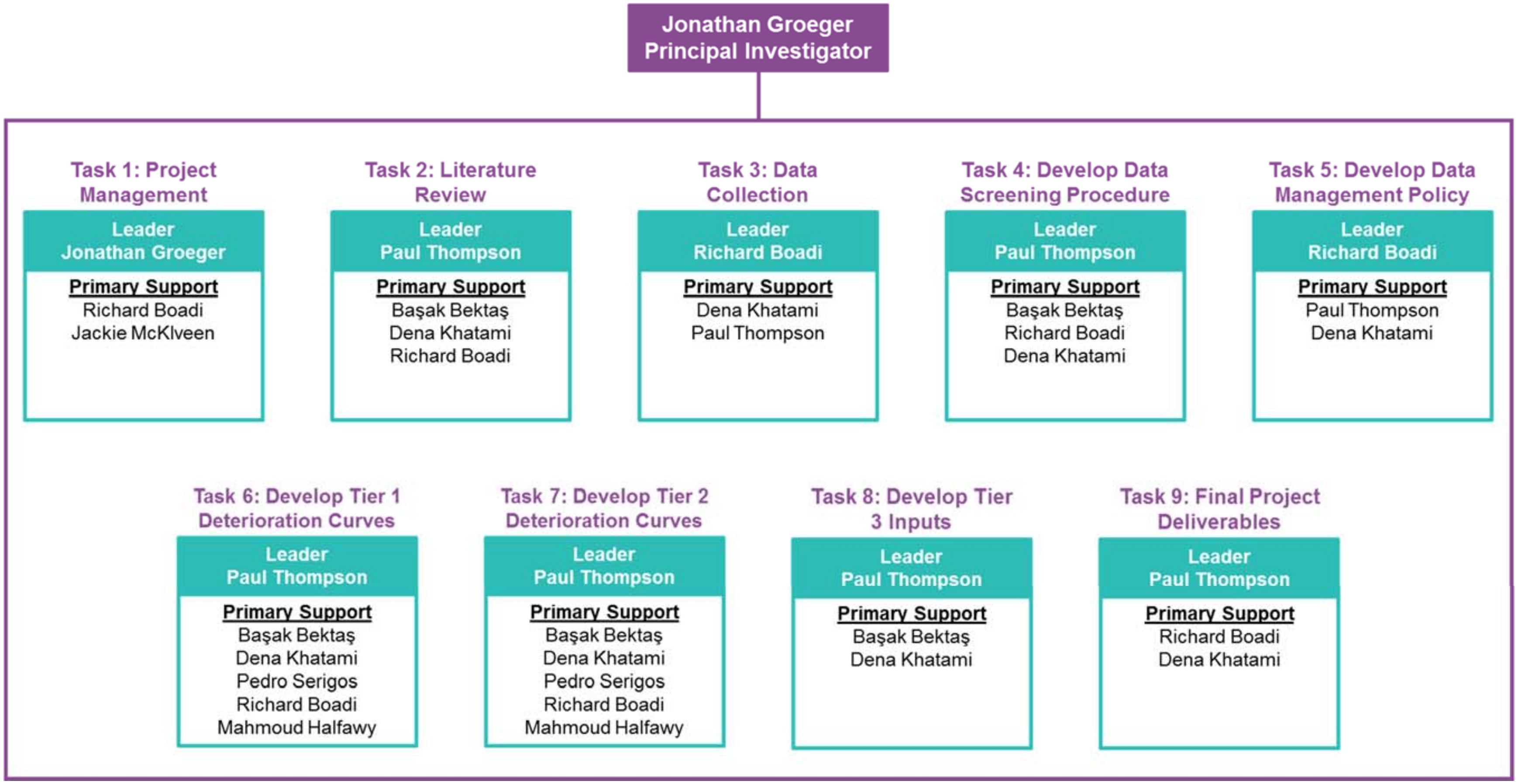


Figure 5. Lead and Primary Support Staffing Matrix

Key Team Members

Jonathan Groeger – Principal Investigator

Mr. Jonathan Groeger will serve in the Principal Investigator (PI) role. Mr. Groeger is a civil engineer with over 30 years of experience in infrastructure design, management, and performance. He has served as a program manager or project manager on numerous FHWA and State DOT projects. He leads diverse teams of civil engineers, information technology professionals, data analysts, designers, and managers in his work. Mr. Groeger currently serves as the Program Manager for the Federal Highway Administration (FHWA) contract to develop the FHWA Long Term Bridge Performance (LTBP) InfoBridge portal. He has been involved in bridge management since 2012, and led the FHWA Infrastructure Health Study which provided input to the performance rules for bridges and pavement in the United States. He has been involved in the development of six Transportation Asset Management Plans, with each containing a bridge management component, and he was previously a certified bridge inspector in the State of Texas. In the PI role Mr. Groeger will be primarily concerned with project management responsibilities.

Mr. Groeger has been a Project Manager for projects involving the following States: South Dakota, Minnesota, Wisconsin, Iowa, Illinois, Kansas, New Hampshire, Vermont, New York, Maryland, Virginia, South Carolina, Louisiana, Arizona, Oregon, New Mexico, Colorado, and Connecticut.

Paul Thompson – Technical Manager

The technical manager for the project will be renowned bridge management expert Paul Thompson. He will be the primary leader for technical activities, supported by a world-class team.

Mr. Thompson is an internationally recognized expert in management systems and engineering economics, including research, design, and development of analytical processes for managing transportation assets. Mr. Thompson is one of the world's leading authorities on bridge deterioration. He has served as a consultant in this area to transportation agencies at the local, State, and national levels worldwide since 1980, and has authored many of the major AASHTO and international guidebooks on asset management implementation. For many years, he served as Chair of the TRB Subcommittee on Bridge Life Cycle Cost Analysis.

Mr. Thompson has been manager and principal architect of the multi-contract implementation program for Pontis (now AASHTOWare Bridge Management – BrM). He has provided customization and implementation support services in connection with Pontis and BrM to more than 25 States and several other countries. He has designed and/or managed development of more than a dozen other bridge, pavement, and transit management systems worldwide. For FHWA, Florida, Alabama, Virginia, Kansas, and British Columbia he has developed bridge element deterioration models using element and condition state inspection data. For FHWA, Florida, Montana, Minnesota, Ohio, Nevada, Texas, Alabama, Kentucky, and British Columbia, as well as in NCHRP-Report 590, he has developed spreadsheet-based life cycle cost models able to evaluate scoping and timing alternatives at the project and network levels.

He was a co-author of Florida DOT's comprehensive study of bridge-related risk in asset management, showing how risk can be integrated into life cycle cost analysis. He was also the developer of Minnesota's Bridge Risk and Improvement Management System. For NCHRP Project 20-07 Task 378 he developed a comprehensive bridge risk analysis able to consider 16 types of potential hazards including earthquake, landslide, storm surge, high wind, flood, scour, wildfire, temperature extremes, permafrost instability, overload, over-height collision, truck collision, vessel collision, sabotage, advanced deterioration, and fatigue. In projects for Alaska, Colorado, Montana, Western Federal Lands, and NCHRP 24-35, he helped to develop the framework for the new field of geotechnical asset management, addressing roadway embankments, unstable slopes, retaining walls, material sites, and rockfall protection systems where risk is a primary concern.

Mr. Thompson was a co-author of the first two editions of the AASHTO Guide for Transportation Asset Management (TAM). He participated in the writing of seven current state risk-based TAM Plans (Minnesota, Ohio, Nevada, Texas, Louisiana, Alabama, and Kansas), and in the first half of 2019 will be assisting in two more (Arizona and Georgia). He is now developing for FHWA a next-generation methodology for implementation of a comprehensive asset management plan, capable of tradeoff analysis across pavements, bridges, and other asset classes. For the Alaska Department of Transportation and Public Facilities, he prepared a Synthesis and Work Plan for Asset Management Implementation which addresses all of the infrastructure assets owned by the department, including roads, bridges, transit, airports, ferries, buildings, and equipment.

Dr. Başak Bektaş – Bridge Management Subject Matter Expert

Dr. Başak Bektaş is a program director at the Iowa State University (ISU) Institute for Transportation (InTrans). She also is an adjunct assistant professor in the Department of Civil, Construction, and Environmental Engineering at ISU. Dr. Bektaş's research experience is on infrastructure asset management with a focus on bridges, pavement and pavement markings, bridge preservation, performance measurement, asset performance modeling, risk and reliability analysis, engineering economic analysis, and transportation safety. Dr. Bektaş has worked on projects that addressed asset management and preservation with the Federal Highway Administration, U.S. DOT, National Cooperative Highway Research Program, Iowa Department of Transportation, Iowa Highway Research Board, Minnesota Department of Transportation, and Wisconsin Department of Transportation. She chairs the Transportation Research Board AHD35 Bridge Management Committee and IRF Asset Management Committee. She is a founding member of AHD37 Bridge Preservation Committee and a member of the AASHTOWare Bridge Management Software Technical Review Team and the Federal Highway Administration Bridge Preservation Expert Task Group. Dr. Bektaş is InTrans's resident statistical expert, and she is experienced in applying statistical methods and data mining to a variety of transportation problems. Bridge data analytics has been central to Dr. Bektaş's research over the years. She has developed a mapping algorithm between element condition data and NBI condition ratings, developed time-dependent NBI condition rating deterioration models for Iowa, and led NCHRP Project 20-07 Task 397, "Characteristics of Decommissioned Bridges", which analyzed historic NBI data to identify main drivers of bridge decommissioning. Her current work includes development of deterioration and treatment efficiency models for Wisconsin, South Dakota, Michigan, and Minnesota for a WHRP project. She will support the technical manager and provide technical leadership to the team.

Support Staff

The project will be supported by several people. These are:

Dr. Pedro Serigos is a data scientist who is an expert in modeling and data visualization. He will assist with setting up the analysis database and the R analysis program needed to analyze the data (more on this can be found in the work plan). He has a master's degree in Statistics and a Ph.D. in Civil Engineering, a unique combination.

Dr. Dena Khatami is a graduate of Iowa State University and a bridge management expert. Dr. Khatami is a structural engineer with over 8 years of experience in modeling the deterioration of bridges considering aging mechanisms and extreme events. She is trained to perform multi-disciplinary projects consisting of design and asset management. She has the ability to apply mathematical and statistical concepts in structural projects. Dr. Khatami has been published and presented technical papers in peer-reviewed journals and academic conferences. She has:

- Modeled the degradation process of bridge elements using statistical modeling (Markovian & Bayesian).
- Simulated the penetration of aggressive ions (e.g. chloride) and corrosion process in bridge reinforced concrete elements using finite element analysis (ANSYS).
- Analyzed 50000+ inspection data sets using MATLAB and R.
- Evaluated risk assessment of bridges with respect to natural hazards such as earthquakes using fragility and hazard curves.
- Developed life-cycle cost estimation for bridge maintenance actions.

She is currently developing NBI and NBE bridge deterioration models for the District of Columbia. Dr. Khatami will provide the bulk of the data gathering and modeling effort for the project under the technical direction of Mr. Thompson.

Dr. Richard Boadi specializes in transportation asset management, risk management, performance management, and data and systems integration to improve decision-making. Specifically, he assists multilevel transportation clients in applying asset management principles to develop long- and short-range investment strategies to support integrated transportation asset management, performance-based planning, and resource allocation, with a principal objective of minimizing the life-cycle cost of their assets. He has demonstrated experience in working with multilevel public agencies to improve decision making. Dr. Boadi is actively involved in the transportation asset management community and has an in-depth understanding of TAM requirements pertaining to life-cycle planning. As a senior consultant at Wood, Dr. Boadi is actively assisting several DOTs, including in South Carolina, the District of Columbia, New Hampshire, and Kansas, to develop strategies and identify tools to support life-cycle planning and development of their transportation asset management plans. He has worked on four Transportation Asset Management Plans (TAMP) and is well versed in performance management and the requirements for bridge modeling and the need for bridge deterioration models in the context of a TAMP.

Ms. Barbara Ostrom, P.E. serves as the FHWA LTBP InfoBridge database engineer and customer support source. She knows how to extract the data from the FHWA LTBP InfoBridge portal and will assist with gathering this important dataset. As part of the LTBP InfoBridge team she is the on-site interface between the development team and the FHWA, database engineer for design of the LTBP Information Management System, data integrator for the deterioration models, responsible for answering all data requests for LTBP datasets, key staff for design and implementation of new features, customer support services center personnel for LTBP, and responsible for review and documentation of incoming datasets for deviation from standards.

Dr. Mahmoud Halfway, P.E. is the founder and Asset Management Lead at IDS, specializing in the asset management and sustainability of infrastructure systems. He is the lead architect of the award-winning Asset OptimizerTM software. He holds a Ph.D. from Ohio State University (1998), and is a licensed Professional Engineer and certified Project Management Professional. Over a career spanning over 30 years, he has successfully directed large and multi-disciplinary asset management projects. He has experience covering major infrastructure asset types such as transportation, municipal, transit, ports, airports, and facilities. His consulting and research work culminated in the development of innovative solutions for optimized management and renewal planning of infrastructure assets.

Before founding IDS in 2012, he served as a Senior Research Officer and Group Leader since 2004 at the Center of Sustainable Infrastructure Research, National Research Council Canada. He also served as Bridge Research Engineer at the Center of Transportation Research and Education at the Iowa State University, USA and as Engineering Scientist at EMH&T Inc., Ohio, USA. He is an adjunct professor at the University of Regina, and authored/co-authored over 65 publications on various topics related to infrastructure management and the applications of new technologies to solve asset management problems. is also a data scientist who has developed tools to model bridge deterioration. He is the lead architect of the award-winning Asset OptimizerTM software. He will assist with formulating the proper analysis of each deterioration curve.

The project will be supported by Ms. Tess Seidewitz as the Technical Editor. She has a B.A. in English and extensive experience in editing technical manuscripts. Ms. Jackie McKlveen will provide the management of subcontractors/consultants and the invoicing for the project.

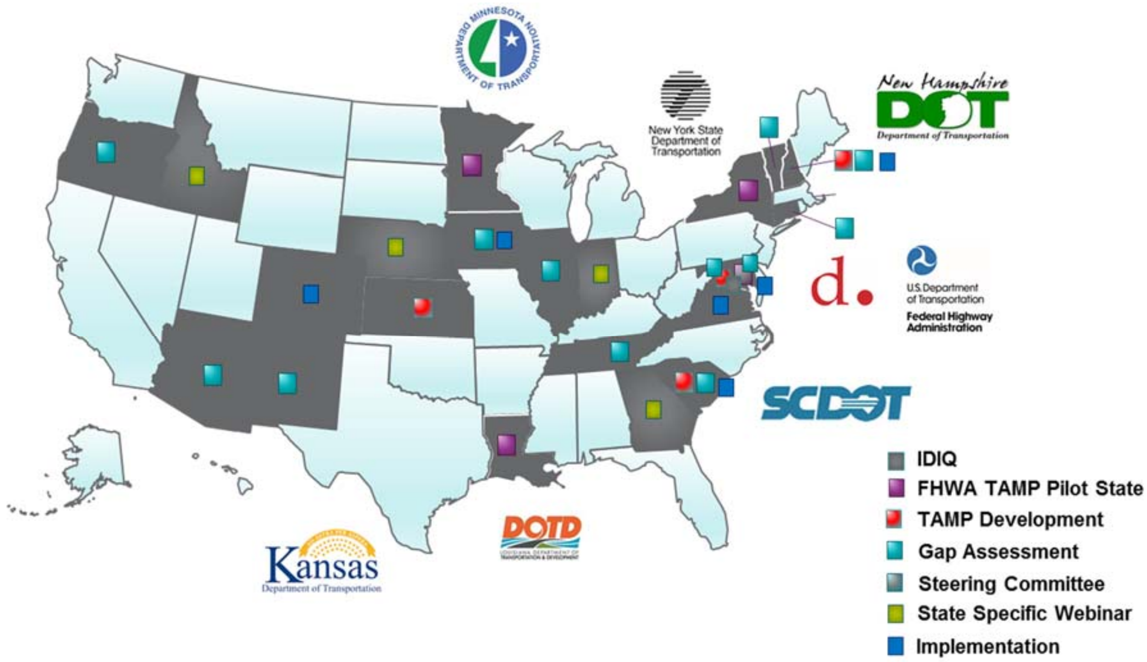
The research team has the necessary technical skills, breadth, depth, and capacity to perform the project. Wood has been involved in other Transportation Pooled Fund efforts and we understand the requirements of this special arrangement.

Team Experience

The following portions of this proposal outline various projects that the constituent team members have worked on that are relevant to this RFP.

Wood Environment & Infrastructure Solutions, Inc.

The following map depicts work Wood (and specifically the Beltsville office proposed for this project) has performed on Transportation Asset Management in the past seven years. All of these projects were managed by Mr. Groeger. Most of these projects contained a bridge deterioration component or involved developing bridge financial plans and investment strategies.



The following are select project summaries from this experience.

Transportation Asset Management Plan (TAMP) for Pavement, Bridges, and Tunnels, District Department of Transportation

Wood is assisting the District of Columbia DOT with the development of a TAMP, as required by the Moving Ahead for Progress in the 21st Century Act (MAP-21). The scope of work includes project management, TAM analyses, meeting coordination with staff and stakeholders to develop risk management plans, performance targets, financial plans, technical analysis for project development and delivery to achieve performance targets, plan preparation and editing, and implementation of the plan. As part of the TAMP, we developed a complete set of deterioration curves using NBI data so as to model the performance targets established by the District. We are currently developing NDE models as well.

LTBP InfoBridge Development, Technical Support Services Contract Work Order Number 5, Federal Highway Administration

The objectives of this task order were: 1) to develop the LTBP InfoBridge Information Management System (IMS), and 2) to maintain and enhance the LTBP InfoBridge web portal, and to facilitate data uploads and updates. The primary coding of the InfoBridge portal was performed by a subcontractor who was managed by Wood. Based on the work that the Wood team performed, FHWA successfully released the LTBP InfoBridge portal at TRB 2019 to solid reviews. Wood's primary role on this project was manage the work and to serve as the database analyst. In this role, we specified the tables to hold the NBI and NBE data and we created extraction procedures for the visualization of the data. It is through this process that we have an expert knowledge of the underlying data structure of the LTBP InfoBridge portal. Our work continues on this task under a separate task order to update, maintain, and add functionality to the LTBP InfoBridge portal.

Improving FHWA's Ability to Assess Highway Infrastructure Health, Federal Highway Administration

This project focused on a three-state corridor Study in an effort to define a consistent and reliable method to document infrastructure health, with a focus on pavements and bridges on the Interstate System that can be expanded to the National Highway System, and to develop tools to provide FHWA and State DOTs ready access to key information that will allow for better and more complete assessments of infrastructure health nationally. During the course of the project, Wood coordinated with the three States to extract data from their management systems, interacted with a technical working group made up of State DOT personnel, and developed a report that offered multiple recommendations for improvement of data collection procedures, pavement performance analysis enhancements, and collection of HPMS data. Wood also developed prototype good/fair/poor thresholds and metrics for pavements and bridges to report health of the corridor. These recommendations, in part, have already been acted on by FHWA. Wood also developed a prototype pavement and bridge health reporting tool that FHWA is implementing.

Gap Analysis/Information Plan Update, Iowa Department of Transportation

This project focuses on development of a Transportation Asset Management (TAM) Strategic Plan for the Iowa DOT. It involves performing interviews with stakeholders (including bridge management personnel), performing a gap analysis to determine the "as-is" and "to-be" states of TAM in the agency, and development of a 10-year strategic plan to guide TAM efforts into the future.

Development of a Strategic Data Business Plan, Iowa Department of Transportation

The purpose of this Task Order is to assist the Iowa DOT in developing an agency-wide Data Management Strategy and Data Business Plan (Strategic Data Business Plan, SDBP) for assets. A SDBP is a document that outlines a policy-based approach to guide agencies' data management throughout its lifecycle following standards, policies, and procedures that specifically focus on the efficient and effective use of available resources.

Development of Transportation Asset Management Plans by the Louisiana, Minnesota, and New York Departments of Transportation, Federal Highway Administration

FHWA contracted Wood to provide professional support services to support the development of the first MAP-21 compliant TAMPs for the Louisiana, Minnesota, and New York State Departments of Transportation (DOT). The TAMPs continue to serve as three models to be studied or serve as examples by agencies responsible for managing highway infrastructure assets at the state or local level. The developed TAMPs will be implemented to manage the organization's infrastructure so as to cost-effectively achieve the organization's strategic goals in the long-term. All of these TAMPs by their nature involved a bridge management component.

Transportation Asset Management Plan, South Carolina Department of Transportation

Wood assisted the South Carolina DOT with the development of a TAMP, as required by MAP-21. The scope of work included project management, developing project scope, meeting coordination with staff and stakeholders, technical analysis of bridge and pavement assets and performance measures, plan preparation and editing, and implementation of the plan.

Transportation Asset Management Plan, New Hampshire Department of Transportation

Engineering consulting services for the development of a TAMP compliant with the requirements of MAP-21. Services include facilitation, communication, documentation, writing/editing, financial analysis, and data system analysis/development to support the development of the asset management initiatives, including bridge management.

Asset Management Gap Analysis and Outreach Support, Federal Highway Administration

This project entails engineering technical support services, reviewing existing asset information and transportation asset management (TAM) self-assessments for 10 State DOTs, interviewing key State DOT staff, and conducting two workshops per State. The results of these activities were compiled into a gap analysis from which an asset management improvement plan was produced for each State DOT. FHWA took the key findings to incorporate as best practices that can be shared with other key stakeholders. This included a bridge management component for each of the ten States.

Transportation Asset Management Plan, Kansas Department of Transportation

The scope of work consists of engineering consulting services towards the development of KDOT's Transportation Asset Management Plan, compliant with the requirements of MAP-21. In addition to supporting the development of the TAMP, our services included facilitation of meetings and workshops with KDOT staff and stakeholders, communication, writing/editing, technical analysis, and data system analysis to support the development and implementation of the TAMP.

Paul Thompson

Alabama Bridge Deterioration Model

Analyzed Alabama's bridge inspection history and performed statistical analysis to develop a bridge element deterioration model for use in AASHTOWare Bridge Management.

Georgia DOT Asset Management Plan

Assisted in development of a TAMP for Georgia DOT. He focused on life cycle cost analysis, risk management, and the preservation of bridges and culverts.

Arizona DOT Asset Management Plan

Assisted in development of a TAMP for Arizona DOT. He focused on life cycle cost analysis, risk management, and the preservation of bridges and culverts.

New York State Implementation of Element-Level Inspection Data and Analysis

Assisted the Department to incorporate their new element-level bridge inspection data into their performance indexes and decision rules for preservation treatment selection.

Minnesota Bridge Risk-Based Planning System

In a legislatively-mandated study, Mr. Thompson developed in 2010 a set of models and reports in Microsoft Excel, for assessing the resilience of bridges in the face of natural and man-made hazards, including advanced deterioration, scour, fracture criticality, fatigue, overweight trucks, over-height trucks, vehicle collisions, and overtopping by floods. The project included the establishment of service-level definitions for each type of risk, to guide the risk assessment. The state is currently using the system as the basis for the bridge portion of its STIP. In 2018 MnDOT re-engaged Mr. Thompson to incorporate culverts and non-bridge structures into the system.

Kentucky Bridge Needs Analysis

For the Kentucky Transportation Cabinet, Mr. Thompson developed a bridge needs analysis including life cycle cost and risk, to assist in the selection of rehabilitation and replacement projects for a population of small rural bridges across the state.

British Columbia Bridge Needs Analysis

Mr. Thompson analyzed British Columbia's bridge inspection history and performed statistical analysis to develop a bridge element deterioration model. He then incorporated the model into a spreadsheet-based life cycle cost analysis to inform the selection of bridge preservation and risk mitigation projects for future funding.

Kansas DOT Asset Management Plan

Assisted in development of a TAMP for Kansas DOT. He focused on life cycle cost analysis, risk management, and the preservation of bridges and culverts. KDOT also engaged Paul Thompson in a task to develop deterioration models based on element and condition state inspection data to support their BrM implementation.

Use of Element-Level Data in Management of Big Bridges

Pooled-fund study led by Michigan DOT. Mr. Thompson developed a management methodology to adapt element-level bridge inspection data to the special needs of Big Bridges in support of preservation, risk mitigation, and operations.

Transportation Asset Management Plan for Caltrans State Highway Operations and Protection Plan Project Prioritization

Evaluated Caltrans' existing pilot program and developed recommendations for improvements and for implementation. The program uses multi-objective decision analysis (MODA) to establish a uniform framework for prioritization, incorporating all of the agency's major performance objectives as well as life cycle cost and risk. Mr. Thompson's specific focus in the project is in the development of appropriate scoring methods and consistent treatment, across asset classes, of asset condition and resilience using the available quantitative data.

Methodologies to Enable Full Implementation of a Comprehensive Asset Management Plan for FHWA

Developed methodologies to enable full implementation of a comprehensive asset management plan, including trade-off analysis from a common ground among disparate assets that are traditionally individually assessed and managed. Starting from the MAP-21 objectives in 23 USC 150(b), and allowing for State and local variations as well as State and metropolitan transportation plans, the methodology developed a set of performance measures and methods relevant for various cross-asset TAM business processes, particularly needs estimation, levels of service, priority programming, resource allocation, target-setting, and tracking and updating of targets. Methods for computing these measures were documented from existing sources. The methodology uses condition, resilience, and other asset-level data to compute generic cost, risk, and performance quantities, which are then correlated with safety, mobility, environmental sustainability, and other performance concerns. Once a consistent set of cross-asset metrics was developed, a multi-objective decision analysis (MODA) methodology was used to support transparent and repeatable decision criteria.

NCHRP Guide for Assessing Risk in Bridge Management Systems

Developed a guidelines document for incorporating risk management in bridge management systems in NCHRP Project 20-07(378). The hazards addressed in the quantitative worksheet-based methodology include earthquakes, landslides, storm surge, high winds, floods, scour, wildfire, temperature extremes, permafrost instability, overload, over-height collisions, hazardous truck collisions, vessel collisions, sabotage, advanced deterioration, and fatigue. All were addressed in terms of likelihood of service disruption and consequences to cost, safety, mobility, and environmental sustainability.

Benefit/Cost Framework for Federal Land Management Agencies

Developed a set of benefit/cost priority-setting methods, at varying levels of detail, to enable the FLMAs to program risk mitigation activities on their slopes, embankments, and retaining walls. The primary concern for these assets is the risk of service disruption.

Nevada DOT Asset Management Plan

Assisted in development of a TAMP for Nevada DOT. Mr. Thompson focused on life cycle cost analysis, risk management, and the preservation of bridges and culverts.

Ohio DOT Asset Management Plan

Assisted in development of a TAMP for Ohio DOT. Mr. Thompson prepared the life cycle management and risk management aspects of the project, particularly for transportation structures. He also reviewed agency asset management business processes and made recommendations for improvements.

Alabama Transportation Asset Management Plan

Developed the bridge-related portions of the state's risk-based TAMP.

Design of AASHTOWare Bridge Management (BrM) 5.2

Pontis is used by 46 state Departments of Transportation to manage their bridge inventories and inspection programs. It is also used by a majority of these states for project planning, programming, and budgeting. Mr. Thompson was the original project manager, beginning in 1989, while an employee of Cambridge Systematics. He more recently served as the system architect and designer (as a subcontractor to Michael Baker and to Bentley

Systems) for the successor to Pontis, AASHTOWare BrM release 5.2. The new system features an all-new life cycle analysis and optimization framework that combines life cycle cost, condition, safety, mobility, and risk. It includes a re-engineered workflow for developing preventive maintenance programs across corridors and other groups of structures, including non-bridge structures.

Development of Deterioration and Cost Models for the FHWA's National Bridge Investment Analysis System

NBIAS is the investment model used by the Federal Highway Administration to estimate nationwide highway bridge needs. It performs a life cycle cost analysis based on the 600,000 bridges in the National Bridge Inventory. Mr. Thompson was the architect of the original system in 1995 (while an employee of Cambridge Systematics), and returned to the project in 2005 and 2015 to re-calibrate the deterioration and action effectiveness models for the National Bridge Elements.

Rockfall hazard process assessment for Montana DOT

Developed a risk management and life cycle cost framework to enable Montana DOT to prioritize and program rockfall mitigation projects in the maintenance program and STIP.

Geotechnical Asset Management Plan for Alaska DOT

Developed one of the nation's first Geotechnical Asset Management Plans, covering retaining walls, slopes, embankments, and materials sites. The work involved designing the performance management framework including levels of service and risk, drawing on the products of several related studies.

Manitoba Assistance with AASHTOWare BrM Implementation

Reviewed the province's bridge inspection processes and recommended a plan to transition to AASHTO elements for use in BrM.

Washington Legislature, Review of WisDOT Bridge Preservation Needs Analysis

Provided an in-depth review of the data and analysis methods used by the Washington State Department of Transportation to estimate ten-year preservation and maintenance needs. The review was prepared at the request of the Joint Legislative Audit and Review Committee.

Florida DOT AASHTOWare Bridge Management adaptation

Helped Florida DOT to adapt its bridge management data, models, and decision support tools to take advantage of the new capabilities of AASHTO's latest revision of the Pontis bridge management system, AASHTOWare Bridge Management.

Texas DOT Transportation Asset Management Plan

Assisted with the bridge-related portions of TxDOT's MAP-21 mandated TAMP.

Louisiana DOT Transportation Asset Management Plan

Assisted with the bridge-related portions of LaDOTD's MAP-21 mandated TAMP.

Minnesota DOT Asset Management Plan

Assisted in development of a TAMP for Minnesota DOT. Mr. Thompson's focus in the project was on bridges, culverts, stormwater tunnels, and performance forecasting in general for all types of assets covered by the plan.

Massachusetts Bay Transportation Authority State of Good Repair Analysis

Developed deterioration and cost models for MBTA bridges, as a part of the Transit State of Good Repair analysis.

Development of Risk Models for Florida's Bridge Management System

Mr. Thompson developed risk assessment and management models and built them into Florida's existing implemented bridge management tools, which he had developed earlier. The methodology depends on the utility theory and multi-objective optimization approaches developed by Mr. Thompson earlier in NCHRP Project 12-67, which resulted in Report 590. Risk factors for natural hazards are developed from geographic databases maintained by a variety of state and Federal agencies. Risk of failure due to advanced deterioration and fatigue were developed by analyzing inventory and condition data, and adapting the AASHTO fatigue life model for bridge management use.

Bridge Life Cycle Cost Analysis System

For the US Federal Highway Administration Office of Asset Management, Mr. Thompson developed a software package for estimating life cycle costs for bridge alternatives, to support design, widening, rehabilitation, and maintenance decisions. The system incorporates element-level condition data and explicitly models uncertainty. It adapts the methods used in NCHRP Report 483 to modern data and technology.

Michigan DOT Asset Management Analytical Assistance

Developed inventory, condition, and needs assessment matrices for county and city bridges in Michigan.

Development of Bridge Deterioration and Cost Models for Florida's Implementation of the AASHTO Pontis Bridge Management System

Florida DOT had gathered 14 years of valuable bridge inspection and maintenance work accomplishment data since first implementing AASHTO's Pontis Bridge Management System. In this project it put the data to work to estimate new bridge deterioration and cost models, and to develop management guidance for sizing and planning preventive maintenance programs. Mr. Thompson developed the new deterioration models and conducted the life cycle analysis. He applied the methods from NCHRP Project 14-15, which he had developed earlier, to produce models of the effectiveness of bridge maintenance actions using Florida maintenance and contract data.

NCHRP Guide for Estimating Life Expectancies of Highway Assets (NCHRP Project 08-71)

The guide provides a cookbook on the development of life expectancy estimates for a wide variety of transportation assets including culverts, traffic signs, traffic signals, roadway lighting, pavement markings, curbs, gutters, sidewalks, pavements, and bridges. It builds on the survey of practices in NCHRP Synthesis 371 by providing computational methods and examples based on a level-of-service approach to service life definition. Mr. Thompson is the primary author.

Finland Bridge Management System

Mr. Thompson designed the conceptual framework for an all-new bridge management planning and programming system. The new system builds on the capabilities of Finland's existing bridge management system, which Mr. Thompson helped to design 25 years previously and which is still in full-scale use throughout the country. The new system will improve on the old one with modernized analytical processes, geographic analysis and interfaces, and the use of up-to date technology.

Virginia Bridge Management Deterioration Models

Analyzed 14 years of Pontis bridge inspection data to develop statistical models of deterioration suitable for use in the AASHTO Pontis bridge management system.

AASHTO Asset Management Guide, Volume 2: Focus on Implementation (NCHRP Project 08-69)

Volume 2 of the AASHTO Asset Management Guide gives practical guidance, step-by-step instructions, and a rich variety of domestic and international case studies to help transportation agencies improve their asset management capabilities. Mr. Thompson was a co-author, focusing on organizational alignment, performance management, and implementation of analytical methods.

Multiple-Objective Optimization for Bridge Management Systems (NCHRP Project 12-67)

This project developed a new optimization framework to incorporate multiple objectives—such as life cycle cost, condition, mobility, safety, and risk—into a bridge- and program-level analysis. As soon as it was published as Report 590, implementation planning by AASHTO for the Pontis bridge management system immediately began. Mr. Thompson developed the optimization algorithms and a novel digital dashboard system (using Microsoft Excel) for applying and presenting the research results.

Başak Aldemir Bektaş

Advancing the Development and Deployment of BIM-Infrastructure, Federal Highway Administration

The objective of this project is to develop and deliver work for the Office of Infrastructure on "Advancing Building Information Modeling (BIM) for Infrastructure." A series of definition and marketing materials will be developed. The scope also includes organization of a national workshop with broad and diverse attendance of 20-30 stakeholders in order to develop a national strategic roadmap for BIM deployment.

Protocols for Concrete Bridge Deck Protections and Treatments, Wisconsin Department of Transportation

The main objective of this research project is to develop a cost-effective lifecycle treatment plan for preservation of Wisconsin bridge decks. The research team will identify a comprehensive list of strategies through the review of current practice and DOT policies, provide data-driven estimates of performance of treatments and optimum timing with respect to condition and age analyzing historic bridge condition data from WisDOT and other state DOTs, and develop a lifecycle treatment plan based on the research finding and engineering economics principles.

AASHTOWare BrM Bridge Management System Implementation and Operation, Iowa Department of Transportation

Research to develop, implement, and operate an integrated bridge asset management system for the state of Iowa with the objective to enable the Iowa DOT to make objective, cost-effective, and timely decisions regarding bridge maintenance, rehabilitation, and replacement. Recent tasks include development of reliability-based bridge deterioration models, development of bridge action costs, and modeling scour risk.

Life-Cycle Planning for Pavement and Bridge Assets, Federal Highway Administration, Subcontractor to ICF

This new FHWA initiative, Life-Cycle Planning for Pavement and Bridge Assets, builds on the information provided in the LCP guidance by providing more detailed information on developing an LCP process for both pavements and bridges. If authorized by FHWA, the project will also extend to a second phase to include a pilot application of the expanded processes and a webinar to communicate the lessons learned to a large number of asset management practitioners.

National Cooperative Highway Research Program (NCHRP) 20-07/Task 397 Characteristics of Decommissioned Bridges, National Academy of Sciences

The objective of this research project was to determine the driving causes of bridge decommissioning for state highway owned bridges in the United States. Characteristic drivers of bridge replacements were identified by analyzing NBI data, data from agency surveys, and investigation of bridge project records.

Technical Analysis to Support the Bridge Condition Performance Measure, Federal Highway Administration

Analysis of NBI data to show the impacts of proposed NPRM bridge performance measures of Good, Fair, and Poor condition on the national network, and the impact of the expanded National Highway System on bridge population and bridge performance metrics.

Risk-Based Bridge Management: A Methodology to Assess and Incorporate Risk in Decision-Making, MTC/USDOT

Research to define and model regionally relevant bridge hazards and develop a methodology for risk-based prioritization of bridge maintenance, rehabilitation, and replacement projects for sustainable bridge networks.

Next Generation Bridge Management Tools and Inspection, Minnesota Department of Transportation

Research to incorporate the new national bridge element inspection methodology into MnDOT's bridge inspections, migrate historical data, and customize their bridge management tools that are used for developing annual bridge program to fit the new inspection methodology.

Infrastructure Decision Systems (IDS)

Risk-Based Prioritization and Multi-Objective Optimization for Long-Term Network-Level Preservation Planning of Bridges in Iowa, Iowa Department of Transportation

The Iowa Department of Transportation uses IDS services and tools to support the management of state-owned bridge inventory and the development of optimized bridge renewal and asset management programs. IDS developed deterioration models based on historical NBI bridge data. A comprehensive risk model was developed to prioritize bridges based on their sufficiency to remain in service. Costs and benefits models were also developed for a range of renewal actions including preservation, rehabilitation, functional improvement, and replacement actions. Funding needs analysis and bridge improvement programming have been developed through detailed analysis of a number of scenarios over a 5-, 10-, and 20-year planning horizon. Planning scenarios were developed to evaluate the impact of varying funding levels on the condition and risk measures of the bridge inventory, and to evaluate funding needs to achieve required condition and risk targets. The analysis of various scenarios helped to explicitly define performance objectives and constraints and accurately assess funding needs and consequences of alternative scenarios.

Asset Management Services, South Coast British Columbia Transportation Authority (TransLink)

IDS provided asset management services to support the optimization of 10-year capital plans for a number of TransLink asset classes, including asphalt and concrete pavement, escalators, elevators, and hoists. Deterioration and risk models were developed, and asset management plans were created for several budget and performance target scenarios. Advanced data analytics tools were used to analyze and generate reports and GIS layers for most of the asset portfolio of TransLink. Dashboards were used to share analysis results across the organization.

Asset Management Services, AECOM

IDS provided asset management services and software to AECOM to support the development of optimized long-range capital plans for a number of clients spanning multiple sectors. Examples of these clients include the Comox Valley Regional District, BC, the International Atomic Energy Agency, Vienna, and TransLink, BC.

Asset Management Planning Development, City of Vernon, BC, Canada

IDS supported the development of optimized cross-asset management planning for the City of Vernon infrastructure systems including roads, water, wastewater, storm water, and parks. IDS worked with the City to develop 10-year capital plan for all of their assets. Optimal capital plans were developed under a range of scenarios to analyze the trade-offs between various investment strategies and funding levels. A comprehensive risk model and detailed deterioration models for various asset groups were also developed. A comprehensive database of the costs, benefits, and rules of various intervention methods was also developed.

20-Year Renewal Plan Development, City of Regina, SK, Canada

IDS supported the support the development of optimal 20-year renewal plans for the City's water network. Optimal renewal plans were generated under a range of scenarios to analyze the trade-offs between various investment strategies and funding levels. A comprehensive risk model and detailed deterioration models for all water system assets were developed. Annual project lists defined which pipe segment to rehabilitate or replace and which rehabilitation or replacement method to use.

Experiences and References

As required by the RFP, the following five projects are relevant to the research project in question. These have been formatted as per the requirements of WisDOT and include nature of the work, dates, locations, results and client reference contact information.

Transportation Asset Management Plan for Pavement, Bridges, and Tunnels

Contract Information
Client Name: District of Columbia Department of Transportation
Period of Performance: July 2017 – July 2019 (POP for development of TAMP)
Location: Washington, D.C.
Value: $695,138
Client Contact: Wolde Makonnen, P.E., Asset Management Engineer Phone Number: 202-671-4684 Email: Wolde.Makonnen@dc.gov
Performed by: Wood Environment & Infrastructure Solutions, Inc. as prime. **Key Personnel:** Jonathan Groeger as Project Manager, Dr. Richard Boadi as Asset Management Engineer, Dr. Pedro Serigos as Senior Analyst, Dr. Sareh Kouchaki as Pavement Modeler, and Dr. Dena Khatami as Bridge Modeler.

Wood is assisting the District of Columbia DOT with the development of a TAMP, as required by the Moving Ahead for Progress in the 21st Century Act (MAP-21). The scope of work includes project management, TAM analyses, meeting coordination with staff and stakeholders to develop risk management plans, performance targets, and financial plans, technical analysis for project development and delivery to achieve performance targets, plan preparation and editing, and implementation of the plan.

Relevance to this RFP: To develop the TAMP, Wood was tasked with performing the pavement and bridge modeling necessary to predict conditions for a given budget input. This was performed on NBI data and was completed.

Currently, we are modeling bridge deterioration using NBI and NBE data.

LTBP InfoBridge Development, Technical Support Services Contract Work Order Number 5

Contract Information
Client Name: Federal Highway Administration
Period of Performance: May 2018 – May 2019
Location: McLean, Virginia
Value: $648,000
Client Contact: Jane Jiang, Contracting Officer's Representative Phone Number: 202-493-3149 Email: jane.jiang@dot.gov
Performed by: Wood Environment & Infrastructure Solutions, Inc. as prime. **Key Personnel:** Jonathan Groeger as Program Manager and Barbara Ostrom as LTBP InfoBridge Data Engineer.

The objectives of this task order were: 1) to develop the LTBP InfoBridge Information Management System (IMS), and 2) to maintain and enhance the LTBP InfoBridge web portal, and to facilitate data uploads and updates. The primary coding of the InfoBridge portal was performed by a subcontractor who was managed by Wood.

Relevance to this RFP: Based on the work that the Wood team performed, FHWA successfully released the LTBP InfoBridge portal at TRB 2019 to solid reviews. Wood's primary role on this project was manage the work and to serve as the database analyst. In this role, we specified the tables to hold the NBI and NBE data and we created extraction procedures for the visualization of the data. It is through this process that we have an expert knowledge of the underlying data structure of the LTBP InfoBridge portal. Our work continues on this task under a separate task order to update, maintain and add functionality to the LTBP InfoBridge portal.

Development of Transportation Asset Management Plans by the Louisiana, Minnesota, and New York Departments of Transportation

Contract Information
Client Name: Federal Highway Administration
Period of Performance: September 2012 – May 2014
Location: Louisiana, Minnesota, and New York
Value: $445,926
Client Contact: Nastaran Saadatmand, P.E., Asset Management Program Manager Phone Number: 202-366-1337 Email: Nastaran.Saadatmand@dot.gov
Performed by: Wood Environment & Infrastructure Solutions, Inc. as prime. **Key Personnel:** Jonathan Groeger as Project Manager.

FHWA contracted Wood to provide professional support services to support the development of the first MAP-21 compliant TAMPs for the Louisiana, Minnesota, and New York State Departments of Transportation (DOT). The TAMPs serve as three models to be studied or serve as examples by agencies responsible for managing highway infrastructure assets at the state or local level. The developed TAMPs are implemented to manage the organization's infrastructure so as to cost-effectively achieve the organization's strategic goals in the long-term.

Relevance to this RFP: Wood (then Amec Foster Wheeler) developed the template that most DOT TAMPs followed in this project. We assisted with performing first of its kind pavement and bridge modeling to develop financial plans and investment strategies.

Development of Decision Trees to Enhance Decision-Making Process

Contract Information
Client Name: New Hampshire Department of Transportation
Period of Performance: February 2019 – July 2019
Location: Concord, New Hampshire
Value: $45,000
Client Contact: Nicholas Alexander, Director, Asset Management, Performance, and Strategies Phone Number: 603-271-1620 Email: Nicholas.Alexander@dot.nh.gov
Performed by: Wood Environment & Infrastructure Solutions, Inc. as a subcontractor to Cambridge Systematics, Inc. **Key Personnel:** Jonathan Groeger as Project Manager and Pedro Serigos as Data Analyst.

The goal of this work order was to develop decision trees that reproduce the logic followed by the New Hampshire Department of Transportation (NHDOT) pavement management (PM) engineers for selecting when and what surface treatments to apply. These decision trees were developed to be coded into PM Systems (PMS) software based on historical data and information received from NHDOT PM engineers involved in the selection of surface treatments.

The benefits of this project to NHDOT are:

- A modern, state-of-the-art decision tree process that reproduces their current business practices.
- The ability to integrate the decision trees directly into their pavement management system.
- Enhanced, systematic decision making for their highest value asset—their pavements.

Relevance to this RFP: This work demonstrates Wood's ability to work with a client in a collaborative manner to perform detailed data analysis and produce an actionable product for the State.

Development of a Transportation Asset Management Plan

Contract Information
Client Name: South Carolina Department of Transportation
Period of Performance: December 2014 – December 2016
Location: Columbia, South Carolina
Value: $399,881
Client Contact: Kevin L. Gantt, P.E., Asset Management Engineer (now District Engineer) Phone Number: 803-413-7924 Email: GanttKL@scdot.org
Performed by: Wood Environment & Infrastructure Solutions, Inc. as prime. **Key Personnel:** Jonathan Groeger as Project Manager and Richard Boadi as Transportation Asset Management Engineer

Wood assisted the South Carolina DOT with the development of a TAMP, as required by MAP-21. The scope of work included project management, developing project scope, meeting coordination with staff and stakeholders, technical analysis of bridge and pavement performance measures, plan preparation and editing, and implementation of the plan.

Relevance to this RFP: Assistance with bridge performance modeling, financial plan, and investment strategies, to fulfil the requirements of the TAMP.

Appendix A: References

1- AASHTO 1998. AASHTO Guide for Commonly Recognized Structural Elements with 2002 and 2010 Interim Revisions. Washington: American Association of State Highway and Transportation Officials.

2- AASHTO 2013. AASHTO Manual for Bridge Element Inspection. Washington: American Association of State Highway and Transportation Officials.

3- FHWA 1995. Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges. Washing-ton: US Federal Highway Administration. Report FHWA-PD-96-001.

4- FHWA 2014. Specification for the National Bridge Inventory Bridge Elements. Washington: Federal Highway Administration.

5- FHWA 2014. Highway Performance Monitoring System: Field Manual. Washington: US Federal Highway Administration. OMB Control No. 2125-0028.

6- FHWA 2016. Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance. Washington: US Federal Highway Administration.

7- Mirzaei, Z., B.T. Adey, L. Klatter, and P.D. Thompson 2014. Overview of Existing Bridge Management Systems. Inter-national Association of Bridge Maintenance and Safety, Bridge Management Committee.

8- Sobanjo, J.O. and P.D. Thompson 2016. Implementation of the 2013 AASHTO Manual for Bridge Element Inspection: Fi-nal Report. Tallahassee: Florida Department of Transportation. Contract BDK30-977-07.

9- Thompson, Paul D., and John O Sobanjo. 2010. Estimation of enhanced Pontis deterioration models in Florida. Proceedings of IABMAS 2010: The Fifth International Conference on Bridge Maintenance, Safety, and Management, Philadelphia. Rotterdam: Balkema.

10- Consequences of Delayed Maintenance, NCHRP 14-20, Cambridge Systematics Inc., Applied Research Associates, Inc., and Spy Pond Partners, 2011.

11- Development of bridge element deterioration models for Alabama's bridge management system and Transportation Asset Management Plan, Thompson, P., 2018.

12- Deterioration and Cost Information for Bridge Management, Report No.CDOT-2012-4, Hearn, G., 2012.

13- Investigation of Mechanistic Deterioration Modeling for Bridge Design and Management, Report No.CDOT-2017-05, Nickless, K., and Atadero, R., 2017.

14- Enhancement of the FDOT's Project Level and Network Level Bridge Management Analysis Tools, State Sobanjo, J.O., and Thompson, P.D., 2011.

15- Bridge Deterioration Models to Support Indiana's Bridge Management System, FHWA/IN/JTRP-2016/03, Moomen, M., Qjao, Y., Agbelie, B.R., Labi, S., and Sinha, K.C., 2016.

16- Best Practice in Bridge Management Decision-Making, Scan 07-05, American Association of State Highway and Transportation Officials, Weykamp, P., Kimball, T., Hearn, G., Bruce V. J., Ramsey, K., D'Andrea, A., and Becker, S., 2009.

17- A Process for Systematic Review of Bridge Deterioration Rates, Michigan Department of Transportation, Kelley, R., 2016.

18- Determining Economic Strategies for Repair and Replacement of Low Slump Overlays of Bridge Decks, Zimmerman, J., Olson, S., and Schultz,A. Minnesota Department of Transportation, 2007.

19- Developing Deterioration Models for Nebraska Bridges, Hatami,A. and Morcous, G. Nebraska Department of Roads, 2011.

20- Life-Cycle Assessment of Nebraska Bridges, Hatami,A., and Morcous, G. Nebraska Department of Roads, 2013.

21- Determination of Bridge Deterioration Models and Bridge User Costs for the NCDOT Bridge Management System, FHWA/NC/2014-07, Cavalline, T., Whelan, M., Tempest, B., Goyal, R., and Ramsey, J., North Carolina Department of Transportation, 2015.

22- Bridge Element Deterioration Rates, New York State Department of Transportation, Agrawal, A., and Kawaguchi, A., 2009.

23- Bridge Deck Cracking: Effects on In-Service Performance, Prevention, and Remediation, FHWA-PA-2015-006-120103, Pennsylvania Department of Transportation, Hopper, T., Manafpour, A., Radlinska, A., Warn, G., Rajabipour, F., Morian, D., and Jahangirnejad, S., 2015.

24- Bridge Element Deterioration of Concrete Substructures, WA-RD 893.1, Washington State Department of Transportation, O'Leary, M., and Walsh, J., 2018.

25- Developing Wyoming Specific Bridge Deterioration Models for Bridge Management, Wyoming Department of Transportation, Cortez, P., and Maguire, M., 2014.

26- AASHTOWare Bridge Management User Manual, version 6.

27- Methodology of Homogeneous and Non-Homogeneous Markov Chains for Modelling Bridge Element Deterioration, Michigan Department of Transportation, Fu, G., and Araj, D., 2008.

28- Culvert Asset Management Practices and Deterioration Modeling, Salam, O., Salman, B., and Najafi, M., Transportation Research Record: Journal of the Transportation Research Board, No. 2285, Transportation Research Board of the National Academies, Washington, D.C., 2012, pp. 1–7.

29- Modeling Bridge Deterioration Using Case-based Reasoning, Morcous, G., Rivard, H., and Hanna, A., *Joyrnal Of Infrastructure Systems*, 2002, 8(3), pp. 86-95.

30- Artificial Neural Network Model of Bridge Deterioration, Huang, Y., Journal of Performance of Constructed Facilities, 24(6), 2010.

Appendix B: Wood WisDOT Rate Approval Letter

WISCONSIN DEPARTMENT OF TRANSPORTATION

DIVISION OF BUSINESS MANAGEMENT

BUREAU OF FINANCIAL MANAGEMENT

MEMORANDUM

TO: ROBERT J. FEIGHERY

FROM: JUSTIN KIEKHAEFER, AUDIT SUPERVISOR

SUBJECT: CFR ACCEPTANCE

DATE: JULY 9, 2019

CC: AUDIT FILES

We have received the Wood Environment & Infrastructure Solutions, Inc. Consultant Financial Report for the year-ended December 31, 2018. Based on our evaluation, your Consultant Financial Report has met the requirements of our Facilities Development Manual 8-5-47.

The indirect cost rates shown below are the approved **provisional maximum rates to be used immediately for estimating** on WisDOT contracts. For rates to be used for invoicing, please see the CARS table included in your approval email.

142.68% Home Office
125.62% Field Office

We have also received the RSM US, LLP audit report of the Wood Environment & Infrastructure Solutions, Inc. indirect cost rates for the year ended December 31, 2018, and the Georgia cognizant acceptance of the audit report and indirect cost rates.

As per 23 U.S.C. § 112(b)(2)(c) and 23 C.F.R. § 172 we are accepting the **cognizant rates to be used during an audit and/or adjustment of closed actual cost projects** (cost plus fixed fee). Actual cost projects are subject to audit and/or adjustment with the invoiced indirect cost rate(s) adjusted to the accepted indirect rate(s) for the applicable period. This may result in **money owed to WisDOT** or to the consultant, not to exceed contract maximums.

Costs included in the direct cost list submitted with the Consultant Financial Report, with the exception of computer usage, software (approved as needed), telephone, temporary agency labor (sub item), and title searches (sub item), are approved to be charged directly to WisDOT projects at actual cost. No markup is allowable per Federal Acquisition Regulations, Part 31.202.

Justin Kiekhaefer, Audit Supervisor
Audit & Contract Administration Section
Justin.Kiekhaefer@dot.wi.gov
(608) 261-6270

Appendix C: Resumes

Jonathan L. Groeger, BSCE, MBA

Summary

Mr. Jonathan Groeger will serve in the Principal Investigator (PI) role. Mr. Groeger is a civil engineer with over 30 years of experience in infrastructure design, management, and performance. He has served as a Principal Investigator, Program Manager, or Project Manager on numerous FHWA and State DOT projects. He leads diverse teams of civil engineers, information technology professionals, data analysts, designers, and managers in his work.

Mr. Groeger currently serves as the Program Manager for the Federal Highway Administration (FHWA) contract to develop the FHWA Long Term Bridge Performance (LTBP) InfoBridge portal. He has been involved in bridge management since 2012, and led the FHWA Infrastructure Health Study, which provided input to the performance rules for bridges and pavement in the United States. He has been involved in the development of six Transportation Asset Management Plans, with each containing a bridge management component, and he was previously a certified bridge inspector in the State of Texas.

Mr. Groeger has been a Principal Investigator/Project Manager for projects involving the following States: South Dakota, Minnesota, Wisconsin, Iowa, Illinois, Kansas, New Hampshire, Vermont, New York, Maryland, Virginia, South Carolina, Louisiana, Arizona, Oregon, New Mexico, Colorado, and Connecticut.

Wood Project Level Experience

LTBP InfoBridge Development, Technical Support Services Contract Work Order Number 5, Federal Highway Administration, Program Manager. The objectives of this task order were: 1) to develop the LTBP InfoBridge Information Management System (IMS), and 2) to maintain and enhance the LTBP InfoBridge web portal, and to facilitate data uploads and updates. The primary coding of the InfoBridge portal was performed by a subcontractor who was managed by Mr. Groeger. Based on the work that the Wood team performed, FHWA successfully released the LTBP InfoBridge portal at TRB 2019 to solid reviews. Mr. Groeger is managing the follow-on work under a separate task order to update, maintain, and add functionality to the LTBP InfoBridge portal.

Proposed Role
Principal Investigator

Years of Experience
30

Academic Background
- MBA, University of Maryland, 2004
- B.S., Civil Engineering, University of Maryland, 1989

Professional Affiliations, Licenses, Designations or National Committee Appointments
- Transportation Research Board, Chair – Committee AFD20 2015–present (member since 2004)
- Transportation Research Board, Member – Committee AFD00, 2015–present

Transportation Asset Management Plan (TAMP) for Pavement, Bridges and Tunnels, District Department of Transportation, Washington, D.C., Project Manager.

- Bridges: The main goal of this study is life cycle analysis for bridges located in the District of Columbia. To ensure the serviceability and safety of identified bridges, the first step is to model the deterioration process and predict the future condition of them. Based on the estimated structural condition of bridges, an optimized plan for maintenance and repair strategies is provided. To this end, various maintenance and repair strategies are taken into account and compared to each other in terms of cost, efficiency, and available budget. The outcome of this study will lead to the development of a systematic plan for the proper allocation of budget invested on bridge repair and retrofit. We are currently working on NBI and NBE element-level bridge modeling to assist with determining the future deterioration of each bridge in the network.
- Pavement: The main goal of this study is proposing a comprehensive pavement prediction and modeling for the District Department of Transportation. The developed performance model is used to provide a cost-effective pavement preservation and maintenance plan. To this end, the data processing and cleaning was performed to categorize the pavement sections into subgroups such as NHS/non-NHS and interstate/non-interstate, and then proposed the best-fitted performance model for different condition pavement matrices for each such groups. The last step was to implement the generated models in the pavement management system (Paver) to find the most efficient maintenance strategies for allocating budget.

Asset Management Improving FHWA's Ability to Assess Highway Infrastructure Health. Project Manager. Played a lead technical role responsible for coordinating all project tasks and deliverables, communication with clients, and financial and contract management. This was a research study to define a consistent and reliable method to document infrastructure health with a focus on pavements and bridges on the Interstate Highway System. This resulted in a first version of the bridge and pavement performance rules later adopted by the FHWA.

FHWA Office of Asset Management, Pavement and Construction, Non-personal, Professional Support Services to Provide Program Support, Nationwide. Program Manager. Responsible for project oversight ensuring client satisfaction through constant communication and producing quality results, management of task orders, budget management and financial compliance, and quality review of project deliverables. Engineering and program support services for a 5-year Blanket Purchase Agreement (BPA) contract to support the program activities for asset management, pavement and construction program, technology transfer, and subject matter expertise.

Data Self-Assessment Workshops. Project Manager. Responsible for facilitating meetings that included 12 state DOTs and a Metropolitan Planning Organization. This included personally making the meeting arrangements for the two workshops, assisting with travel arrangements, meeting facilitation, development of the 508 compliant report (including layout, development, editing, and final publication), and follow-up with FHWA.

Paul D. Thompson

Management Systems • Engineering Economics

17035 NE 28th Place, Bellevue, WA 98008

425-224-5443; pdt@pdth.com

Paul D. Thompson is an internationally recognized expert in management systems and engineering economics, including research, design, and development of analytical processes for managing transportation assets. Mr. Thompson is one of the world's leading authorities on life-cycle planning of infrastructure investments, including optimal funding and timing to keep roads and bridges in service at minimum cost. He has served as a consultant in this area to transportation agencies at the local, state, and national levels worldwide since 1980, and has authored many of the major AASHTO and international guidebooks on asset management implementation.

Mr. Thompson has been Manager and principal architect of the multi-contract implementation program for Pontis (now AASHTOWare Bridge Management – BrM). He has provided customization and implementation support services in connection with Pontis and BrM to more than half of the states and several other countries. He has designed and/or managed development of more than a dozen other bridge, pavement, and transit management systems worldwide. For FHWA, Florida, Alabama, Virginia, and Kansas he has developed bridge element deterioration models using element and condition state inspection data. For FHWA, Florida, Montana, Minnesota, Ohio, Nevada, Texas, Alabama, Kentucky, and British Columbia, and in NCHRP-Report 590, he has developed spreadsheet-based life cycle cost models able to evaluate scoping and timing alternatives at the project and network levels.

He was a co-author of Florida DOT's comprehensive study of bridge-related risk in asset management, and of Minnesota's Bridge Risk and Improvement Management System. For NCHRP Project 20-07 Task 378 he developed a comprehensive bridge risk analysis able to consider 16 types of potential hazards including earthquake, landslide, storm surge, high wind, flood, scour, wildfire, temperature extremes, permafrost instability, overload, over-height collision, truck collision, vessel collision, sabotage, advanced deterioration, and fatigue. In projects for Alaska, Colorado, Montana, Western Federal Lands, and NCHRP 24-35, he has helped develop the framework for the new field of geotechnical asset management, addressing roadway embankments, unstable slopes, retaining walls, material sites, and rockfall protection systems where risk is a primary concern.

Mr. Thompson was a co-author of the first two editions of the AASHTO Guide for Transportation Asset Management (TAM). He participated in the writing of 9 state risk-based TAM Plans. He is now developing for FHWA a next-generation methodology for implementation of a comprehensive asset management plan, capable of tradeoff analysis across pavements, bridges, and other asset classes. For the Alaska Department of Transportation and Public Facilities, he prepared a Synthesis and Work Plan for Asset Management Implementation which addresses all of the infrastructure assets owned by the department, including roads, bridges, transit, airports, ferries, buildings, and equipment.

Mr. Thompson has been Manager and principal architect of the multi-contract implementation program for Pontis (now AASHTOWare Bridge Management – BrM). He has provided customization and implementation support services in connection with Pontis and BrM to more than half of the states and several other countries. He has designed and/or managed development of more than a dozen other bridge, pavement, and transit management systems worldwide. For FHWA, Florida, Alabama, Virginia, and Kansas he has developed bridge element deterioration models using element and condition state inspection data. For FHWA, Florida, Montana, Minnesota, Ohio, Nevada, Texas, Alabama, Kentucky, and British Columbia, and in NCHRP-Report 590, he has developed spreadsheet-based life cycle cost models able to evaluate scoping and timing alternatives at the project and network levels.

Bridge Management	Integration of element inspection data in decision making, New York State DOT
	NCHRP Project 20-07(378) – Assessing risk in bridge management systems
	Management methodology for Big Bridges – pooled fund study led by Michigan DOT
	Design and modeling for FHWA's National Bridge Investment Analysis System (NBIAS)
	Transit bridge deterioration and cost modeling for the Massachusetts Bay Transportation Authority
	Bridge deterioration models for Florida, Virginia, Alabama, Kansas, FHWA, and British Columbia
	Updating of the NCHRP Report 483 Bridge Life Cycle Cost Analysis model for FHWA
	Pontis Bridge Management System for AASHTO and the US Federal Highway Administration
	Design of risk-based bridge management tools for Minnesota and Pennsylvania DOTs
	Development of risk, deterioration, cost models, user cost, and life cycle cost tools for Florida DOT
	Design of the Québec and Ontario bridge management systems
	Technical consultant for the Triborough Bridge & Tunnel Authority (NY) Bridge Management System
	Design of the Massachusetts Bay Transportation Authority (Boston) Bridge Management System
	BMS Design and Development assistance, Switzerland, Sweden, Finland, Manitoba, Ohio, Alabama

Advisor, FHWA Bridge Management Systems Laboratory and Long-Term Bridge Program
Customization of the Florida Project Level Analysis Tool for Maine DOT
Development of Pontis implementation plan for New Jersey DOT
FHWA-sponsored Pontis workshops for the states of ME, NH, VT, MA, RI, CT, NY, NJ, DE, MD, LA, AR, MO, IA, MN, NE, KS, OK, TX, CO, WY, MT, ID, UT, AZ, CA, OR, WA, HI
Locally-sponsored Pontis workshops and training courses for Rhode Island, Illinois, Ohio, Puerto Rico, Switzerland, Hungary, United Kingdom, Spain, Australia, Kuwait
Course designer and lead instructor for NHI Bridge Management Training Courses for South Carolina, Arizona, Washington, Louisiana, Oklahoma, Florida, Texas, Tennessee, and Michigan
Technical support of Pontis implementation for the City of Denver and the States of Maine, Florida, Tennessee, Ohio, Illinois, Michigan, Louisiana, Iowa, and Colorado
Technical support of Stantec Bridge Management System implementation for the Provinces of Ontario, British Columbia, Saskatchewan, Québec, and Nova Scotia and the City of Hamilton
NCHRP 14-15, Development of a national maintenance database for bridges
NCHRP 12-67, Multi-Objective Optimization for BMS
Co-author, AASHTO Guidelines for Bridge Management Systems
NCHRP Synthesis 227, Collecting and Managing Cost Data for BMS
NCHRP 20-07, Bridge Performance Measures
NCHRP 12-50, Bridge Software Validation Guidelines and Examples
NCHRP 12-51, Effect of Truck Weight on Bridge Network Costs

Asset Management

Multi-objective cross-asset TAM Plan implementation methodology for FHWA
Project prioritization methodology for California Department of Transportation
Minnesota, Nevada, Ohio, Texas, Louisiana, Alabama, Kansas, Georgia, Arizona TAM Plans
Alaska Geotechnical Asset Management Plan – retaining walls, slopes, material sites
Montana DOT asset management concepts for rock slopes
Benefit/cost framework for Federal Land Management Agencies for unstable slopes
Alaska DOT&PF Asset Management Gap Analysis, Synthesis, and Work Plan
NCHRP 24-35, Asset Management for Flexible Rockfall Protection Systems
Colorado DOT retaining wall asset management plan
TAM long-term needs analysis process for the Washington State Legislature
NCHRP 20-24(11), Asset Management Guidelines for Transportation Agencies
NCHRP 08-69, Asset Management Volume 2: Focus on Implementation
NCHRP 20-74A, Service Levels for the Interstate Highway System
NCHRP 20-74, Asset Management Plan for the Interstate Highway System
NCHRP 08-71, Life Expectancies of Highway Assets
Final report author, FHWA Management System Integration Committee
Colorado DOT inspection system for sign, signal, and high-mast light pole structures
Asset Management Guidelines, Transport Association of Canada
FHWA peer review panels for national infrastructure needs analysis for the US Congress
Technical consultant, NCHRP 20-64 - TransXML
NCHRP 363, Role of Highway Maintenance in Integrated Management Systems
Finland integrated bridge, pavement, and maintenance management systems
Statewide asset management framework for Michigan
Michigan, Delaware, Puerto Rico, Nova Scotia integrated management systems
Asset costing and performance measures for NJ Transit and Massachusetts Bay Transp Authority

Committees

Central Puget Sound Regional Transit Authority (Sound Transit) Citizen Oversight Panel
Transportation Research Board Committee on Asset Management
Emeritus Member, Transportation Research Board Committee on Bridge Management
Chair, Transportation Research Board Subcommittee on Bridge Life Cycle Cost Analysis
SHRP2 Reliability Technical Expert Task Group on Statistics, Models and Methods
Editorial Board, Structures and Infrastructure Engineering Journal
International Association for Bridge Maintenance and Safety, Bridge Management Committee

Education

C.S.S., Administration and Management, Harvard University Extension (1987)
M.S., Transportation, Massachusetts Institute of Technology (1982)
B.S., Civil Engineering, University of Washington (1980)

More info

www.pdth.com.

Updated May, 2019

BAŞAK BEKTAŞ, PHD
Program Director, Center for Transportation Research and Education,
Institute for Transportation, Iowa State University

ACADEMIC BACKGROUND

Ph.D. in Transportation Engineering, Iowa State University
M.Sc. in Industrial Engineering, Systems Management, Middle East Technical University, Turkey (ABET accredited)
B.S. in Civil Engineering, Middle East Technical University, Turkey (ABET accredited)

TECHNICAL QUALIFICATIONS

- Program Director (since May 2019)
- Associate Scientist (6/2012-5/2019)
  Institute for Transportation (InTrans), Iowa State University
- Adjunct Assistant Professor (since 9/2014)
  Department of Civil, Construction and Environmental Eng., Iowa State University
- Research Associate (5/2010-6/2012)
- Institute for Transportation (InTrans), Iowa State University

Dr. Bektaş has over 10 years of experience in the area of infrastructure asset management and preservation with a focus on bridges and including other infrastructure assets such as pavements and pavement marking. Dr. Bektas has served as the PI on transportation infrastructure projects with the Federal Highway Administration, U.S. DOT, National Cooperative Highway Research Program, Iowa Department of Transportation, Iowa Highway Research Board, Minnesota Department of Transportation and Wisconsin Department of Transportation. Dr. Bektas is InTrans's resident statistical expert and she is experienced in applying statistical methods and data mining to a variety of transportation problems. She chairs Transportation Research Board AHD35 Bridge Management Committee and IRF Asset Management Committee. She is a founding member of AHD37 Bridge Preservation Committee, a member of AASHTOWare Bridge Management Software Technical Review Team and Federal Highway Administration Bridge Preservation Expert Task Group. Dr. Bektas also teaches courses at ISU on infrastructure asset management and engineering economics.

PROJECT MANAGEMENT

- *Advancing the Development and Deployment of BIM-Infrastructure, Federal Highway Administration (FHWA),* 2018-2019.
- *AASHTOWare BrM Bridge Management System Implementation and Operation, Iowa DOT,* since 2011.
- *Led two groups of State DOT engineers on tasks for deterioration modeling and utility functions for multi-objective optimization for AASHTOWare BrM Technical Review Team.*
- *National Cooperative Highway Research Program (NCHRP) 20-07/Task 397 Characteristics of Decommissioned Bridges*, National Academies.
- *Risk-Based Bridge Management: A Methodology to Assess and Incorporate Risk in Decision-Making*, MTC/USDOT, 2014-2017.
- *Next Generation Bridge Management Tools and Inspection*, Minnesota DOT, 2013-2016.

SUBJECT MATTER EXPERTISE

- Infrastructure asset management
- Bridge management
- Bridge preservation
- Transportation data analytics

RELEVANT PROJECT-LEVEL EXPERIENCE

- Bektas, B. A. (PI). Use of Innovative Technology to Deter Bat Bridge Use Prior to and During Construction, Minnesota DOT (2019-2020).
- Advancing the Development and Deployment of BIM-Infrastructure, Federal Highway Administration (FHWA), 2018-2019.
- Development of Next Generation Pavement Performance Measures and Asset Management Methodologies, FHWA, Subcontractor to ApTech, Researcher, (2017-2021).
- Life-Cycle Planning for Pavement and Bridge Assets, FHWA, Subcontractor to ICF, Researcher, (2017-2019).
- Identification of Effective Next Generation Pavement Performance Measures and Asset Management Methodologies to Support MAP-21 Performance Management Requirements, FHWA, Subcontractor to ApTech, Researcher, (2015-2016).
- Bektas B. A. (PI). AASHTOWare BrM Bridge Management System Implementation and Operation, Iowa DOT, 2011-2019.
- Bektas, B. A. (PI). Protocols for Concrete Bridge Deck Protections and Treatments, WisDOT, 2017-2019.
- Bektas, B. A. (PI). National Academies, National Cooperative Highway Research Program (NCHRP) 20-07/Task 397 Characteristics of Decommissioned Bridges, 2017-2018.
- Bektas, B. A. (Co-PI), Smadi, O. (PI) Technical Analysis to Support the Bridge Condition Performance Measure, Task Order with Applied Pavement Technology, Inc., FHWA, 2014-2016.
- Bektas B. A. (PI). Risk-Based Bridge Management: A Methodology to Assess and Incorporate Risk in Decision-Making, MTC/USDOT, 2014-2017.
- Bektas B. A. (PI). Next Generation Bridge Management Tools and Inspection, Minnesota DOT, 2013-2016.

PROFESSIONAL AFFILIATIONS, LICENSES, DESIGNATIONS, OR NATIONAL COMMITTEE APPOINTMENTS

- Chair, TRB Committee AHD35 – Bridge Management (since 2017, member since 2009)
- Member, TRB Committee AHD37 – Bridge Preservation (since 2014)
- Friend, TRB Committee on Asset Management, ABC40
- Friend, TRB Committee on Structures Maintenance, AHD 30, 2010-present
- FHWA Member, Bridge Preservation Expert Task Group
- National Bridge Management Systems Working Group

Pedro Serigos, Ph.D.

Summary

Dr. Serigos is proficient at using software for processing and visualization of data. For example, he is an expert in using the statistical program R to process and create dynamic visualizations of data that can be modified by the user simply by using sliders and check boxes. He is proficient in the use of Tableau and GIS products including ESRI, KML, and R GIS products. Dr. Serigos works with the FHWA and State DOTs on several data collection, analysis, and visualization projects, always looking out for ways data can be used in new and more efficient ways and consumed by the users more readily.

Wood Project Level Experience

Transportation Asset Management Plan (TAMP) for Pavement, Bridges and Tunnels, District Department of Transportation, Washington, D.C.

- Bridges: The main goal of this study is life cycle analysis for bridges located in the District of Columbia. To ensure the serviceability and safety of identified bridges, the first step is to model the deterioration process and predict the future condition of them. Based on the estimated structural condition of bridges, an optimized plan for maintenance and repair strategies is provided. To this end, various maintenance and repair strategies are taken into account and compared to each other in terms of cost, efficiency, and available budget. The outcome of this study was development of a systematic plan for the proper allocation of budget invested on bridge repair and retrofit. Dr. Serigos provided thought leadership to the team that performed the analysis, developed the modeling methodology, and reviewed the outputs of the analysis.
- Pavement: The main goal of this study is proposing a comprehensive pavement prediction and modeling for the District Department of Transportation. The developed performance model is used to provide a cost-effective pavement preservation and maintenance plan. To this end, the data processing and cleaning was performed to categorize the pavement sections into subgroups such as NHS/non-NHS and interstate/non-interstate, and then proposed the best-fitted performance model for different condition pavement matrices for each such groups. The last step was to implement the generated models in the pavement management system (Paver) to find the most

Proposed Role
Data Scientist

Years of Experience
10

Academic Background

- Ph.D., Civil Engineering, University of Texas at Austin, 2016
- M.S., Statistics, University of Texas at Austin, 2015
- M.S., Civil Engineering, University of Texas at Austin, 2012
- Degree, Civil Engineering, University of Buenos Aires, 2009

Professional Affiliations, Licenses, Designations or National Committee Appointments

- Member, American Society of Civil Engineers efficient maintenance strategies for allocating budget. Dr. Serigos provided thought leadership to the team that performed the analysis, developed the modeling methodology, and reviewed the outputs of the analysis.

Maryland State Highway Administration, Pavement Management Services, Statistician. Ongoing pavement management services consisting of individual projects on a task order basis. Dr. Serigos is responsible for a series of ten statistical analyses with MDSHA data. These analyses include performance models, improvement in surface condition caused by the application of different surface treatments, aggregate friction, skid resistance, update of maintenance and rehabilitation decision trees threshold levels, and other topics using very large datasets.

Development of Models and a Framework for a Unified Pavement Distress Analysis and Prediction System (UPDAPS) for Federal Highway Administration, Federal Highway Administration, McLean, Virginia. Data Analyst. The objective of this ongoing study is to gather user requirements, identify and adapt pavement distress analysis models, and develop a framework to implement them in a computer shared library or service that meets the technical requirements for UPDAPS for use within FHWA when using pavement distress data and making predictions of future conditions with or without treatments—i.e., HERS, NAPCOM, PHT, etc. The framework is to serve as a blueprint to implement the pavement distress analysis models in a computer shared library or service that meets the technical requirements for a UPDAPS.

Interstate Pavement Condition Sampling, Federal Highway Administration. Data Analyst / Statistician. Dr. Serigos was tasked near the end of this project with statistical evaluation and peer review of the data collected. In this role, Dr. Serigos contributed a detailed understanding of the representativeness of HPMS data and various factors related to the data. In addition, Dr. Serigos applied advanced statistical methodologies to document an understanding of the effect of pavement condition variability on the reported overall condition ratings.

NCHRP 14-38 Timing of Asphalt-Surfaced Pavements Preservation. Data Analyst. The objective of this research was to develop a guide for identifying the timing for preservation of asphalt-surfaced pavements, considering condition-based and non-condition-based factors. Dr. Serigos is a contributing analyst with the lead analyst, for identification and implementation of advanced modeling and statistical methods.

NCHRP 20-50(19) LTPP Data Analysis: Feasibility of Using LTPP Data to Develop Relationships Between Laboratory- and Field-Derived Properties of Unbound Materials. Data Analyst. The objective of this research is to evaluate the feasibility of using Long-Term Pavement Performance (LTPP) data for developing relationships between laboratory- and field-derived properties of unbound materials used in pavements.

Guidance for Quality Management of Pavement Surface Condition Data Collection and Analysis, Federal Highway Administration. Data Analyst. The objective of this research is to develop Quality Management Plan (QMP) guidelines for pavement surface condition data collection and analysis. This entailed numerous analysis to determine the correct inputs and outputs for the QMP for each individual performance metric.

Dena Khatami, Ph.D.

Summary

Dr. Khatami is a structural engineer with over 8 years of experience in modeling the deterioration of bridges considering aging mechanisms and extreme events. She is trained to perform multi-disciplinary projects consisting of design and asset management. She has the ability to apply mathematical and statistical concepts in structural projects. Dr. Khatami has been published and presented technical papers in peer-reviewed journals and academic conferences. She has:

- Modeled the degradation process of bridge elements using statistical modeling (Markovian & Bayesian).
- Simulated the penetration of aggressive ions (e.g. chloride) and corrosion process in bridge reinforced concrete elements using finite element analysis (ANSYS).
- Analyzed 50000+ inspection data sets using MATLAB and R.
- Evaluated risk assessment of bridges with respect to natural hazards such as earthquakes using fragility and hazard curves.
- Developed life-cycle cost estimation for bridge maintenance actions.
- Written 8 technical manuscripts for publication in peer-reviewed journals and conferences.

Wood Project Level Experience

Transportation Asset Management Plan (TAMP) for Pavement, Bridges and Tunnels, District Department of Transportation, Washington, D.C.

- Bridges: The main goal of this study is life cycle analysis for bridges located in the District of Columbia. To ensure the serviceability and safety of identified bridges, the first step is to model the deterioration process and predict the future condition of them. Based on the estimated structural condition of bridges, an optimized plan for maintenance and repair strategies is provided. To this end, various maintenance and repair strategies are taken into account and compared to each other in terms of cost, efficiency, and available budget. The outcome of this study will lead to the development of a systematic plan for the proper allocation of budget invested on bridge

Proposed Role
Data Scientist

Years of Experience
8

Academic Background

- Ph.D., Civil Engineering, Iowa State University, 2018
- M.S., Civil Engineering, University of Massachusetts, 2014
- B.S., Civil Engineering, University of Tehran, 2011

Professional Affiliations, Licenses, Designations or National Committee Appointments

- Student Member of American Society of Civil Engineering (ASCE)
- Student Member of American Concrete Institute (ACI)

repair and retrofit. Dr. Khatami is currently working on NBI and NBE element-level bridge modeling to assist with determining the future deterioration of each bridge in the network.

- Pavement: The main goal of this study is proposing a comprehensive pavement prediction and modeling for the District Department of Transportation. The developed performance model is used to provide a cost-effective pavement preservation and maintenance plan. To this end, the data processing and cleaning was performed to categorize the pavement sections into subgroups such as NHS/non-NHS and interstate/non-interstate, and then proposed the best-fitted performance model for different condition pavement matrices for each such groups. The last step was to implement the generated models in the pavement management system (Paver) to find the most efficient maintenance strategies for allocating budget.

LTBP InfoBridge Development Task Order 5, Long-Term Pavement Performance, Federal Highway Administration, Nationwide. The main goal of this study was to investigate how to support statistics (and graphing) in InfoBridge when bridge information is duplicated in a selection. Data analysis and evaluation were performed in order to identify border bridges through the connected states, extract the responsibility of each state, and report condition ratings for the bridges. We found that there was an inconsistency between the reported numbers of border bridges by the adjacent states. It was suggested to generate a table of border bridges for use in computations.

Other Experience

Management of Bridges Considering Aging Mechanisms and Extreme Events. Modeled the deterioration process of bridges located in Iowa and predicted the condition state. In addition to considering normal operational conditions, the consequences of sudden extreme events on performance of bridges were considered in the project. Moreover, the uncertainties due to environmental stressors, climate change, and human judgment factors were simulated and their effect on the prediction of condition state of deteriorating bridges were captured. The project was sponsored by the Midwest Transportation Center and Iowa Department of Transportation.

Publications/Presentations

- Khatami, D., Shafei, B., and Smadi, O., (2016), “Management of Bridges under Aging Mechanisms and Extreme Events: A Risk-Based Approach,” Journal of Transportation Research Board, 2550, pp. 89-95.
- Khatami, D., and Shafei, B., “Effect of Environmental Exposure on Deterioration of Infrastructures: Climate Change Impact,” to be submitted to the Journal of Bridge Engineering.
- Khatami, D., Shafei, B., and Bektas, A.B., “Bridging the Gap between Theory and Practice toward An Enhanced Bridge Management System,” to be submitted to the Journal of Infrastructure Systems.
- Khatami, D., Shafei, B., (2016), “Optimized Maintenance Policies for Deteriorating Structures,” Geotechnical and Structural Engineering Congress, Phoenix, AZ, USA: pp. 602-612.

Barbara Ostrom, P.E.

Summary

Ms. Barbara Ostrom, P.E. serves as the FHWA LTBP InfoBridge database engineer and customer support source. She knows how to extract the data from the FHWA LTBP InfoBridge portal and will assist with gathering this important dataset. As part of the LTBP InfoBridge team she is the on-site interface between the development team and the FHWA, database engineer for design of the LTBP Information Management System, data integrator for the deterioration models, responsible for answering all data requests for LTBP datasets, key staff for design and implementation of new features, customer support services center personnel for LTBP, and responsible for review and documentation of incoming datasets for deviation from standards.

Wood Project Level Experience

LTBP InfoBridge Development, Technical Support Services Contract Work Order Number 5, FHWA, Database Manager. The objectives of this task order were: 1) to develop the LTBP InfoBridge Information Management System (IMS), and 2) to maintain and enhance the LTBP InfoBridge web portal, and to facilitate data uploads and updates. Based on the work that the Ms. Ostrom performed, FHWA successfully released the LTBP InfoBridge portal at TRB 2019 to solid reviews. Wood's primary role on this project was manage the work and to serve as the database analyst. In this role, we specified the tables to hold the NBI and NBE data and we created extraction procedures for the visualization of the data. It is through this process that Ms. Ostrom has an expert knowledge of the underlying data structure of the LTBP InfoBridge portal.

LTBP InfoBridge Development, Technical Support Services Contract Work Order Number 6, FHWA, Database Manager. The objectives of this new task order are to further build out the LTBP InfoBridge by enhancing the underlying IMS database, updating the climate data, including 2018 NBI and NBE data, and incorporating deterioration models into the schema. This version will be available at TRB 2020.

Proposed Role
LTBP SME

Years of Experience
41

Academic Background

- M.S., Engineering Management, University of Missouri - Rolla, 1981
- M.S., Civil Engineering, Massachusetts Institute of Technology, 1978
- B.S., Civil Engineering, Massachusetts Institute of Technology, 1978

Professional Affiliations, Licenses, Designations or National Committee Appointments

- Member, Institute of Transportation Engineers
- Member, Transportation Research Board
- Member, Women's Transportation Seminar

Richard Boadi, Ph.D.

Summary

Dr. Boadi has 17 years of combined experience in transportation consulting and project management. Dr. Boadi specializes in transportation asset management, risk management, performance management, and data and systems integration to improve decision-making. Specifically, he assists multilevel transportation clients in applying asset management principles to develop long- and short-range investment strategies to support integrated transportation asset management, performance-based planning, and resource allocation, with a principal objective of minimizing the life-cycle cost of their assets. He has demonstrated experience in working with multilevel public agencies to improve decision making. Dr. Boadi is actively involved in the transportation asset management community and has an in-depth understanding of TAM requirements pertaining to life-cycle planning. As a senior consultant at Wood, Dr. Boadi is actively assisting several DOTs, including South Carolina DOT, the District of Columbia, New Hampshire, and Kansas State, to develop strategies and identify tools to support life-cycle planning and development of their transportation asset management plans.

Proposed Role
Asset Management Specialist

Years of Experience
18

Academic Background

- Doctor of Philosophy (Ph.D.), Civil Engineering, Georgia Institute of Technology, 2015
- Master of Science, Transportation Systems Engineering, Georgia Institute of Technology, 2011
- Certificate of Participation, Advance Infrastructure Management Bootcamp, Atlanta, 2012
- Bachelor of Science, Geodetic Engineering, Kwame Nkrumah Univ. of Science and Technology, Ghana, 2001

Professional Affiliations, Licenses, Designations or National Committee Appointments

- Panel Member, NCHRP Project 08-115, Framework for Designing and Managing Data and Information Workflows for Transportation Assets
- Panel Member, NCHRP Synthesis 51-05 - Practices for Coordinating Asset Management Performance Measurement and Monitoring between State Transportation Agencies and Metropolitan Planning Organizations.
- Panel Member, TCRP Synthesis SE-07 - Risk-Based Maintenance Planning for Rail Asset Managemen.t
- Member, Transportation Asset Management Committee (ABC40), April 2019–present
- Member, American Society of Civil Engineers, Women Transportation Seminar, Institute of Transportation Engineers

Wood Project Level Experience

Transportation Asset Management Plan for District of Columbia DOT, Kansas DOT, South Carolina DOT, and New Hampshire DOT. Asset Management Plan Developer. Services include workshop facilitation, process development, documentation, and data system analysis/development to support the development of the plan. Key responsibilities include researching processes and tools, developing recommendations and strategies, and conducting data analysis to support lifecycle planning. This includes bridge analysis to support development of condition states given various investment levels, financial plans, and investment strategies. Facilitation and coordination of workshops to gather and organize data and information to support content development of the Asset Management Plan.

Transportation Asset Management Services, Iowa DOT. Senior Consultant. The objective of this project is to provide transportation asset management services to the Iowa Department of Transportation (Iowa DOT). Key responsibilities include providing support in developing strategies and plans to improve data management and usage throughout the Department, and providing strategic support to promote and institutionalize asset management practice throughout the organization.

Asset Management Software SME, South Carolina and District of Columbia DOT. Senior Consultant. The objective of this project is to assist the DOTs with the implementation of Asset Management Systems (AMS). The AMS will enable the DOTs to minimize the lifecycle cost of assets included in the TAMP. Key responsibilities include conducting workshops to review and document the capabilities of existing systems, developing additional system requirements for the AMS, assisting in writing a Request for Proposal and evaluating responses, and supporting the Department throughout the system acquisition and implementation process.

Data Self-Assessment Implementation, FHWA, Various Locations, United States. Senior Consultant. Services include supporting FHWA to host two full-day workshops involving 12 state DOTs to assess their level of data capabilities to support agency goals including TAM. Key responsibilities included facilitating workshops to introduce NCHRP data self-assessment tools, leading roundtable discussions, and developing recommendations and reports to facilitate the implementation of the tools. This project is a precursor to developing a Data Business Plan to support TAM and lifecycle planning.

Asset Management Gap Analysis and Outreach Support, FHWA, Various Locations, United States. Senior Consultant. Consulting services to support state DOTs in conducting TAM self-assessment and developing TAM improvement plans to meet MAP-21 requirements. Key responsibilities include summarizing the results of the DOTs self-assessment survey and interviews, assisting the project manager with developing the asset management implementation plan including the development of action items to improve lifecycle planning. This included a bridge management component to each self-assessment.

Every Day Counts (EDC-4) Pavement Preservation When Where Support, FHWA, United States. Senior Consultant. EDC-4 is a program identified in the FAST Act legislation to promote the early adoption of proven technologies in State DOTs. Key responsibilities include composing a comprehensive Synthesis of current practices and a Guide to integrate preservation into agency business to support TAM and LCP.

Publications/Presentations

- Boadi, R. S., J. Groeger, and J. Bryce. Integrating Network-level Lifecycle Cost Analysis into Transportation Asset Management while Addressing Variability and Uncertainty. 12th National Conference on Transportation Asset Management. San Diego, CA, July 14-17, 2018.
- Boadi, R. S., and J. Groeger. Integrating Risk Tolerance and Lifecycle Cost Analysis into the Development of TAM Investment Strategies. 12th National Conference on Transportation Asset Management. San Diego, CA, July 14-17, 2018.
- Boadi, R. S., C. R. Wang, A. Amekudzi, and Y. J. Tsai. Aligning System Performance with Investment Levels: Applying Response Surface Methodology to Manage Program Level Vulnerabilities. 10th National Conference on Transportation Asset Management. Miami, Florida, April 28-30, 2014.

Mahmoud R. Halfawy, Ph.D., P.Eng., PMP

Dr. Halfawy is the founder and Asset Management Lead at IDS, specializing in the asset management and sustainability of infrastructure systems. He is the lead architect of the award-winning Asset Optimizer™ software. Over his 32+ years career, he has successfully directed large and multi-disciplinary asset management projects. He has experience covering major infrastructure asset types such as transportation, municipal, transit, ports, airports, and facilities. Before founding IDS in 2012, he served as a Senior Research Officer and Group Leader at the Center of Sustainable Infrastructure Research, National Research Council Canada. He is an adjunct professor at the University of Regina. Mahmoud authored/co-authored over 65 publications on various topics related to municipal infrastructure management. More information on his background can be found at https://ca.linkedin.com/in/halfawymahmoud

EDUCATION

- Ph.D. (Civil Engineering) The Ohio State University, USA (1998).
- M.Sc. (Civil Engineering) Cairo University, Egypt (1991).
- Graduate Diploma (Operations Research), Cairo University, Institute of Statistical Studies and Research, Egypt, 1992.
- Graduate Diploma (Construction Engineering and Management), Ain-Shams University, Egypt, 1992.
- B.Sc. (Civil Engineering) (With Distinction) Assuit University, Egypt, (1986).

SELECTED RELATED PROJECTS

2014-Present	Iowa Department of Transportation Support the development of Iowa DOT bridge management program. Development of deterioration, risk, and intervention models for Iowa DOT bridge inventory. Development of optimal asset management plans under a range of funding scenarios.
2018	South Coast British Columbia Transportation Authority (TransLink) Provided asset management services to support the optimization of 10-year capital plans for a number of Translink asset classes including asphalt and concrete pavement, escalators, elevators, and hoists.
2018-2019	City of Vernon, BC Provided asset management services to support the Implementation of cross-asset optimization models and software to address all major assets such as roads, water, and parks assets.
2018	International Atomic Energy Agency Development of 10-year optimal capital plans under various scenarios for the entire IAEA asset inventory (approximately 55,000 assets) spanning many different classes.

2019	City of Burnaby, BC Development of deterioration and risk models, and asset management plans for linear assets, including roads, water, sanitary, and storm systems.
2013-2014	Government of Yukon, Highways & Public Works Technical services for the development of 20-year optimal renewal plan for Yukon's highway network.

SELECTED RELATED PUBLICATIONS[1]:

1. Halfawy, M.R., "Cloud-Based Scalable Software for Optimal Long-Range Network-Level Bridge Improvement Programming," Transportation Research Record: Journal of the Transportation Research Board 2017 2612:, 132-140
2. Halfawy, M.R. and Neubauer, S. "Multi-Objective Optimization for Long-Range Bridge Improvement Programming: Iowa DOT Case Study," Transportation Research Board Conference, Washington, D.C., January 7-11, 2018.
3. Halfawy, M.R., "Municipal information models and federated software architecture for implementing integrated infrastructure management environments," Journal of Automation in Construction, 19 (4), July 2010, pp. 433-446.
4. Halfawy, M.R., "Integration of municipal infrastructure asset management processes: challenges and solutions," Journal of Computing in Civil Engineering, 22, (3), May/June, pp. 216-229, May 01, 2008.
5. Halfawy, M.R., Vanier, D.J., Froese, T.M., "Standard data models for interoperability of municipal infrastructure asset management systems," Canadian Journal of Civil Engineering, 33, (12), December, pp. 1459-1469, December 01, 2006
6. Halfawy, M.R., and Wipf, T., "Bridge Rating Through Diagnostic Load Testing and Finite Element Analysis," Final Report Submitted to Iowa Department of Transportation, August 2000.
7. Halfawy, M.R., Froese, T., "Building integrated architecture/engineering/construction systems using smart objects: methodology and implementation," Journal of Computing in Civil Engineering, 19 (2), April, pp. 172-181, April 01, 2005.
8. Halfawy, M.R., Hadipriono, F. C., Duane, J., Larew, R., and Froese, T., "Developing a STEP-Based Core Information Model for Bridges," Proceedings of the 6th International Conference on Short and Medium Span Bridges, Vancouver, BC, Canada, July 31-August 2, 2002.
9. Halfawy, M.R., Wipf, T., Wood, D, Abu-Hawwash, A., and B. Phares "An Integrated System for Bridge Load Testing, Finite Element Analysis, and Rating," Proceedings of the 6th International Conference on Short and Medium Span Bridges, Vancouver, BC, Canada, July 31-August 2, 2002.
10. Halfawy, M.R., Wipf, T., Wood, D, Abu-Hawwash, A., and B. Phares "Bridge Load Rating Using an Integrated Load Testing and Finite Element Analysis Approach: A Case Study," Proceedings of the CSCE 2002 Structural Specialty Conference of the Canadian Society for Civil Engineers, Montreal, Canada, June 5-8, 2002.

[1] *For a complete list of publications, please visit Google Scholar at* *http://scholar.google.ca/citations?user=N0HUtFkAAAAJ&hl=en*

Tess Seidewitz

Technical Qualifications

Ms. Seidewitz is an editor with five years of experience. She has provided editorial support for a variety of documents including technical document editing, proposal support, document formatting, and proofreading. Ms. Seidewitz has extensive experience in reviewing documents for consistency, readability, style, formatting, and grammatical errors, as well as for Section 508 compliance. She is experienced in coordinating with partners and clients to minimalize confusion and ensure the on-time delivery of projects and services.

Wood Project Level Experience

Development of Risk-Based Cost Estimating for Highway Projects, National Highway Institute, Federal Highway Administration, Nationwide. Technical Editor/Administrative Assistant. The purpose of this project was to develop a course teaching risk-based cost estimating for highway projects. Wood generated the course content and designed an interactive, stand-alone, and downloadable eBook with elements and features that support the content, such as quizzes, media playback, graphics and visuals, appropriate links, and other learning tools. Ms. Seidewitz provided editorial review for the eBook deliverable and took notes during review meetings for eBook chapters.

Asphalt Expert Task Group (ETG) Meetings Support Services, Federal Highway Administration, Nationwide. Technical Editor/Administrative Assistant. Wood provides meeting support to the FHWA Asphalt Binder and Mixture ETG meetings, including scheduling, organization, documenting meeting activities, and providing travel support for non-Federal members of the ETGs. Ms. Seidewitz assisted in meeting coordination and travel arrangements, as well as providing on-site meeting support and catering coordination. In addition, she edited, proofread, and formatted reports summarizing meeting activities.

EDC-4 Pavement Preservation When/Where Support, Federal Highway Administration, Nationwide. Technical Editor/Administrative Assistant. In service of the EDC-4 Pavement Preservation When/Where program, Wood has provided a variety of support services, including conducting Pavement Preservation peer exchanges and webinars and preparing synthesis of practice and guidance documents. Ms.

Proposed Role
Technical Editor

Years of Experience
5

Academic Background

- B.A., English, George Mason University, 2014

Seidewitz has provided editorial review for the synthesis and guidance documents, assisted in formatting the peer exchange report for Section 508 compliance, formatted PowerPoint presentations, and drafted marketing flyers.

Long Term Pavement Performance Program Technical Support Services Follow-On Contract (TSSC) 2015-2020, Federal Highway Administration, Nationwide. Technical Editor/Administrative Assistant. The objective of this ongoing project is to provide pavement, database, and traffic engineering technical services to the FHWA in support of the LTPP program. This project has an emphasis on monitoring and reporting pavement structural health, and Wood has been responsible for developing all data collection protocols, QC/QA procedures, and software for all major pavement performance data collection types. This project has resulted in the largest research quality pavement performance database in the world. Ms. Seidewitz provided editorial and Section 508 review for the database user guide, as well as formatting a variety of reports, forms, and materials for use in the project.

Interstate Highway Pavement Sampling, Federal Highway Administration, Nationwide. Technical Editor. The objectives of this study were to collect pavement condition data on an unbiased, statistically significant sample of the IHS, determine if the Highway Performance Monitoring System (HPMS) is an unbiased representation of the pavement condition on the IHS, and recommend improvements to HPMS data collection and reporting that are necessary either to make HPMS unbiased or to improve its precision. Ms. Seidewitz provided editorial and Section 508 review of the final report for this project.

Transportation Asset Management Plan (TAMP) for Pavement, Bridges, and Tunnels, District Department of Transportation, Washington, D.C. Technical Editor. Wood is assisting DDOT with the development of a TAMP, as required by MAP-21. The scope of work includes project management, needs analyses, meeting coordination with staff and stakeholders to develop asset management policy and strategy, risk management plans, performance targets, financial plans, technical analysis for program development and delivery to achieve performance targets, plan preparation and editing, and implementation of the plan. Ms. Seidewitz provided editorial review for the final TAMP document.

LTPP Data Analysis: Feasibility of Using LTPP Data to Develop Relationships between Laboratory- and Field-Derived Properties of Unbound Materials, National Cooperative Highway Research Program, National Academy of Sciences, Nationwide. Technical Editor. The objective of this research effort was to evaluate the feasibility of using LTPP data for developing relationships between laboratory- and field-derived properties of unbound materials used in pavements, with the research being limited to those properties required for pavement design and analysis, in accordance with Pavement ME Design procedures. Ms. Seidewitz provided editorial review for the draft and final reports for this project.

Jacqulain McKlveen

Proposed Role
Project Controls

Years of Experience
22

Academic Background
- High School Diploma
- Government Procurement Training (Wood)
- Senior Subcontractor Administration Training (Wood)
- Basic Project Manager Training (Wood)
- Quality Assurance Training (Wood)
- American Traffic Safety Services Association, Registered Flagger

Summary

As a Senior Administrative Assistant, she is involved in engineering and management projects for private, county, state and federal governmental agencies. Mrs. McKlveen is directly responsible for projects initial set-up, contract and task order administration, reviewing monthly reports, invoicing, and coordination of logistics with subcontractors. She also provides direction and administrative quality control to project team members to ensure project needs are met on time and within budget, administers human resources information to office staff, office maintenance and safety. She procures subcontractors and administers work orders.

Wood Project Level Experience

FHWA Data Self-Assessment Workshops. Senior Administrative Assistant. Technical support services to prepare and facilitate workshops to educate and identify states for a comprehensive data program self-assessment to improve their transportation programs.

FHWA Interstate Pavement Condition Sampling. Senior Administrative Assistant. Pavement data collection on 10,000 lane miles of Interstate Highway System (IHS), data analyses for determination if FHWA's Highway Pavement Management (HPMS) is unbiased representation of the IHS pavement condition, and recommendations for improvements to HPMS data collection and reporting necessary to make HPMS unbiased and/or to improve its precision. Responsible for projects initial set-up, contract and task order administration, review of monthly reports, invoicing, and coordination of logistics with subcontractors.

FHWA Predicting Truck and Axle Load Patterns. Senior Administrative Assistant. Engineering technical expertise involving varying levels of data acquisition, evaluation, analysis and documentation of observations and results as part of Modeling and Predicting Truck Loading Patterns. Responsible for projects initial set-up, contract and task order administration, review of monthly reports, invoicing, and coordination of logistics with subcontractors.

FHWA HPTS Model Review. Senior Administrative Assistant. Pavement performance analysis to evaluate the existing procedures in pavement modeling tools currently used by FHWA Office of Policy versus current best practices and research other promising technologies that could extend, or perhaps replace, the current methodology in order to meet policy objectives. Responsible for project initial set-up, contract and task order administration, review of monthly reports, invoicing, and coordination of logistics with subcontractors.

FHWA Development of Transportation Asset Management Plans LA, MN, and NY DOTs. Senior Administrative Assistant. Development of the first Transportation Asset Management Plans (TAMP) by the Louisiana, Minnesota and New York State Departments of Transportation (DOT) which serve as three models to be studied or examples by agencies responsible for managing highway infrastructure assets both at the state or local level. Responsible for project initial set-up, contract and task order administration, review of monthly reports, invoicing, and coordination of logistics with subcontractors.

FHWA Pedestrian and Bicycle Data Collection. Senior Administrative Assistant. Technical support services on pedestrian and bicycle travel data collection and processing. Services include gathering detailed information nationwide on existing counting techniques, quality assurance procedures, and processing techniques and methods to collect, process, and report pedestrian and bicycle data. Responsible for project initial set-up, contract and task order administration, review of monthly reports, invoicing, and coordination of logistics with subcontractors.

FHWA Long Term Pavement Performance Program Technical Support Services Follow-On Contract. Senior Administrative Assistant. Engineering, technical, logistical, and administrative support services including development and conduct of LTPP studies and all necessary facilities, equipment, services, supplies, materials, and personnel associated with pavement, database, and traffic engineering. Responsible for handling administrative duties, including issuing all program purchase orders, locating new subcontractors, coordinating invoicing with Program Manager, verifying that invoicing followed FHWA contract requirements; reviewing and update fee changes for all projects; reviewed all draft invoices for accuracy; investigate and resolve problems in financial / billing / invoicing area; compile cost information; and prepare financial tables and related information for monthly work assignment progress reports.

Senior Project Coordinator: Pavement Management Services, Maryland State Highway Administration, Statewide, MD. Senior Administrative Assistant**.** Pavement management services consisting of individual projects on a task order basis including on-site engineering support. Services include provide support and enhancement of the PMS, pavement data collection, data processing and analysis of pavement management information, development and improvement of engineering analysis tools and applications, enhancement of optimization routines, and pavement management special studies. Responsible for project initial set-up, contract and task order administration, review of monthly reports, invoicing, and coordination of logistics with subcontractors.