# Evaluate Risk-Based Asset Management Systems (AMS): BrM Implementation

WA-RD 880.1 Dye Management Group, Inc. April 2018

Washington State Department of Transportation
Office of Research & Library Services

WSDOT Research Report

18-07-0278

# TECHNICAL REPORT STANDARD TITLE PAGE

| 1. REPORT NO. | 2. GOVERNMENT ACCESSION NO. | 3. RECIPIENT'S CATALOG NO. |
|---|---|---|
| WA-RD 880.1 | | |

| 4. TITLE AND SUBTITLE | 5. REPORT DATE |
|---|---|
| Evaluate Risk-Based Asset Management Systems (AMS): BrM Implementation Strategy | April 2018 |
| | 6. PERFORMING ORGANIZATION CODE |
| 7. AUTHOR(S) | 8. PERFORMING ORGANIZATION REPORT NO. |
| Dye Management Group | |
| 9. PERFORMING ORGANIZATION NAME AND ADDRESS<br>Dye Management Group, Inc.<br>601 108th Ave NE, Suite 1900<br>Bellevue, WA 98004 | 10. WORK UNIT NO. |
| | 11. CONTRACT OR GRANT NO.<br>Agreement Y-11957 |
| 12. SPONSORING AGENCY NAME AND ADDRESS<br>Research Office<br>Washington State Department of Transportation<br>Transportation Building, MS 47372<br>Olympia, Washington 98504-7372<br>Lu Saechao, Research Manager, (360) 705-7260 | 13. TYPE OF REPORT AND PERIOD COVERED<br>Final Research Report |
| | 14. SPONSORING AGENCY CODE |

15. SUPPLEMENTARY NOTES

This study was conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration.

16. ABSTRACT


The Washington Department of Transportation (WSDOT) engaged Dye Management Group, Inc. (DMG) to evaluate risk-based asset management processes and systems for potential implementation at WSDOT.

DMG summarized WSDOT's existing asset management-related processes, systems, and data in the *Current State Report.* Taking into consideration WSDOT's current asset management state and the asset management-related goals of WSDOT and its stakeholders, DMG developed a baseline set of functional and technical requirements against which potential asset management systems (AMS) were evaluated. This approach helped ensure that any future AMS will be able to support both WSDOT's existing and future best practices. The primary focus of the evaluated systems was bridges, although some requirements dealt with broader asset management functions. DMG conducted outreach to determine which software systems best met the requirements.

DMG summarized the results of our assessment in the *AMS Assessment Report.* Based on our review, they recommended that WSDOT consider the AASHTOWare BrM/Decision Lens combined solution. This *BrM Implementation Strategy* report summarizes the steps and processes necessary to implement the AASHTOWare BrM solution, including a timeline for the implementation.


| 17. KEY WORDS | 18. DISTRIBUTION STATEMENT |
|---|---|
| Risk-based, asset management, AASHTOWare BrM, life cycle, asset condition, Decision Lens | No restrictions. This document is available to the public through the National Technical Information Service, Springfield, VA 22616 |

| 19. SECURITY CLASSIF. (of this report) | 20. SECURITY CLASSIF. (of this page) | 21. NO. OF PAGES | 22. PRICE |
|---|---|---|---|
| None | None | 15 | |

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DYE MANAGEMENT GROUP, INC.
601 108th Avenue NE, Suite 1900, Bellevue, WA 98004
T: (425) 637-8010 • F: (425) 637-8020 • www.dyemanagement.com

Washington State Department of Transportation

# Evaluate Risk-Based Asset Management Systems (AMS)

## BrM Implementation Strategy

April 2018

# Washington State Department of Transportation

## Asset Management System

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## BrM Implementation Strategy

# I. Introduction

The Washington Department of Transportation (WSDOT) engaged Dye Management Group, Inc. (DMG) to evaluate risk-based asset management processes and systems for potential implementation at WSDOT. DMG used WSDOT's existing process and system documentation as the foundation for this project. We further augmented our understanding with information provided by WSDOT staff through stakeholder interviews. DMG summarized WSDOT's existing asset management-related processes, systems, and data in the *Current State Report.*

DMG identified four main asset management challenges for WSDOT:

- **Education –** Not all stakeholders and decisions makers understand the benefits of life-cycle asset management.
- **Leadership –** There is no single owner or champion for this effort at the enterprise level.
- **Data –** Outside pavement and bridge management, asset inventories are not sufficient. Either the inventory or condition data is incomplete or insufficient to meet the need.
- **Resources –** Compiling inventories and assessing asset condition is a time-consuming task. Priorities must be realigned to allow for this work to be completed by current staff.

WSDOT has already begun to address some of these challenges. Under the Practical Solutions initiative, WSDOT has developed a Statewide Transportation Asset Management Plan (STAMP), which provides a framework for making investment decisions across the full range of transportation assets. Also, the Highway Asset Management Technical Advisory Group (HAMTAG) was established as part of the Practical Solutions initiative and is charged with developing highway asset management proposals for Executive Steering Committee consideration.

Accurate asset inventory and condition data are critical to the success of an asset management program. Our research and interviews noted the following regarding asset condition and inventory at WSDOT:

- **Pavement –** WSDOT's pavement management process, system, and data are very mature, and considered by many to be world class. A recent Joint Legislative Audit and Review Committee (JLARC) study cited WSDOT's pavement management program as an approach to be emulated for other assets.

- **Bridge and structures –** WSDOT employs a strong bridge and structures management program, which is evolving. Each bridge is inspected every two years under the National Bridge Investment Analysis System (NBIAS). However, the bridge and structures management program lacks forecasting capability on the level of WSDOT's pavement management program.
- **Other assets –** WSDOT's inventory and condition data for other assets varies by asset and depends on stakeholder opinion. Facilities, ferries, terminals, and signs all have good inventory and condition data. Guardrail has good inventory but incomplete or non-existent condition data. Culverts and walls have incomplete or non-existent inventory and condition data.

Taking into consideration WSDOT's current asset management state and the asset management-related goals of WSDOT and its stakeholders, DMG developed a baseline set of functional and technical requirements against which potential asset management systems (AMS) were evaluated. This approach helped ensure that any future AMS will be able to support both WSDOT's existing and future best practices. The primary focus of the evaluated systems is bridges, although some requirements dealt with broader asset management functions. DMG conducted outreach to determine which software systems best met the requirements.

Vendors responded with an assessment of their current software capabilities measured against the requirements and an estimated cost for implementation, which included any necessary customization. For each of the seven vendor-provided solutions, DMG assessed the following:

- Ability to meet WSDOT requirements, including the strengths and weaknesses of each solution
- Implementation and integration approach and capabilities, including training
- Seven-year total cost of ownership (TCO) estimate

DMG summarized the results of our assessment in the *AMS Assessment Report*. Based on our review, we recommended that WSDOT consider the AASHTOWare BrM/Decision Lens combined solution for the following reasons:

- WSDOT currently owns site licenses for both products, which decreases the short-term implementation costs and eliminates the need for a costly and lengthy procurement process.
- The seven-year TCO is the lowest of the evaluated solutions.
- The BrM solution is the most widely used BMS – indicated by forty-one of fifty states licensing it to manage their bridges.
- Decision Lens provides a highly configurable tradeoff analysis engine that can be configured to WSDOT's exact needs.

This *BrM Implementation Strategy* report summarizes the steps and processes necessary to implement the AASHTOWare BrM solution.

# II. Solution Overview

The AASHTOWare Bridge Management software (BrM), formerly known as Pontis, was developed in the early 1990s as part of a National Cooperative Highway Research Program (NCHRP) project. The latest official release of BrM is 5.3, which was released in September 2017. BrM is licensed by forty-one state DOTs and four additional non-DOT agencies throughout the United States.

BrM allows state DOTs to take all the National Bridge Inventory (NBI) data, that the Federal Highway Administration (FHWA) mandates that they collect and add the AASHTO element-level data, and develop a bridge management program to identify risks and priorities and strategic ways to spend funds.

BrM includes capabilities to enable or perform the following:

- Planning
- Deterioration
- Risk
- Multi-objective analysis
- Lifecycle costs
- Project models
- Dashboards
- Corridor planning

# III. Implementation Approach

Bentley Systems, Inc. (Bentley) is the contract developer for BrM. In that role, Bentley is the provider for implementation services and modifications for the software. BrM is a web-based bridge management tool, and AASHTO offers the option to have the software hosted by Bentley.

Bentley offers initial set-up of BrM. This is an “out-of-the-box” set up of BrM and does not include training or system customization. Additional fees apply for importing inventory or historical inspection data into BrM. These services must be paid for using Service Units through AASHTO. This is further explained in Section V (Cost) of this report.

Both Bentley and other independent contractors offer BrM training programs, deterioration modeling, and tradeoff analysis services. We also understand that WSDOT is planning to hire internal technical resources to facilitate the BrM implementation, which will be critical to the success of this multi-year implementation. Based on our experience assisting the implementation of BrM at other agencies, we recommend that WSDOT designate a project manager to serve as a point-of-contact for the implementation effort. We anticipate that the implementation team for BrM will comprise internal WSDOT resources, Bentley, and other consultants.

DMG has developed an implementation project work plan and schedule to help WSDOT plan for its BrM implementation. The work plan comprises six phases and an additional post-implementation support phase for the ninety days following go-live.

DMG estimates a full statewide implementation of BrM will take three years. However, it is important to recognize that key functionality within BrM will be available before that three-year mark. We have developed a project schedule that allows for concurrent activities. This shortens the overall project timeline without affecting critical project activities.

The project phases, and estimated duration for each, are provided in Exhibit 1. Each phase is discussed in more detail in the next section. The full project schedule and Gantt chart is provided in Appendix A.

**Exhibit 1: Project Phases and Duration**

| Project Phase | Duration, in working days |
|---|---|
| Acquisition | 45 |
| Design | 120 |
| Installation/Configuration | 220 |
| Development | 240 |
| Integration and Testing | 200 |
| Implementation | 105 |
| Post-Implementation Support | 65 |
| **Total Project Duration** | **775** |

# IV. Implementation Work Plan

## A. Acquisition Phase

The acquisition phase of this effort includes the tasks necessary to procure the BrM software, implementation and integration services, project support, and training. We understand that WSDOT currently has an annual commitment to license the BrM software. To move forward with the implementation of BrM, WSDOT must purchase AASHTO Service Units to support the implementation scope defined in this project phase. AASHTO Service Units would be used specifically for Bentley's effort relating to installing, configuring, and integrating the BrM solution.

WSDOT has the option to leverage other contractors and consultants for non-Bentley specific activities. These include project management support, developing and delivering customized training, developing WSDOT-specific cost and deterioration models, and independent quality assurance of the installed solution.

The tasks and subtasks for the acquisition phase are shown in Exhibit 2.

**Exhibit 2: Acquisition Phase Tasks**

| **Acquisition Phase** | **45 days** |
|---|---|
| **Develop scope for AASHTO Service Units** | **20 days** |
| Prepare draft scope | 10 days |
| Provide draft scope to WSDOT for review | 5 days |
| Finalize scope based on WSDOT comments | 5 days |
| **Support AASHTO Service Units Procurement** | **15 days** |
| Purchase required Service Units from AASHTO | 10 days |
| Support scope of work discussions with AASHTO BrM contractor as required | 5 days |

| | |
|---|---|
| **Develop Work Plan for AASHTOWare BrM Integration Tasks** | **25 days** |
| Prepare draft work plan | 15 days |
| Provide draft work plan to WSDOT for review | 5 days |
| Finalize work plan based on WSDOT comments | 5 days |
| **Define Integration Support Tasks** | **25 days** |
| Develop draft support task summary for non AASHTOWare-specific integration tasks | 15 days |
| Provide draft support task summary to WSDOT for review | 5 days |
| Finalize support task summary based on WSDOT comments | 5 days |

## B. Design Phase

This phase of the effort includes the tasks necessary to conceptualize, define, and establish the design of WSDOT's bridge management system. The design phase begins with a kickoff meeting for the overall project. Following the kickoff, the project team will work to define enterprise and system designs.

Developing an enterprise design focuses on defining how BrM will exist in WSDOT's environment, including ensuring BrM's database and system configuration align with WSDOT's enterprise technology standards.

System design centers on formally defining the configuration of BrM, and its interfaces, necessary to meet WSDOT's requirements. The system design includes developing definitions for all customizations, interfaces, data loads, screen designs, and report layouts.

The results of the design phase findings will be compiled in a system design document. The system design document will serve as a project reference artifact, against which the installation and configuration of the system will be measured.

The final task in the design phase is developing a formal knowledge transfer plan. The knowledge transfer plan will define a strategy for capturing critical functional and technical information from the project team to ensure WSDOT has the capacity to maintain and operate the BrM implementation after implementation with minimal reliance on Bentley or other contractors.

The tasks and subtasks for the design phase are shown in Exhibit 3.

**Exhibit 3: Design Phase Tasks**

| | |
|---|---|
| **Design Phase** | **120 days** |
| **Conduct BrM Implementation Project Kickoff Meeting** | **10 days** |
| Schedule and prepare for kickoff meeting | 5 days |
| Conduct kickoff meeting; document results | 5 days |
| **Perform Enterprise Design** | **50 days** |
| Establish development environment | 10 days |
| Develop initial design configuration | 15 days |
| Schedule and conduct design workshops | 15 days |
| Update configuration based on workshops | 10 days |
| **Finalize System Design** | **70 days** |

| | |
|---|---|
| Identify gaps | 20 days |
| Identify inventory of customizations | 20 days |
| Identify inventory of interfaces | 20 days |
| Identify inventory of initial data loads | 20 days |
| Create any required screen designs | 15 days |
| Create any required report layouts | 15 days |
| Document System Design | 15 days |
| Provide System Design document to WSDOT to review | 10 days |
| Finalize System Design document based on WSDOT input | 10 days |
| **Establish formal knowledge transfer plan to WSDOT** | **30 days** |
| Develop draft of knowledge transfer plan | 20 days |
| Provide draft plan to WSDOT for review | 5 days |
| Finalize knowledge transfer plan based on WSDOT feedback | 5 days |
| **Manage Design Phase** | **120 days** |
| Monitor and update project work plan | 120 days |
| Prepare monthly progress reports | 120 days |
| Conduct project status meetings | 120 days |
| Conduct periodic Steering Committee meetings | 120 days |

# C. Installation/Configuration Phase

This phase includes the tasks necessary to conduct an initial installation and configuration of the BrM solution. Bentley will perform a lead role on most of the tasks and subtask in this phase with one key exception: developing WSDOT-specific deterioration and cost models.

During our review of possible bridge asset management solutions for WSDOT, DMG noted two requirements that would require additional data review and analysis to be enabled in BrM. The first was requirement 3.1:

| | |
|---|---|
| 3.1 | Ability to forecast asset condition, including leveraging current and future WSDOT-defined deterioration models/curves. |

BrM has this capability, but the agency must provide the quantitative parameters, specifically transition times between condition states, for it to function. Agencies define these models in either or both of two ways: (1) Using the judgment of a panel of in-house experts (experienced inspectors), sometimes informed by existing agency models using other types of condition data if the agency has performed such research previously; or (2) Statistical analysis of historical inspection data.

The second requirement:

| | |
|---|---|
| 3.3 | Ability to determine the impact of natural disaster and/or third-party damage on expected bridge life and risk of collapse. |

BrM also has a feature to help WSDOT implement this type of model. However, WSDOT research is required to establish metrics for the likelihood of extreme events and the likelihood that such events would disrupt service on given classes of structures.

We have included a task in this phase to develop these models so that they can be enabled in BrM during the development phase. It is important to understand that this task is not considered to be on the critical path (noted in maroon on the project task list and schedule) for the project and can be enabled at any time during the implementation, including earlier in the design phase if resources are available. WSDOT would have full use of existing BrM models in the software until the WSDOT-specific models are enabled.

The tasks and subtasks for the installation/configuration phase are shown in Exhibit 4.

**Exhibit 4: Installation/Configuration Phase Tasks**

| Installation/Configuration Phase | 220 days |
|---|---|
| **Perform Installation Activities** | **45 days** |
| Acquire, install, and test hardware environment | 15 days |
| Install BrM software | 5 days |
| Perform BrM configuration | 5 days |
| Expand the BrM database to include all WSDOT-specific inventory and inspection items | 10 days |
| Develop customizations of inspection planning form of BrM | 10 days |
| Configure BrM to capture work recommendations | 10 days |
| Convert WSDOT reports to BrM-ready format | 20 days |
| Create additional standard reports. | 20 days |
| **Design test inspection process** | **30 days** |
| Develop and document bridge risk assessment process | 15 days |
| Revise inspection documentation and procedures | 5 days |
| Pilot testing of the inspection process | 10 days |
| **Develop deterioration and cost models** | **180 days** |
| Develop WSDOT-specific deterioration model | 150 days |
| Develop WSDOT-specific cost model | 180 days |
| **Setup Element List** | **45 days** |
| Enter and configure non-CoRe and sub-elements in BrM | 15 days |
| Create element lists from drawings - state bridges | 15 days |
| Feed scour data into BrM risk assessment | 15 days |
| **Manage Installation/Configuration Phase** | **95 days** |
| Monitor and update project work plan | 95 days |
| Prepare monthly progress reports | 95 days |
| Conduct project status meetings | 95 days |
| Conduct periodic Steering Committee meetings | 95 days |

# D. Development Phase

This phase includes the tasks necessary to customize and fully configure BrM for WSDOT's environment. This phase begins with the development of a data conversion plan that will specify the process for moving WSDOT's existing bridge data into BrM. To accomplish the data conversion, the project team will create a detailed design document for all required interfaces, initial data loads, and software customizations.

Following the documentation of the detailed design, Bentley will code and test the interfaces, data loads, and custom software components. Bentley will also work with WSDOT and their project support consultant, to prepare for the data conversion by performing dry runs of the conversion process. Bentley will then revise the processes based on the results of the dry run to ensure the data is ready for system cutover in the implementation phase.

The tasks and subtasks for the development phase are shown in Exhibit 5.

**Exhibit 5: Development Phase Tasks**

| Development Phase | 240 days |
|---|---|
| **Plan Data Conversion** | **45 days** |
| Develop detailed data conversion plan | 30 days |
| Provide detailed conversion plan to WSDOT for review | 10 days |
| Finalize detailed conversion plan based on WSDOT input | 5 days |
| **Perform detail design for interfaces, initial data loads, and custom components** | **65 days** |
| Prepare functional specifications | 50 days |
| Obtain WSDOT sign-off on functional specifications | 15 days |
| Prepare technical specification | 50 days |
| Obtain WSDOT sign-off on technical specifications | 15 days |
| **Code and unit test interfaces, initial data loads, and custom components** | **105 days** |
| Code assigned program units | 60 days |
| Develop unit test plans | 40 days |
| Test assigned program units | 20 days |
| Obtain WSDOT sign-offs | 5 days |
| **Prepare for Data Conversion** | **25 days** |
| Conduct dry runs of conversion processes | 10 days |
| Make conversion program updates as needed | 5 days |
| Perform necessary data clean-up | 5 days |
| Develop procedures for manual conversion | 5 days |
| **Manage Development Phase** | **240 days** |
| Monitor and update project work plan | 240 days |
| Prepare monthly progress reports | 240 days |
| Conduct project status meetings | 240 days |
| Conduct periodic Steering Committee meetings | 240 days |

## E. Testing Phase

This phase includes the tasks necessary to test the BrM solution prior to implementation in WSDOT's environment. The successful completion of the tasks in this phase will ensure that the customized and configured BrM software is ready for implementation at WSDOT. The testing phase is the final step prior to system go-live.

To start this phase, Bentley will work with WSDOT, and their project support consultant, to define a load testing plan and a system testing plan. The load testing plan will detail the process that will ensure WSDOT's installation of BrM can handle the expected amount of bridge-related data and anticipated number of users. The system test plan focuses on defining the processes for testing all components of the software holistically. This includes testing the installed software and all custom components to ensure they meet the test acceptance criteria. Bentley will have a lead role on conducting the system test, with support from WSDOT and their project support consultant. Bentley will then revise any system components that didn't meet acceptance criteria and retest them for compliance.

Once the system and load testing have been successfully completed, WSDOT will be ready for user acceptance testing (UAT). UAT is the last phase of the software testing process, where expected software users test the software to make sure it can handle required tasks in real-world scenarios, according to specifications and acceptance criteria.

The UAT test plan will be designed jointly by Bentley and WSDOT's project support consultant, and the consultant will lead the UAT process. The consultant will then report the UAT results to Bentley. Bentley will then correct any issues or software bugs observed during UAT and submit for retesting by WSDOT.

The tasks and subtasks for the testing phase are shown in Exhibit 6.

**Exhibit 6: Testing Phase Tasks**

| Testing Phase | 200 days |
|---|---|
| **Prepare Load Testing Plan** | **35 days** |
| Develop detailed Load Testing Plan | 20 days |
| Provide Load Testing Plan to WSDOT for review | 10 days |
| Finalize Load Testing Plan based on WSDOT input | 5 days |
| **Prepare System Test Plan** | **65 days** |
| Develop draft system test plan | 30 days |
| Provide system test plan to WSDOT for review | 10 days |
| Finalize system test plan based on WSDOT review | 5 days |
| Develop draft of system test scripts | 20 days |
| Provide system test scripts to WSDOT for review | 10 days |
| Finalize system test scripts based on WSDOT input | 5 days |
| **Conduct System Test** | **65 days** |
| Set-up system test environment (hardware & software) | 10 days |
| Configure system test instance of application software | 10 days |
| Install/migrate custom programs | 10 days |
| Perform initial data loads | 5 days |
| Conduct system testing | 10 days |
| Make program fixes | 10 days |
| Update application software configuration based on system testing | 10 days |
| **User Acceptance Testing** | **95 days** |
| Prepare user acceptance test plan | 15 days |
| Create user acceptance test scripts | 15 days |
| Establish user acceptance testing environment (hardware and software) | 10 days |
| Configure user acceptance test version of application software | 5 days |
| Install/migrate custom programs | 10 days |
| Perform data loads | 10 days |
| Perform manual conversions | 10 days |
| Execute user acceptance test | 20 days |
| Make program fixes based on user acceptance testing | 10 days |
| Update application software configuration based on user acceptance testing | 10 days |
| Perform load test | 5 days |

| | |
|---|---|
| Obtain user sign-off on system | 5 days |
| **Manage Integration and Test Phase** | **200 days** |
| Monitor and update project work plan | 200 days |
| Prepare monthly progress reports | 200 days |
| Conduct project status meetings | 200 days |
| Conduct periodic Steering Committee meetings | 200 days |

# F. Implementation Phase

This implementation phase includes the tasks necessary for WSDOT to go live in their new BrM system environment. This phase begins with preparing for and conducting user training on BrM. We anticipate that user training will comprise an "administrator" training component for users that will maintain the software and data; and a user training component for inspectors and other users of BrM. Bentley will prepare all necessary training materials using the basic BrM training material as a foundation. Bentley will then work with WSDOT's project support consultant to schedule and conduct the training.

Within this phase, WSDOT and Bentley will develop a cutover plan that describes the steps for decommissioning existing systems and utilizing BrM from that point forward. The cutover plan will align with the scheduled user training dates to ensure all training is complete prior to cutover.

The tasks and subtasks for the development phase are shown in Exhibit 7.

**Exhibit 7: Implementation Phase Tasks**

| **Implementation Phase** | **105 days** |
|---|---|
| **Plan and prepare for user training** | **65 days** |
| Prepare draft Training Plan | 20 days |
| Provide Training Plan to WSDOT for review | 10 days |
| Finalize Training Plan | 5 days |
| Prepare draft training materials | 15 days |
| Provide training materials to WSDOT for review | 10 days |
| Finalize training materials based on WSDOT review | 5 days |
| Schedule training classes | 10 days |
| Establish training environment (hardware and software) | 10 days |
| Configure application software in training environment | 10 days |
| **Prepare Cutover Plan** | **30 days** |
| Develop draft of cutover plan | 15 days |
| Provide draft of cutover plan to WSDOT for review | 10 days |
| Finalize cutover plan based on WSDOT review | 5 days |
| **WSDOT State Level Rollout** | **40 days** |
| Conduct administrator training | 10 days |
| Conduct end-user training | 15 days |
| Conduct lessons learned meeting | 5 days |
| Document lessons learned | 5 days |

| | |
|---|---|
| Revise training materials based on feedback | 5 days |
| Execute System Cutover Plan | 5 days |
| **Manage Implementation Phase** | **105 days** |
| Monitor and update project work plan | 105 days |
| Prepare monthly progress reports | 105 days |
| Conduct project status meetings | 105 days |
| Conduct periodic Steering Committee meetings | 105 days |

## G. Post-Implementation Support

This phase focuses on providing ninety days of support for WSDOT after BrM go-live. During this phase, WSDOT's project support consultant will monitor BrM performance and usability to ensure it continues to meet WSDOT's requirements. If necessary, follow-up training will be provided during this period. The consultant will also provide status updates on post-implementation activities.

# V. Cost

WSDOT has a super site license, which "allows for use of AASHTOWare BrM within the agency. The license permits WSDOT to use the software on specified structures within the bounds of the licensing agency's inspection and management responsibilities." Licensing costs for BrM are $36,000 per year, which provides licenses for the following users:

- Bridge Asset Management (users that would perform lifecycle cost analyses, risk analyses, replacement candidate analyses, etc.): **three users**
- Bridge Operations (inventory and inspection data entry, etc.): **ten users**

Additional implementation costs are as follows:

- A single service unit from AASHTO costs $13,500. After administration fees, $12,200 from each Service Unit is available for services. We estimate that WSDOT will require approximately fifteen (15) service units to complete the installation and integration of BrM. That total cost is $202,500.
- To meet requirement 3.1, we estimate WSDOT will spend $100,000.
- To meet requirement 3.3, we estimate WSDOT will spend $200,000.
- We anticipate WSDOT needing consultant project support for the project, which would cost approximately $250,000 for the three-year implementation. Project support would include assistance with developing technical and functional specifications, supporting the software testing process, project management support, and customizing the training program.
- Hardware costs are not included in this estimate. Those costs will be determined during the design phase of the project.

Exhibit 8 summarizes WSDOT's estimated BrM implementation costs.

## Exhibit 8: WSDOT BrM Estimated Implementation Costs

| | |
|---|---|
| AASHTO Service Units | $202,500 |
| WSDOT-Specific Bridge Deterioration Modeling | $100,000 |
| WSDOT Risk Forecasting for Condition and Collapse | $200,000 |
| Consultant Project Support | $250,000 |
| Hardware | TBD |
| Contingency (15%) | $112,875 |
| **Total** | **$865,375** |

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