FINAL REPORT

Mississippi Department of Transportation

Performance Audit

JANUARY 2020

This page is intentionally left blank

Table of Contents

1. Summary

1.1 Scope of Engagement

The Mississippi Office of the State Auditor engaged HKA Global Inc. (HKA) to conduct a performance audit of the Mississippi Department of Transportation (MDOT) for the purpose of identifying potential changes in policy, practice, and/or organizational structure that would provide opportunities to increase efficiency, minimize waste, and/or realize cost savings.

1.2 Methodology

HKA's approach to conducting the audit entailed an iterative process of document reviews, interviews, and data analyses to address the areas of inquiry summarized below. The audit was conducted under the AICPA Consulting Standards for Performance Audits.

Organization and Staffing

- Does MDOT have the internal resources needed to effectively and efficiently meet its mission of providing "a safe intermodal transportation network that is planned, designed, constructed and maintained in an effective, cost efficient, and environmentally sensitive manner"?
- Has MDOT implemented a rational system for determining when to contract out for services?
- Are there any initiatives MDOT can implement, apart from increasing salaries, to help retain in-house engineering and project management expertise?
- Is a formal process in place to capture institutional knowledge and lessons learned as a growing number of experienced staff approach retirement?

Consultant Services

- Has MDOT implemented effective processes to ensure consultant contracts are awarded to the most qualified firm, at a fair and reasonable cost?
- Are consultant fees reasonable?
- What processes has MDOT implemented to monitor consultant progress and performance?

Delivery of Capital Construction Projects

- Does MDOT effectively oversee the process for soliciting bids and awarding construction contracts?
- How accurate and reliable are MDOT's estimates of probable construction costs?
- How robust are MDOT's processes for managing project risks and uncertainties, and for ensuring the on-time and on-budget delivery of projects?
- How does MDOT assure quality of construction? Are there opportunities to streamline certain non-critical inspection activities or acceptance practices in the interest of cost or time savings?

Maintenance

- Is MDOT's performance-based maintenance management system being used effectively and consistently by the District maintenance offices?

Audit Focus Areas

Audit focus areas included:

- Organization and Staffing
- Consultant Services
- Delivery of Construction Projects
- Maintenance
- Fleet Management
- Local Public Agency Program

- Is MDOT's self-performance or outsourcing of certain maintenance functions cost-effective (especially given the costs associated with fleet management and staff turnover)?
- Can maintenance and operations be optimized for rest areas?

Fleet Management

- Is MDOT's fleet of vehicles and specialty equipment right-sized for its operational needs?
- Are fleet vehicles being replaced on an optimal schedule?
- Does MDOT have the appropriate number of mechanics on staff to maintain the fleet?

Local Public Agency (LPA) Program

- Does MDOT's oversight of Local Public Agencies (LPA) projects that use Federal funds contribute to cost increases and schedule delays on such projects?
- Are the perceived additional costs and schedule impacts attributable to preferential policies on the part of MDOT, or is MDOT merely implementing Federal requirements?
- To the extent that FHWA allows for flexibility in a DOT's oversight of LPA projects, do opportunities exist for MDOT to streamline its processes?

Document Reviews & Data Analyses

HKA reviewed MDOT's existing policies, procedures, standard forms, contracts and other documents, including, but not limited to:

- Standard Specifications for Road and Bridge Construction (2017 Edition)
- Construction Manual (2017 Edition)
- Inspector's Handbook (2007 Edition)
- Materials Division Inspection, Testing, and Certification Manual (April 2010 Edition)
- Concrete Field Manual (September 7, 2018 Revision)
- Field Manual for Asphalt Mixtures (April 1, 2015 Revision)
- Materials Division SOPs
- Project Development Manual for Local Public Agencies (April 2019)
- Consultant Services Unit (CSU) Manual, Procurement, Management, and Administration of Engineering and Design-Related Services
- Standard Engineering Services Contract, including Exhibit 11, Progress Reporting Process

In addition, HKA analyzed the following data, as exported by MDOT from its various financial and management systems:

- Nov. 2019 – MDOT Staff Data: All MDOT employees, with salary information and division. Employee names are not included. Titles only.

- Engineer Consultant Contracts 2016 - 2018: All the awarded consultant contracts between 2016 and 2018. Includes the total contract amount, contract start and end date, and expenditures.

- MDOT projects data: Information for 388 MDOT projects executed between January 2016 and November 2018. The data includes information on awarded bid price, selected contractor, original completion date, final completion date, type of contract etc.

- Bid Tabulations: For selected projects, MDOT provided detailed information on all the bid items of the contracts, including comparison to the original State Estimate.

- Detailed Cost Breakdown for Selected Projects: MDOT provided an export from FMS that breaks down the selected projects with all the associated contracts and expenditure. (ROW, Construction cost, Consultant cost, etc.)

- Nov. 2019 – MDOT Vehicle data: The state of MDOT's vehicle fleet as of November 2019. Includes information for the lifetime usage and cost for each vehicle in MDOT's fleet.

- FY19 – MDOT Vehicle Cost and Usage: The state of MDOT's vehicle fleet for the fiscal year 2019. Includes information for the usage and cost for each vehicle during the fiscal year 2019.

- FY15-FY19 MDOT Disposed Vehicle Data: All the vehicles disposed by MDOT from the fiscal year 2015 to the fiscal year 2019.

Interviews

HKA supplemented its document review and data analysis with interviews conducted with MDOT personnel (both at the Central Office and District Offices 3 and 5) to fully understand the effectiveness of the processes and procedures employed by DOT staff to deliver projects.

HKA also reached out to various external stakeholders, including representatives of:

- Federal Highway Administration (FHWA) Mississippi Division Office;
- Counties and Cities who engage with MDOT on the delivery of local public agency (LPA) projects;
- Mississippi Office of State Aid Road Construction; and
- Mississippi construction industry.

Benchmarking against Peer Agencies

HKA performed a selective comparison of MDOT's project governance practices to those used by peer agencies to identify opportunities to adapt cost-reducing strategies successfully implemented by other agencies to MDOT's program. HKA focused primarily on the contiguous states of Tennessee, Louisiana, Alabama, and Arkansas. HKA also reviewed national data and best practice information published by the American Association of State Highway and Transportation Officials (AASHTO), FHWA, and other transportation research organizations.

1.3 Overview of MDOT

Capital Program

MDOT's Statewide Transportation Improvement Program (STIP) for Fiscal years 2019-2022 is a framework for needed project expenditures to support the continued development of the state's transportation system. The current MDOT system includes approximately 11,000 centerline miles of roadway statewide. This includes close to 700 centerline miles of interstate highway, over 2,500 centerline miles of U.S. Highway, and nearly 7,600 centerline miles of State Routes in three Commission and six Maintenance Districts.

As noted in the MDOT's STIP for FY 2019-2022, MDOT's capital program falls into four general categories: *Highway Capacity, System Preservation, Bridge Replacement, and Highway Safety Improvements*. The current program is weighted heavily towards system preservation of pavements, and to a lesser extent bridge replacements, and safety improvements. Capacity projects are prioritized by year of need, volume to capacity ratio, and Average Annual Daily Traffic (AADT) volumes in accordance with State statutes

(Vision 21). System preservation and bridge projects are prioritized and rated by pavement or structural condition, significance of the route and other factors. Safety improvements are based on potential for reducing accidents and fatalities.

MDOT, like many transportation agencies, has been monitoring the asset condition of the state-maintained pavements and bridges and investing in maintenance and preservation to ensure current asset and performance management activities meet the new Federal objectives for performance-based asset management. Its STIP was developed towards meeting established performance targets by allocating the maximum available funding to maintenance and preservation of state-maintained pavements and bridges and to safety.

MDOT's overall program spending and categories of expenditures for fiscal year 2018 is shown in the following tables:

MDOT Spending by Program FY2018

Program	FY2018 Actuals
Construction	$ 759,592,348
Maintenance	$ 188,624,517
Administration, Equip. & Buildings	$ 47,453,520
Enforcement	$ 14,528,055
Aero, Rails, Tran & Ports	$ 34,879,897
Debt Service	$ 74,547,603
Total	$ 1,119,625,940

MDOT Spending by Object FY2018

Program	FY2018 Actuals
Salaries and Benefits	$ 157,902,681
Travel	$ 1,704,233
Contractual Services	$ 111,669,806
Commodities	$ 34,379,977
Capital Outlay - Payments to Contractors	$ 603,786,034
Capital Outlay - Land and Buildings	$ 20,953,980
Capital Outlay - Equipment	$ 12,584,568
Subsidies - Payments to State Aid, Public Transit, & Debit Service	$ 176,644,661
Total	$ 1,119,625,940

Governance Structure

State departments of transportation employ various types of governance models. Most state departments of transportation are governed by a secretary, commissioner, or director, as well as a policymaking board or commission, which is the model that governs MDOT. However, Mississippi's model is unique in that its transportation commissioners are elected.

Organizational Structure

Consistent with industry trends towards increasing decentralization of program delivery (to move decision-making closer to the customer), MDOT's organizational structure includes six District Offices. The District Offices are responsible for much of the day-to-

day highway maintenance operations within the District, as well as the execution and oversight of construction projects.

Supporting these District efforts are Central Office personnel, who are responsible for establishing policies and procedures and for performing the research, design, materials management, and administrative functions needed to establish and implement the capital program.

Centralization of such core functions enhances programmatic consistency and eliminates redundancies. Similar to many other DOTs, MDOT's Central Office personnel are organized into different functional areas of specialized expertise, which provides efficiencies through the coordinated use of specialized technical skills and equipment.

MDOT currently has a total of 2,974 employees spread across the Central and various District offices. 905 (or just over 30 percent) of the employees report to the Central Office, while the remaining 2,069 are assigned to District Offices.

1.4 What does MDOT do well?

HKA's analysis showed that there are many things that MDOT currently does well in each of the individual areas of inquiry, as summarized below.

Organization and Staffing

- Recognizing that something must be done to improve employee recruitment and retention, MDOT has engaged a consultant to help evaluate its succession planning and knowledge management practices.
- MDOT's performance-based management system piloted by the Bridge Design Division is an innovative model for career development and promotion that MDOT should consider extending to other engineering divisions, such as Roadway Design. (Wider implementation of such a system would likely require coordination with the Mississippi State Personnel Board to establish mechanisms for tracking employee skill development and granting promotions.)

Consultant Services

- MDOT has implemented several best practices designed to ensure consultant contracts are awarded to the most qualified firm, at a fair and reasonable price, and are subsequently managed using an effective performance monitoring system.

Delivery of Capital Construction Projects

- MDOT solicits and evaluates bids in a fair and transparent manner.
- MDOT is developing a performance-based contractor prequalification system to help incentivize quality construction.
- Since 2011, MDOT has met FHWA's guidelines for estimate accuracy, with the State Estimate being within +/-10% of the low bid for at least 50% of the projects awarded each year. MDOT maintains a historical cost database, has a dedicated team of experienced Staff Estimators, and uses a uniform structure for preparing and presenting estimates.
- In response to difficult market conditions that often lack multiple bidders, MDOT strategically manages project lettings to encourage competition, and re-advertises projects when appropriate. (MDOT's re-advertisement of non-critical projects resulted in approximately **$4.5M in savings** from 2016 – 2018.)

• MDOT's Quality Assurance (QA) requirements for construction are generally reasonable, efficient, not overly restrictive, and allow the agency to remain cost effective while still providing appropriate assurance of the quality of the materials and manufactured products incorporated into work.
Maintenance
• MDOT was an early implementer of performance-based maintenance management and uses a performance-based maintenance management system.
Fleet Management
• In 2017 MDOT began installing GPS devices on all fleet vehicles. MDOT is now able to track among other things, idle time, speed alerts, harsh cornering, harsh braking, rapid acceleration, and similar information, and track if the issue occurred during working hours or not. Conservatively assuming 10 percent fuel savings due to GPS implementation, MDOT is likely saving upwards of $450,000 annually based on typical fuel expenditures of $4.5 million.
Local Public Agency (LPA) Program
• MDOT administers the program in strict accordance with FHWA guidelines for stewardship and oversight of federal aid projects administered by LPAs.

1.5 What could MDOT improve?

HKA's analysis also identified several recommendations that would allow it to improve the efficiency of its operations or generate cost savings. These recommendations are summarized below.

Recommendations	Potential Benefits
Organization and Staffing	
Resource Management 1. MDOT should conduct a workforce study (leveraging the labor productivity data collected in MDOT's AMMO system and the operational cost information in the equipment management system) to determine what maintenance functions should be supported with in-house labor and equipment and what should be outsourced. 2. Similarly, for engineering staff, MDOT should manage and track the time spent by internal engineering resources on active projects and, as a longer-term goal, use such information for better prioritization and management of design workloads and more rational and transparent decision-making regarding the need for outsourcing.	• Improved resource management • More rational and transparent decision-making and documentation of the justification to outsource vs. self-peform • Improved workload prioritization
Staff Retention 3. MDOT should establish a thoughtful career development process that acts to attract and retain experienced staff through exposure to diverse projects and transparent career advancement opportunities. The performance-based based management system implemented by the Bridge Design Division provides a good model to follow for engineering staff.	• Improved employee engagement and resource management

Recommendations	Potential Benefits
Knowledge Management 4. MDOT should implement a formal process for capturing and disseminating lessons learned from projects as a knowledge transfer and career development tool.	• Improved capture of institutional knowledge
Delivery of Capital Construction Projects	
Hiring Contractors 5. Improved competition will save costs. If MDOT had received at least 2 bids on 67 contracts in the audit sample that only attracted one bidder, it may have realized potential **savings of approximately $18M** in construction costs. As market conditions change or the program expands, MDOT should consider a formal contractor and supplier outreach program to enhance competition in the regions of the State with the lowest competition.	• MDOT's re-bidding of projects that initially received poor competition **saved $4.5 million** between 2016 and 2018
Cost Estimates 6. MDOT should assess project-specific risks and uncertainties to establish appropriate project contingency levels. 7. MDOT currently co-mingles contingency risk costs and construction engineering costs as a single budget line item. Construction engineering costs should be tracked as a separate line item to provide more visibility to the use of risk-related contingency funds for changes and quantity overruns.	• Improved understanding and visibility of how project risks can affect construction cost
Construction Cost Performance 8. Analysis of the 249 completed projects within the 3-year study period revealed that 52% were completed within budget and 48% were completed over budget resulting in a total overrun of $29M, primarily related to quantity variations. MDOT District Offices should require Project Engineers to improve the controls for actively tracking quantity variations, develop and use a standard template for tracking change orders, and more consistently document the reasons for quantity variations. 9. For the same 249 projects, 119 projects underran the budget. This appeared to be driven by overly conservative quantity estimates in the bid documents. This practice resulted in the **inefficient allocation of more than $23M**. MDOT should impart more rigor into its development of quantity estimates and discipline into its real-time monitoring and forecasting of potential overruns/underruns.	• Improved cost control and forecasts at completion • More efficient budget allocation through rigorous development of quantity estimates
Schedule Performance 10. Schedule growth appears to be closely correlated to project size and use of completion day contracts. For completion date contracts, MDOT should improve real-time schedule monitoring and forecasting of potential delays. 11. For the delivery of large projects with sensitive schedules and potential constructability challenges (i.e., similar to the active US 49 project), MDOT should consider requesting statutory authorization to use the CM/GC contracting method to potentially save delivery costs and time.	• Improved schedule management

Recommendations	Potential Benefits
Quality Management 12. MDOT should consider moving towards a more programmatic risk-based approach to inspection and sampling and testing to focus limited inspection resources on critical items of work. 13. Converting to a system-based Independent Assurance program for certain items can result in better utilization of qualified sampling and testing personnel and avoid duplication of sampling and testing effort. 14. Using alternative measurement and payment methods (e.g., plan quantities or lump sum items) for selected items or features of work that can be accepted without the need for detailed field measurements (e.g., pier caps, bridge deck, etc.) could relieve some of the burden placed on overextended field staff.	• Opportunity for cost savings and time savings and improved resource allocation of personnel
Maintenance	
Performance-Based Maintenance Management 15. MDOT should standardize the use of the AMMO system across all Districts and encourage its use as a planning tool for resources, equipment and commodities for more predictable maintenance activities. 16. MDOT should tie performance-based Level of Service (LOS) targets to budgeting and planning and scheduling estimates for maintenance to determine the most effective deployment of maintenance staff to meet the targets.	• Better planning for maintenance staffing and resources tied to performance targets and goals
Outsourcing Decisions 17. MDOT should selectively outsource maintenance work that can be demonstrated to be reasonably competitive and cost effective compared to retaining permanent in-house staff and equipment.	• More rational and transparent decision-making • Potential for cost savings
Rest Area Optimization 18. MDOT should carefully evaluate its welcome centers and rest areas on the state highway system and either close underutilized rest areas in the vicinity of available alternate private commercial facilities or reduce service unless (or until) needed for emergencies. Comparable studies conducted by other DOTs have identified significant savings in janitorial and operations costs. 19. As an alternative to closures, MDOT could explore opportunities to privatize rest areas using a lease agreement with a private developer/operator to generate income and provide additional services to the traveling public. (Note that this recommendation would require a change in state statutes to allow a private operator.)	• Opportunity for cost savings in janitorial and operations costs
Fleet Management	
Vehicle Utilization 20. MDOT should take incremental steps to eliminate non-commute vehicles from the fleet that are consistently underutilized. 21. MDOT should eliminate underutilized commuting vehicles (< 15,000 miles/year) and repurpose as non-commute assignments.	Potential savings due to the avoidance of future acquisition costs: • **$13M** by not replacing underutilized non-commute vehicles • **$895K** by not replacing underutilized commute vehicles

Recommendations	Potential Benefits
Optimization of Vehicle Replacement Schedule 22. MDOT should seek exemption from DFA's current fleet replacement policy and implement a more optimal strategy for major categories of vehicles and equipment in the fleet (both on-road and off-road) with the goal of reducing the overall age of the fleet and maximizing the salvage value	• Evaluating just pickup fleet with more than 150,000 miles, the projected savings are **$4.2M**.
Fleet Standardization 23. If the fleet were standardized to a few vehicle types or critical components, MDOT could potentially realize savings on parts, maintenance, repairs, and training, in addition to minimizing down time. (Note that this recommendation would require a change in DFA policy.)	• Potential for lower operating costs
Fleet Mechanics 24. MDOT should right size in-house vehicle maintenance staff in proportion to any reductions in fleet inventory.	• Reducing the number of mechanics by 20% (assuming a 20% reduction in vehicles) would lead to projected savings of up to **$600,000 annually**
Local Public Agency (LPA) Program	
25. MDOT should assess whether its internal LPA project development resources need to be increased to meet the demand for timely project development and concurrence reviews. Alternatively, reviews could be outsourced to others within MDOT or to consultants. 26. MDOT should consider implementing more robust LPA certification programs that would reduce its need for oversight and allow certified LPAs to use approved local standards and specifications and practice greater discretion regarding the use of federal funds. 27. MDOT should work with FHWA to increase the flexibility for LPAs to use federal funding where they need it most and allow projects to move forward earlier than they would otherwise.	• Expedited project delivery • Potential for significant cost and time savings to the LPA stemming from less stringent design and QA requirements

This page is intentionally left blank

2. Staffing

2.1 Introduction

Overview

The success of any organization, MDOT included, is largely dependent on the performance of its employees. The ability to develop and retain experienced staff is both an essential element and an indicator of an organization's success. Moreover, as analyzed in a 2014 Report to the Mississippi Legislature prepared by the Joint Legislative Committee on Performance Evaluation and Expenditure Review (PEER), substantial cost savings could be realized if MDOT had the internal resources to perform more engineering work in-house, thereby reducing the current reliance on more costly external consultants (PEER Report #581).

Considering the challenges transportation agencies nationwide are facing with staff retention in a competitive labor market, substantial growth in MDOT's staff resources is unlikely given the current salary structure. Assuming outsourcing of specialty work and peak-load demand will therefore remain unavoidable, this chapter focuses on the strategies MDOT is employing to develop and retain its existing staff structure so as not to lose vital institutional knowledge and the ability to effectively oversee work performed by others.

To provide context for these strategies, Section 2.2 first characterizes MDOT's current staff resources, focusing primarily on the engineering and maintenance staff who are critical to MDOT's mission of providing "a safe intermodal transportation network that is planned, designed, constructed and maintained in an effective, cost efficient, and environmentally sensitive manner." Section 2.3 then explores the following questions:

- What initiatives can MDOT implement, apart from increasing salaries, to help retain in-house engineering and project management expertise?
- Are formal training, career development paths, and succession plans established to help ensure a sustainable core workforce?
- Is a formal process in place to capture institutional knowledge and lessons learned as a growing number of experienced staff approach retirement?

Chapter Highlights

Area of Inquiry	How is MDOT performing?	Key Observations	Recommendations
Section 2.2: Organizational Structure and Staffing			
Organizational Structure	▲	• Consistent with industry trends to move decision-making closer to the customer, MDOT largely has a decentralized structure consisting of: – Six District Offices, responsible for much of the day-to-day highway maintenance operations – Central Office staff, responsible for establishing policies and procedures and for performing the research, design, materials management, and administrative functions needed to establish and implement the capital program	• Central Office staff could assume a stronger leadership role in harnessing the information available in MDOT's various information management systems (e.g., AMMO, STEMS) to identify trends and assist with workforce planning and outsourcing decisions.

Area of Inquiry	How is MDOT performing?	Key Observations	Recommendations
Staff Turnover (Maintenance)	■	• Similar to other DOTs nationally, MDOT struggles to attract and retain employees given the pay disparity between the public and private sector. MDOT salaries are also lower than the national and regional averages of other DOTs. • For maintenance workers, low wages are contributing to excessive turnover, leaving behind a largely inexperienced staff, who appear to be less efficient than their peers in other DOTs (as measured by the number of lane miles maintained per maintenance worker).	• Maintaining and preserving a deteriorating highway system with inexperienced crews and high turnover rates is not sustainable. If salaries cannot be increased, MDOT should conduct a workforce study to determine: – What activities can MDOT perform efficiently (using productivity rates that reflect the current crew composition and level of experience)? – What is the real cost (labor, equipment, and materials) for MDOT to perform these work activities in-house? – How competitive is the market for outsourced maintenance and repair work, which may entail unpredictable, low volume, and resource-intensive work? • Such information should then be used to make rational decisions regarding outsourcing vs. self-performance.
Staff Turnover (Engineering)	■	• Engineering Divisions are likewise experiencing heavy turnover and have difficulty retaining mid-level engineers. • MDOT may soon face a loss of institutional knowledge as its more senior-level workforce begins to retire. • To fill resource gaps, a significant amount of engineering design work is contracted out to private sector consultants. • Potential savings in contractual expenditures could be realized if MDOT had the resources to perform more engineering work in-house (as reported previously in PEER Report #581).	• Instituting a robust process to manage internal resources would allow for better prioritization and management of design workloads and more rational and transparent decision-making regarding the need for outsourcing.
Section 2.3: Staff Retention Strategies			
Recruitment and Retention	▲	• Recognizing that something must be done to improve employee recruitment and retention, MDOT has engaged a consultant to help evaluate its succession planning and knowledge management practices. • To allow for internal promotions, MDOT maintains several open positions that it can draw upon to promote talented employees.	• Establish a thoughtful career development process that acts to attract and retain experienced staff through exposure to diverse projects and transparent career advancement opportunities.

Area of Inquiry	How is MDOT performing?	Key Observations	Recommendations
Professional Development	▲	• To implement a rational promotion policy while also broadening the skillsets of its staff, MDOT's Bridge Design Division developed an innovative performance-based employee management system in January 2018. In the time since first piloting this system, the Bridge Design Division has realized the following benefits: – Better employee management – More in-house expertise – Increased project awareness • MDOT's Bridge Design Division estimates that newly developed in-house skills in steel plate girder designs will avoid $100,000 to $300,000 in consultant fees annually by reducing the need to outsource such design services.	• MDOT should extend this performance-based management system to other engineering divisions, such as Roadway Design. Although the exact framework (tasks, points, etc.) would be unique to each division, the approach used to develop the system could be modeled after the system successfully piloted by the Bridge Division. • As a longer-term goal, once more data has been collected, MDOT should use the information and metrics collected from the management system to better understand typical task durations for project planning purposes.
Knowledge Management	▲	• MDOT maintains a very detailed set of programmatic documents (e.g., manuals, standard practices, standard specifications, checklists, etc.), accessible online, that can be used to: – Counter the loss of institutional knowledge (e.g. when long-tenured staff retire or move to new positions); and to – Facilitate communication, training, and the regular re-evaluation of processes and standards.	• As part of the lessons learned process, MDOT should periodically review these manuals to determine if updates are needed.
Lessons Learned	●	• Lessons-learned appear to be only captured on an ad hoc basis. For example, one District has been working to identify common sources of change orders.	• MDOT would benefit from a formal process for capturing lessons learned from larger projects. • These lessons learned could then be used to facilitate regular (e.g., semi-annual or annual) workshops in which personnel from the various Districts and Central Office meet to discuss common issues and transfer knowledge. • As a longer-term goal, lessons learned should be archived into a readily accessible platform (e.g., a Sharepoint site) to assist future project development activities.

▲ MDOT meets or exceeds industry leading practices
● Potential for improvement
■ Policy or market condition largely out of MDOT's control

2.2 Organizational Structure and Staffing

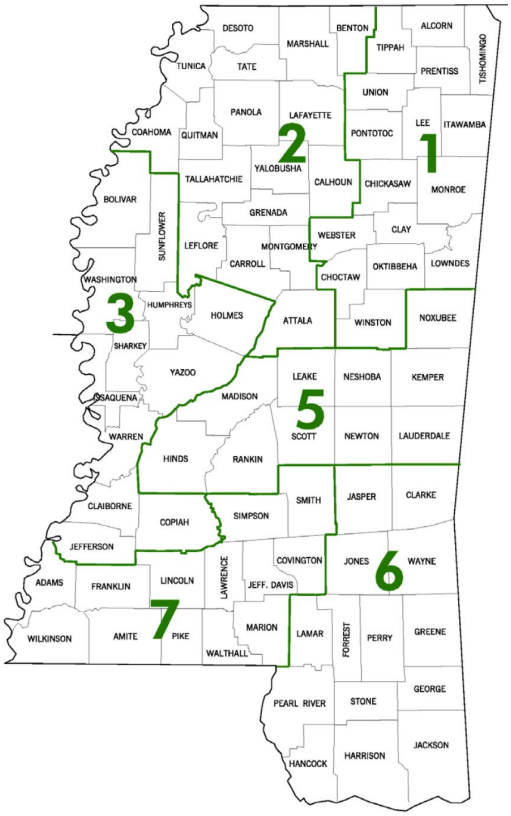
Organizational Management Structure

1. Consistent with industry trends towards increasing decentralization of program delivery (to move decision-making closer to the customer), MDOT's organizational structure includes six District Offices, as shown in Figure 2.2-1. The District Offices are responsible for much of the day-to-day highway maintenance operations within the District, as well as the execution and oversight of construction projects. Each District has a District Engineer who oversees, directs, and coordinates all MDOT operations within that District.

Figure 2.2-1: MDOT Organizational Structure

Six District Offices act as the "action arm" of MDOT, ensuring that the Department's mission is carried out.

Central Office staff (i.e., "Headquarters") provides support in the form of setting policies and procedures and performing the research, design and administrative functions needed to establish and implement the capital program.



MDOT Districts:

District 1: Alcorn, Chickasaw, Choctaw, Clay, Itawamba, Lee, Lowndes, Monroe, Oktibbeha, Pontotoc, Prentiss, Tippah, Tishomingo, Union, Webster, and Winston.

District 2: Attala, Benton, Calhoun, Carroll, Coahoma, DeSoto, Grenada, Lafayette, Leflore, Marshall, Montgomery, Panola, Quitman, Tallahatchie, Tate, Tunica, and Yalobusha.

District 3: Bolivar, Claiborne, Copiah, Holmes, Humphreys, Issaquena, Jefferson, Sharkey, Sunflower, Warren, Washington, and Yazoo.

District 5: Hinds, Rankin, Madison, Noxubee, Kemper, Lauderdale, Neshoba, Newton, Leake, and Scott.

District 6: Clarke, Jasper, Wayne, Jones, Greene, Perry, Forrest, Lamar, George, Stone, Pearl River, Jackson, Harrison, and Hancock.

District 7: Adams, Amite, Covington, Franklin, Jefferson Davis, Lawrence, Lincoln, Marion, Pike, Simpson, Smith, Walthall, and Wilkinson

(There is no longer a District 4.)

2. Supporting these District efforts are Central Office personnel, who are responsible for establishing policies and procedures and for performing the research, design, materials management, and administrative functions needed to establish and implement the capital program. Centralization of such core functions enhances programmatic consistency and eliminates redundancies.

3. As a direct result of some of the staffing challenges cited later in this section, MDOT has increasingly been resorting to outsourcing certain activities that were historically performed in-house.

    a. For example, to help fill resource gaps, a significant amount of engineering design work for roadways and bridges is now contracted out to private sector consultants.

    b. For the most part, MDOT's maintenance program activities continue to be performed by in-house District staff. However, voluntary turnover in

response to a competitive labor market is resulting in significant knowledge and experience gaps that threaten the ability of MDOT to continue to perform more specialized work (e.g., seal coating) with in-house forces.

Staff Numbers

4. MDOT currently has a total of 2,974 employees spread across the Central and various District offices.

    a. As summarized in Table 2.2-1 below, 905 (or just over 30 percent) of the employees report to the Central Office, while the remaining 2,069 are assigned to District Offices.

    b. Befitting their role as the "action arm" of MDOT, District personnel on average fall into the following categories:

        - Maintenance staff – 53%
        - Engineers and engineer technicians – 31%
        - Other positions (including mechanics, administrators, bridge inspectors, etc.) – 17%

    c. Compared to the Districts, the Central Office has a larger number of engineers, in addition to several other specialty roles including enforcement officers (163), information analysts and systems administrators (86), accountants/auditors (39), and other non-operational administrative functions.

Table 2.2-1: Filled Staff Positions by Location (as of November 2019)

Location	Engineers[1]	Engineer Tech	Maintenance[2]	Mechanics	Admin	Other	Grand Total
District 1	21	89	184	11	10	26	**341**
District 2	28	88	198	13	11	35	**373**
District 3	15	47	133	10	14	20	**239**
District 5	29	137	203	20	19	33	**441**
District 6	24	101	186	11	19	44	**385**
District 7	14	64	169	11	12	20	**290**
Central Office	123	99	33	4	63	583[3]	**905**
Grand Total	**254**	**625**	**1,106**	**80**	**148**	**761**	**2,974**

1. Includes Engineers, Engineer Administrator Assistant, Engineer Bureau Administrator, & Engineer Division Administrator
2. Includes Maintenance Technician, Maintenance Support, & Maintenance Operation Manager
3. Includes Enforcement Officers (163), Accountants/Auditors (39), information systems analysts and administrators (86), and other roles

5. Similar to many other DOTs, MDOT's Central Office personnel are organized into different functional areas of specialized expertise (see Table 2.2-2). Given MDOT's current focus on system preservation, this organizational structure provides efficiencies through the coordinated use of specialized technical skills and equipment.

Table 2.2-2: Central Office Employee Distribution by Division

Central Office Divisions	# of Employees	% of Central Office Total
Office of Enforcement	196	21.66%
Information Systems	89	9.83%
Traffic Engineering	76	8.40%
Materials	73	8.07%
Central Services	52	5.75%
Roadway Design	46	5.08%
Planning	40	4.42%
Bridge Design	39	4.31%
Financial Management	37	4.09%
Right of Way	32	3.54%
Human Resources	28	3.09%
Environmental	20	2.21%
Maintenance	18	1.99%
Construction	15	1.66%
Public Transit	13	1.44%
Contract Administration	13	1.44%
Procurement	12	1.33%
Research	11	1.22%
Public Affairs	9	0.99%
Highway and Rail Safety	9	0.99%
Asset Management	8	0.88%
Consulting Contractual Services	7	0.77%
Office of Civil Rights	7	0.77%
Audit	6	0.66%
Office of Administrative Services	6	0.66%
Office of Highways - Chief Engineer	6	0.66%
Programming	5	0.55%
Budget	5	0.55%
Local Public Agencies	4	0.44%
Transportation Commission - Southern	3	0.33%
Transportation Commission - Central	3	0.33%
Ports and Waterways	3	0.33%
Aeronautics	3	0.33%
Office of Intermodal Planning	2	0.22%
Transportation Commission	2	0.22%
Office of Executive Director	2	0.22%
Transportation Commission - Northern	2	0.22%
Administration - Operations	1	0.11%
Legal	1	0.11%
Administration – Pre-Construction	1	0.11%
Grand Total	**905**	**100.00%**

Staff Salary

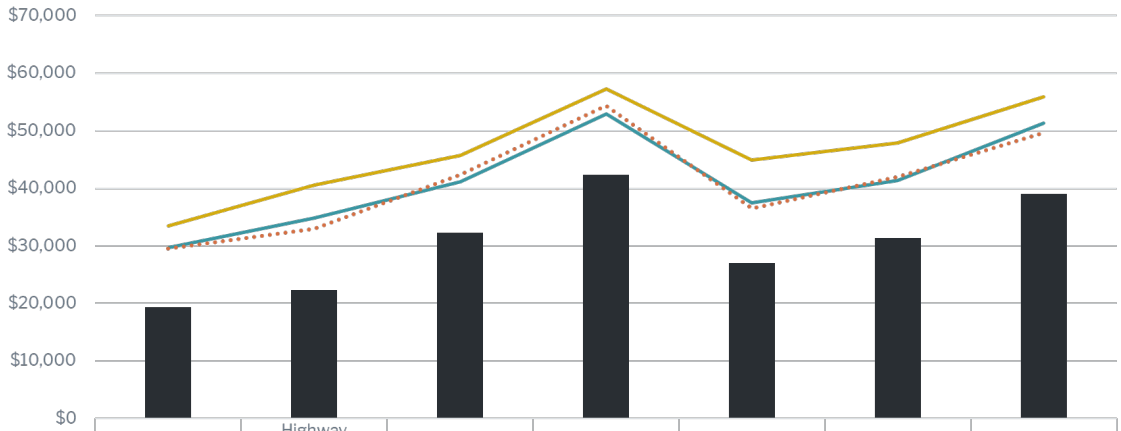
6. Salaries of MDOT staff are set by the State Personnel Board.

7. Similar to other DOTs nationally, MDOT struggles to attract and retain employees given the pay disparity between the public and private sector.

8. In addition to losing talent to the private sector, MDOT claims that higher wages offered by other public sector agencies (including the DOTs of surrounding states and counties within Mississippi) are also contributing to the voluntary turnover seen amongst maintenance workers and design engineers.

9. Focusing first on maintenance workers and mechanics, Figure 2.2-2 demonstrates that the average salary for MDOT employees ranks below the averages seen nationally across all DOTs as well as on a more regional basis (i.e., in the DOTs comprising AASHTO Region 2 and in the DOTs of the States contiguous to Mississippi).

Figure 2.2-2: Comparison of Average Salary for Maintenance and Mechanic Positions
(Data source: 2018 American Association of State Highway and Transportation Officials (AASHTO) Salary Survey)



	Highway Maintenance Worker Entry	Highway Maintenance Worker Intermediate	Highway Maintenance Worker Senior	Highway Maintenance Supervisor	Equipment Mechanic Intermediate	Equipment Mechanic Senior	Equipment Mechanic Supervisor
MS Actual Avg	$19,373	$22,296	$32,260	$42,344	$27,031	$31,411	$39,023
National Avg	$33,429	$40,600	$45,718	$57,283	$44,916	$47,868	$55,895
AASHTO Region 2	$29,675	$34,842	$41,199	$52,897	$37,498	$41,326	$51,334
Contiguous states	$29,501	$32,915	$42,387	$54,370	$36,534	$42,063	$49,642

Note: AASHTO is a nonprofit, nonpartisan association representing highway and transportation departments in the 50 States, including the District of Columbia and Puerto Rico.
AASHTO Region 2 includes the following states: Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Puerto Rico, South Carolina, Tennessee, Virginia, West Virginia. The contiguous states include Alabama, Arkansas, Louisiana, and Tennessee.

Key Takeaway: The average salary for MDOT's maintenance workers and mechanics ranks below the averages seen nationally across all DOTs, in the DOTs comprising AASHTO Region 2, and in the DOTs of the States contiguous to Mississippi.

a. Specifically, the salaries of MDOT's maintenance workers are on average:

- 36% less than the national DOT average;
- 28% less than the AASHTO Region 2 average (with AASHTO Region 2 including the DOTs in Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Puerto Rico, South Carolina, Tennessee, Virginia, and West Virginia); and

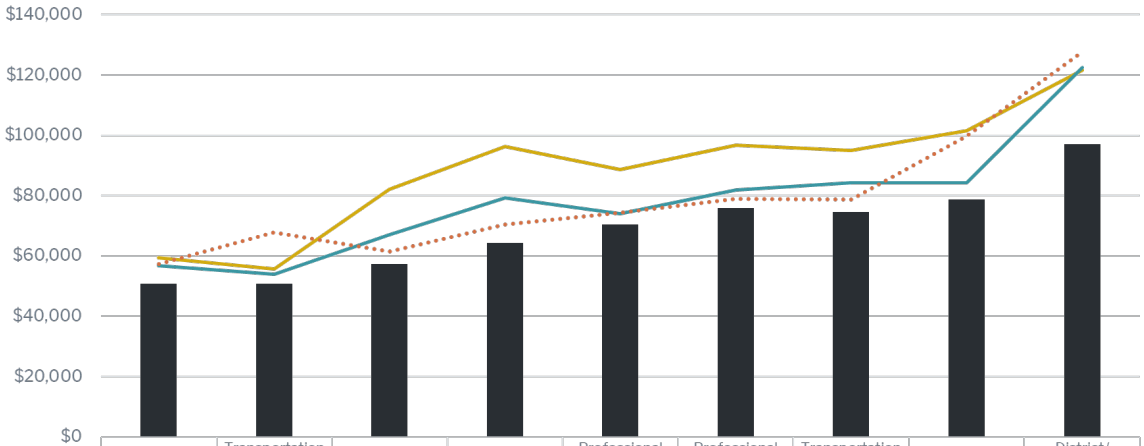
- 28% less than the average of the DOTs in the contiguous states of Alabama, Arkansas, Louisiana, and Tennessee.

b. Likewise, the salaries of MDOT's mechanics are on average:

- 35% less than the national DOT average,
- 25% less than the AASHTO Region 2 average, and
- 24% less than the average of the surrounding states.

10. Figure 2.2-3 shows that MDOT also ranks below the national, AASHTO Region 2 and contiguous state averages for salaries paid to engineers.

Figure 2.2-3: Comparison of Average Salary for Engineering Positions
(Data source: 2018 American Association of State Highway and Transportation Officials (AASHTO) Salary Survey)



	Transportation Engineer-in-Training	Transportation Engineer-In-Training Intermediate	Transportation Engineer-in-Training Senior	Professional Transportation Engineer	Professional Transportation Engineer Intermediate	Professional Transportation Engineer Senior	Transportation Engineer Project Supervisor	Transportation Engineer Manager	District/ Division Bureau Transportation Engineer
MS Actual Avg	$50,855	$50,855	$57,451	$64,326	$70,467	$75,885	$74,538	$78,851	$97,190
National Avg	$59,370	$55,668	$82,036	$96,415	$88,709	$96,685	$95,016	$101,570	$121,567
AASHTO Region 2	$56,848	$54,046	$67,027	$79,299	$74,068	$81,890	$84,304	$84,277	$122,462
Contiguous states	$57,441	$67,862	$61,573	$70,479	$74,334	$78,941	$78,730	$99,748	$127,583

Note: AASHTO is a nonprofit, nonpartisan association representing highway and transportation departments in the 50 States, including the District of Columbia and Puerto Rico.
AASHTO Region 2 includes the following states: Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Puerto Rico, South Carolina, Tennessee, Virginia, West Virginia. The contiguous states include Alabama, Arkansas, Louisiana, and Tennessee.

Key Takeaway: MDOT also ranks below the national, AASHTO Region 2 and contiguous state averages for salaries paid to engineers.

---

a. In contrast to the maintenance workers and mechanics, the salaries that MDOT can offer engineers is more in line with, but still below, the averages reported by the surrounding states and AASHTO Region 2, particularly for entry-level and less experienced engineers.

b. Specifically, the average MDOT salary for engineers is 11% less than the AASHTO Region 2 average and 12% less than the average of the surrounding states.

c. The average MDOT entry level salary for engineers (i.e., Engineer-in-Training) is relatively competitive, even compared to the national average.

d. As engineers gain more experience, MDOT salaries begin to significantly diverge from the national average, while remaining somewhat in line with the regional average (where demographics are expected to be more comparable).

e. At the most senior level (district or divisional head), MDOT engineers are far below both national and regional averages.

Focus on MDOT Maintenance Staff

11. As shown earlier in Table 2.2-1, MDOT has a total of 1,106 maintenance workers, who fill the positions of maintenance technicians, maintenance support, and maintenance operation managers. Comparing this staff size to that reported by other DOTs in response to the 2018 AASHTO Salary Survey[1], MDOT has more maintenance workers than the national DOT average of 1,034, but less than the AASHTO Region 2 average of 1,315 and the contiguous state average of 1,174.

12. To better represent the relative size of maintenance staffs across different DOTs, Figure 2.2-4 displays the number of lane miles[2] per DOT maintenance worker by State.

    a. This ratio (lane miles per maintenance worker) was obtained by dividing the total number of lane miles maintained by each State DOT (based on statistics compiled by FHWA[3]) by the number of maintenance workers within that DOT (based on the 2018 AASHTO Salary Survey data).

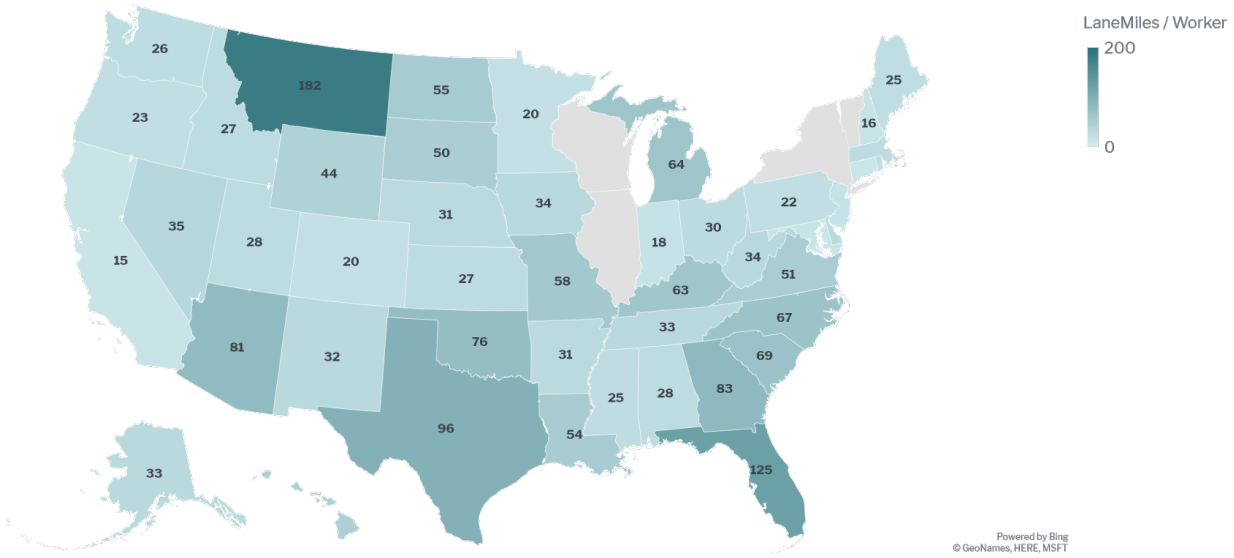
    b. As shown, MDOT has a ratio of 25 lane miles per worker, which is the 13th lowest out of the 46 States responding to the AASHTO survey.

    c. All things being equal, the higher the ratio, the more efficient the maintenance program (i.e., each worker would be responsible for a greater area of roadway). It is important to note, however, that several other factors influence the size of a DOT's maintenance force, including:

        - The degree to which a DOT outsources certain maintenance functions, whether to the private sector or to local counties or municipalities (note that MDOT largely self-performs most highway maintenance functions);
        - The relative experience levels of staff; and
        - The relative condition of the roads being maintained.

[1] https://store.transportation.org/Item/PublicationDetail?ID=4193
[2] Lane miles are used to measure the total length and lane count of a given highway or road. Lane miles are calculated by multiplying the centerline mileage of a road by the number of lanes it has.
[3] https://www.fhwa.dot.gov/policyinformation/statistics/2018/hm81.cfm

Figure 2.2-4: Lane Miles per Maintenance Worker



The map displays the ratio of lane miles per DOT maintenance worker in each state, as obtained by dividing the total number of lane miles maintained by each DOT (based on statistics compiled by FHWA) by the number of maintenance workers within that DOT (based on the 2018 AASHTO Salary Survey data).

The darker the color of the State, the more lane miles per worker. States with gray shading did not submit data.

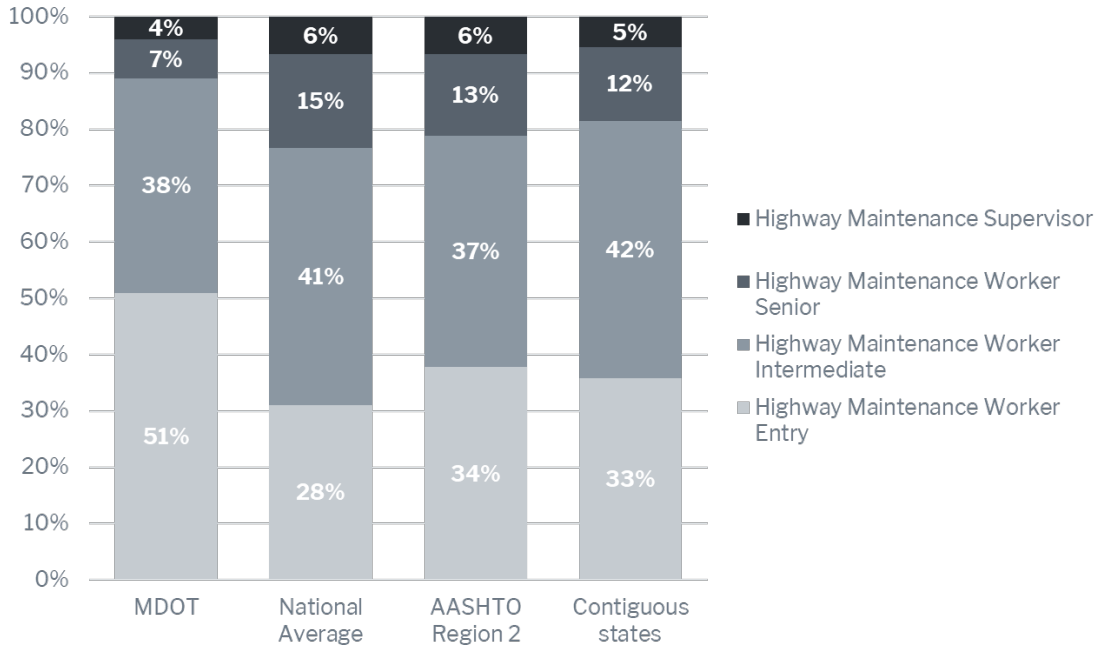
Key Takeaway: MDOT has a relatively large maintenance force in comparison to other DOTs. Factors that could affect the number of internal maintenance staff include the degree of outsourcing performed as well as the relative experience level of staff.

13. Likely contributing to the size of MDOT's maintenance force is staff inexperience. As shown in Figure 2.2-5 below, a much higher percentage of MDOT maintenance workers are entry-level compared to the national and regional averages.

    a. Such data support MDOT's contention that high turnover occurs at the entry-level position, which creates a continual vacuum of experienced maintenance crews with the knowledge, skills, and leadership abilities needed to efficiently carry out maintenance operations.

    b. As characterized by an MDOT District employee, "inexperience is MDOT's biggest efficiency eater."

Figure 2.2-5: Relative Experience of MDOT Maintenance Staff
(Data source: 2018 American Association of State Highway and Transportation Officials (AASHTO) Salary Survey)



Key Takeaway: A much higher percentage of MDOT maintenance workers are entry-level compared to the national and regional averages.

14. According to District personnel, MDOT does not have difficulty attracting entry-level workers, who view working for the DOT as an important steppingstone towards obtaining valuable experience and credentials (e.g., Commercial Driver's Licenses).

15. Retaining these entry level workers is another matter. As previously demonstrated in Figure 2.2-2, MDOT's maintenance workers do not receive a competitive wage, even compared to those working for other public sector agencies. Once such workers obtain the requisite experience with MDOT, they generally move on to higher paying positions elsewhere.

16. Maintaining and preserving a deteriorating highway system with inexperienced crews and high turnover rates is not sustainable.

    a. Other DOTs and agencies across the country have addressed this challenge by handling maintenance and repairs using long-term on-call service contracts, that not only reduce the number of workers needed but also reduce the fleet size and the need for specialized equipment.

    b. For MDOT to determine a rational course of action regarding continuing to perform work in-house with employees that do not earn a competitive wage versus outsourcing, it should harness the workforce productivity information collected in its Accountability in MDOT Maintenance

Maintaining and preserving a deteriorating highway system with inexperienced crews and high turnover rates is not sustainable.

Operations (AMMO) system, along with the relevant utilization and operational cost information maintained in its equipment management system (STEMS), to determine:

- What activities can MDOT perform efficiently (using productivity rates that reflect the current crew composition and level of experience)?
- What is the real cost (labor, equipment, and materials) for MDOT to perform these work activities in-house?
- How competitive is the market for outsourced maintenance and repair work, which may entail unpredictable, low volume, and resource-intensive work?

c. Although some District Offices individually look at such information on an ad hoc basis, a more coordinated and systematic review should be conducted by Central Office personnel responsible for setting policies.

17. Another option to improve maintenance efficiency would entail placing more emphasis on recruiting seasoned employees or recent retirees from construction, trucking, military, or related industries who are interested in starting a second career at the DOT.

    a. Such employees tend to be less focused on salary, career ladders, and flexible schedules than their younger, entry-level counterparts, and could provide a much-needed infusion of knowledge and stability into the maintenance ranks.

    b. Drawing such personnel, however, would likely require modifying the benefits package (defined benefit vs. contribution plans) to make working at the DOT attractive as an encore career.

Focus on MDOT Engineering Staff

18. As previously reported in Table 2.2-1, MDOT employs 254 engineers with varying levels of experience. Figure 2.2-6 below shows how the engineering staff members are distributed across several different experience levels and job functions.

    a. 24 percent of the engineering staff have the title "Engineer-in-Training". Engineers-in-Training are generally recent college graduates with engineering degrees who are working towards acquiring licensure as a professional engineer. While such staff are a much-needed resource in any DOT, their relative inexperience limits the work they can perform.

    b. Professional Engineers and Intermediate Professional Engineers, who together make up 20 percent of MDOT's engineers, are licensed engineers in the State of Mississippi who tend to specialize in a particular engineering discipline such bridge design, with usually 1 to 4 years of professional experience following their time as an Engineer-in-Training.

    c. Senior Professional Engineers (27 percent of MDOT's engineering staff) are considered experts in their discipline and can approve, manage, and design projects.

---

d. The remaining 29 percent of the MDOT engineers hold management and leadership positions in the Districts or in the Central Office.

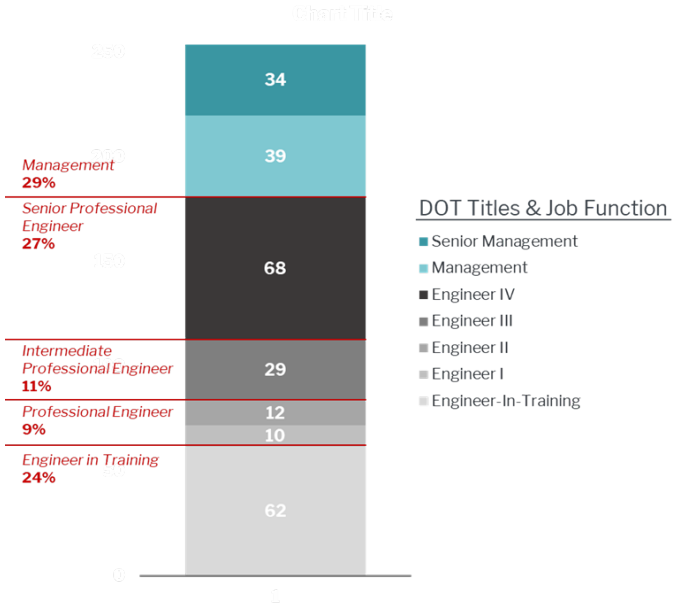
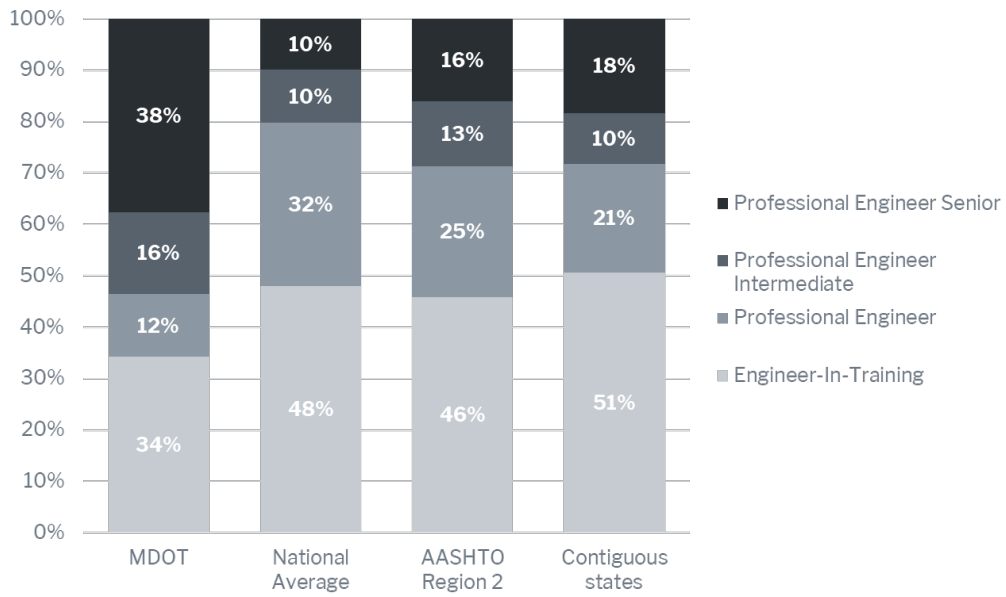


Figure 2.2-6: Distribution of Engineering Positions based on Experience Level and Job Function

The column chart illustrates the number of engineers employed by MDOT (254 in total). The descriptions on the left translate the MDOT titles according to the experience level and job functions seen in other agencies nationally.

19. Excluding those in management and leadership positions, MDOT has 181 engineers. Figure 2.2-7 compares the experience and classifications of these employees to the national and regional DOT averages.

Figure 2.2-7: Relative Experience of MDOT Engineers
(Data source: 2018 American Association of State Highway and Transportation Officials (AASHTO) Salary Survey)



Key Takeaway: In comparison to other DOTs, MDOT has a greater imbalance of engineering knowledge, with the majority of engineers falling into the senior-level classification. This suggests that MDOT may soon face a significant loss of institutional knowledge as this more senior-level workforce begins to retire.

20. As shown, MDOT has a relatively low percentage of mid-level engineers, suggesting that once MDOT's Engineers-in-Training receive the Professional Engineer credential, they are not necessarily inclined to stay on with the DOT.

21. In addition, the majority of MDOT's experienced engineers will soon be eligible for retirement, suggesting that MDOT may soon face a significant loss of institutional knowledge.

The last group of MDOT workers that had exposure to large-scale roadway capacity projects are quickly approaching retirement.

    a. Several DOTs have been challenged with finding ways to manage the knowledge gap left by a wave of retirees. Unlike most DOTs, however, MDOT has not embarked on a substantial new capacity program in decades, as financial constraints forced MDOT to focus its capital construction program on system preservation. Although preservation projects are vital to road user safety and comfort, they rarely offer opportunities for engineers to obtain or practice the highly specialized skillsets needed to design complex road and bridge projects. The last generation of MDOT workers that performed such work are among those in the impending retirement class.

    b. In the short-term, as MDOT continues to pursue relatively routine preservation projects, the loss of such specialized skills may not be strongly felt. However, the condition of MDOT's roadways suggests that substantial investment in reconstruction and new capacity cannot be pushed too far into the future, at which point the knowledge gap would become more pronounced and MDOT would likely require some assistance from specialty consultants.

Outsourcing Design Services

22. As could be expected given the staffing challenges noted above, MDOT has increasingly turned to outsourcing certain services to consultants.

    a. Table 2.2-3 identifies the number and value of consultant contracts executed on the behalf of various MDOT Divisions between fiscal years 2016 and 2018. The table also identifies the number of MDOT employees in these divisions.

    b. As shown, the most prominent users of consultant contracts (both by the number and aggregated dollar value of contracts) are the Bridge Design and Roadway Design Divisions.

Table 2.2-3: Consultant Contracts and Employees by Division (Fiscal Years 2016-2018)

Division	MDOT Employees	# of Contracts	Total Contract Amount
Bridge Design	39	189	$ 32,995,349.22
Roadway Design	46	104	$ 23,201,830.21
Planning	40	34	$ 9,117,910.93
Traffic Engineering	76	25	$ 4,644,311.05
Research	11	23	$ 3,883,160.24
Maintenance	18	8	$ 1,358,769.46
Materials	73	13	$ 1,153,836.38

Division	MDOT Employees	# of Contracts	Total Contract Amount
Environmental	20	27	$ 951,675.27
Office of Civil Rights	7	9	$ 558,655.75
Programming	5	17	$ 487,840.32
Local Public Agencies	4	4	$ 429,948.65
Consulting Contractual Services	7	3	$ 276,989.91
Construction	15	2	$ 224,669.25

The following division/contracts were excluded from this table due to comparatively negligible contract values: District 3, District 5, State Surveyor, US49 Construction Engineering/Inspection and Geotechnical Branch.

Key Takeaway: MDOT's Bridge and Roadway Design Divisions are the largest users of consultant services.

23. Based on the number and composition of staff within the Bridge Design and Roadway Design Divisions, as shown in Table 2.2-4, the need for consultant support is not surprising.

Table 2.2-4: Staff Breakdowns of Bridge Design and Roadway Design Divisions

Bridge Design Division		Roadway Design Division	
Role	**# of Employees**	**Role**	**# of Employees**
Administrative Assistant	2	Administrative Assistant	2
Bridge Inspector IV	2	District Surveyor Senior	2
Engineering Tech	1	Engineering Tech	22
Engineer-In-Training	13	Engineer-In-Training	4
Engineer I	0	Engineer I	3
Engineer II	2	Engineer II	2
Engineer III	3	Engineer III	1
Engineer IV	11	Engineer IV	5
Project Officer III	1	Administrator I	1
Engineer Administrator Assistant	3	Engineer Administrator Assistant	3
Engineer Division Administrator	1	Engineer Division Administrator	1
Total – Bridge Design Division	**39**	**Total – Roadway Design Division**	**46**

Key Takeaway: Resource gaps in Bridge Design and Roadway Design are driving these MDOT Divisions to increasingly outsource for design services.

24. PEER Report #581 found that MDOT could realize substantial cost savings (approaching $22 million annually) if it performed more design work in-house.

    a. However, given the current salary constraints, the likelihood of MDOT being able to attract and retain the engineering staff needed to minimize use of consultants is unlikely.

b. What MDOT can control is the processes by which it manages its consultants to ensure quality and prevent cost and scope growth. To this end, MDOT has implemented rigorous processes related to the hiring and managing of consultants (see Chapter 3 of this report). MDOT's implementation of such controls indicates that it understands the risks of outsourcing and is attempting to manage such risks.

c. An area that would benefit from a similar level of discipline and rigor relates to the time and utilization tracking of MDOT's own engineering staff. It would be beneficial for MDOT's internal workload planning and prioritization efforts if a system were in place that tracked in-house engineering personnel hours by project and task (similar to what MDOT requires of its consultants). Such data could then be used to make more rational decisions regarding outsourcing needs.

2.3 Staff Retention Strategies

1. Outside consultants and contractors can provide valuable support and expertise for performing specialized work assignments, as well as for managing peak workloads to avoid cyclic hiring. However, outsourcing must be balanced against the need to develop core competencies within DOT staff who can be held accountable for decision-making and project performance.

2. Because MDOT employees make attractive hires for the local consulting and contracting industries, MDOT needs to make a concerted effort to retain experienced staff on its payroll.

3. Modifying the salary and benefits structure (e.g., pension vesting) is largely out of MDOT's control. This section therefore focuses on the strategies that MDOT has or could implement to help retain talented employees through thoughtful career development paths and knowledge transfer activities.

Lack of staff resources having adequate knowledge and expertise increases the risk of:

- Inconsistent project oversight (leading to cost or schedule growth)
- Overreliance on consultants;
- Ineffective decision-making; and
- Stakeholder dissatisfaction

4. Promoting internal staff provides two key benefits:

   - It saves recruitment and training dollars, while also
   - Contributing to retention by helping staff see opportunities for advancement and their value to the organization.

5. To allow for internal promotions, MDOT maintains several open positions that it can draw upon to promote talented employees.

   a. At the time of the writing of this report, MDOT has 420 vacant positions. As seen on Table 2.3-1, 254 of these positions are in the Districts, with the majority being in the engineering and maintenance positions.

   b. Although some of these vacancies are not by choice (i.e., they reflect the difficulty MDOT has in attracting and retaining employees) others are administrative openings that MDOT maintains for the express purpose of ensuring the upward mobility of talented employees.

Table 2.3-1: Filled vs. Vacant Position

Location	Engineers[1]		Engineer Tech		Maintenance[2]		Mechanics		Admin		Other	
	Filled	Vacant	Filled	Vacant	Filled	Vacant	Filled	Vacant	Filled	Vacant	Filled	Vacant
District 1	21	4	89	15	184	27	11	2	10	1	26	4
District 2	28	1	88	12	198	11	13	4	11	2	35	4
District 3	15	7	47	10	133	6	10	1	14	-	20	4
District 5	29	3	137	25	203	19	20	1	19	1	33	2
District 6	24	3	101	13	186	23	11	6	19	-	44	15
District 7	14	3	64	6	169	14	11	1	12	-	20	4
Central Office	123	24	99	26	33	2	4	-	63	7	583	107
Grand Total	**254**	**45**	**625**	**107**	**1106**	**102**	**80**	**15**	**148**	**11**	**761**	**140**

1. Includes Engineers, Engineer Administrator Assistant, Engineer Bureau Admin, & Engineer Division Administrator
2. Includes Maintenance Technician, Maintenance Support, & Maintenance Operation Manager

6. MDOT should recognize motivated and talented employees and ensure there is a formal career development process in place that:

    - Allows such employees to gain valuable on-the-job experience on a diverse set of projects;
    - Encourages and supports continuing industry education (e.g., training provided by organizations such as the FHWA National Highway Institute); and
    - Provides opportunities for staff to actively engage in national or local association activities (e.g., AASHTO Subcommittees on Materials & Pavements, Construction, Bridges & Structures, and Maintenance) by seeking out speaking engagements and assuming leadership roles.

7. To implement a rational promotion policy while also broadening the skillsets of its staff, MDOT's Bridge Design Division developed and piloted an innovative performance-based employee management system in January 2018.

    a. Recognizing that the historic 30-year career ladder with the DOT was no longer a realistic proposition given the upwardly mobile expectations of today's generation of workers, the Bridge Division sought to standardize the process by which an employee could more quickly advance to the level of Engineer IV (e.g., within ten years).

    b. To develop this system, the Division assigned points to various engineering tasks (e.g., designing a bridge replacement = 250 points; checking plans = 50 points, etc.) and developed detailed forms by which employees could track their accomplishments and for management to sign-off on the acceptability of the work produced.

Employee Engagement

Recognizing that something must be done to improve employee recruitment and retention, MDOT has engaged a consultant to help evaluate its succession planning and knowledge management practices.

c. Once an employee earns a certain amount of points (e.g., 1,000 points = Engineer II; 1,800 points = Engineer III; 3,000 points = Engineer IV) a promotion and salary raise will follow, if allowable under MDOT's human resources budget.

d. The points system, by design, ensures that motivated staff will be exposed to a variety of different tasks (e.g., to move up quickly, one could not just do quality checks), and encourages them to build expertise, either through their own research efforts or by seeking mentoring and advice from subject matter experts within the Department.

MDOT's Bridge Design Division cites the following benefits stemming from its performance-based management system:

- More in-house expertise
- Increased project awareness
- Better employee management

e. In addition to providing more visibility to staff accomplishments, tracking of the work tasks being performed by individual staff members also allows Division management to better balance work activities (e.g., to identify if certain staff have been overly burdened with certain tasks while having minimal exposure to other activities).

f. As a longer-term goal, once more data has been collected and learning curves have been overcome, Division management can use the information to better understand typical task durations for project planning purposes.

g. According to the Bridge Design Division, in addition to improving employee engagement, the performance-based management system has also fostered an increase in internal design expertise. For example, MDOT estimates that newly developed in-house skills in steel plate girder designs will avoid $100,000 to $300,000 annually in consultant fees by reducing the need to outsource such design services.

8. A logical extension of this performance-based management system would be to other engineering divisions within MDOT, such as Roadway Design. Although the exact framework (tasks, points, etc.) would be unique to each division, the approach used to develop the system could be modeled after that successfully implemented by the Bridge Division.

9. Regarding the training and development of non-design staff (e.g., maintenance staff and inspectors working in the District Offices), partnering less experienced personnel with more seasoned staff is a common practice in the Districts. Texas DOT has had success with the implementation of a more formal Inspector Development Program that entails a one-week, intensive Inspector Boot Camp that is then followed by a probationary period of on-the-job training, in which new hires are mentored by more seasoned inspection staff. Texas DOT has also partnered with industry (AGC) on the development of the "We Build Texas" program, which is designed to help foster best practices in both DOT and contractor personnel.

10. MDOT should also remain sensitive to the work-life balance of its staff, particularly short-handed inspectors that must work long hours and night shifts to keep pace with a contractor on an aggressive schedule.

    a. To avoid such overextension of construction inspection staff (which contributes to the turnover seen in the District Offices), MDOT should judiciously apply time-based contractual incentives (e.g., A+B bidding techniques) only on projects that truly require completion by a certain date.

b. To further alleviate some of the inspection burden, MDOT should consider, as suggested in Section 4.5, moving towards more streamlined acceptance and payment methods (e.g., lump sum or plan quantities) for certain items of work (e.g., pier caps, bridge decks) to allow inspectors to focus on critical quality assurance activities instead of compiling and computing quantities for payment purposes.

Knowledge Management

11. MDOT maintains a very detailed set of programmatic documents (e.g., manuals, standard practices, standard specifications, checklists, etc.) that can be used to:

    - Counter the loss of institutional knowledge (e.g. when long-tenured staff retire or move to new positions); and to
    - Facilitate communication, training, and the regular re-evaluation of processes and standards.

12. MDOT would also benefit from a formal process for capturing lessons learned in a manner that could be used to inform future project development activities.

    a. Lessons-learned appear to be primarily captured on an ad hoc basis. For example, one District has been working to identify common sources of change orders.

    b. As a closeout activity on larger projects, lessons learned should be discussed and documented using a standard format. This could include the creation of project "report cards" to evaluate the extent to which the project met performance goals and to document what went well and what did not go as expected.

    c. These lessons could then be used to facilitate regular (e.g., semi-annual or annual) workshops in which personnel from the various Districts and Central Office meet to discuss common issues and transfer knowledge.

    d. As a longer-term goal, lessons learned should be archived into a readily accessible platform (e.g., a Sharepoint site) to assist future project development activities.

2.4 Summary

Similar to other DOTs nationally, MDOT struggles to attract and retain employees given the pay disparity between the public and private sector and often contracts out for services to fill resource gaps.

Focusing on matters within MDOT's control (i.e., strategies that do not entail salary increases), HKA offers the following recommendations to help ensure MDOT maintains a robust workforce while making rational decisions regarding when to outsource.

Recommendations	Potential Benefit
1. Conduct a workforce study (mining the labor productivity data collected in MDOT's AMMO system and the operational cost information in the equipment management system) to determine	More rational and transparent decision-making

Recommendations	Potential Benefit
what maintenance functions should be supported with in-house labor and equipment.	
2. Begin to manage and track the time spent by internal engineering resources on active projects and, as a longer-term goal, use such information for better prioritization and management of design workloads and more rational and transparent decision-making regarding the need for outsourcing.	Improved resource management and workload prioritization
3. Extend the performance-based management system implemented by the Bridge Design Division to other engineering divisions, such as Roadway Design.	Improved resource management and capture of institutional knowledge
4. Implement a formal process for capturing and disseminating lessons learned.	Improved capture of institutional knowledge

3. Consultant Services

3.1 Introduction

Overview

As a result of the internal staffing constraints discussed in Chapter 2 of this report, MDOT now outsources some design and engineering functions to consultants. Even though such services generally represent only a fraction of the cost of a construction project, they can strongly influence overall project outcome (from a cost, time, and quality perspective), in addition to affecting the safety and welfare of the public. For this reason, the processes by which MDOT selects consultants and administers consultant contracts are critical to the successful delivery of MDOT's capital program.

As discussed in this chapter, MDOT has implemented several best practices designed to ensure consultant contracts are awarded to the most qualified firm, at a fair and reasonable price, and are subsequently managed using an effective performance monitoring system.

Chapter Highlights

Area of Inquiry	How is MDOT performing?	Key Observations	Recommendations
Section 3.2: Hiring Consultants			
Procurement Process	▲	• MDOT has recently finalized its Consultant Services Unit (CSU) Manual, which addresses the Procurement, Management, and Administration of Engineering and Design-Related Services. • MDOT has implemented a well-designed consultant procurement process consisting of the following best practices: – Centralized, dedicated team of procurement professionals working to ensure that the procurement process is consistently carried out in accordance with laws and best practices – Formal policies and procedures, as implemented through the development of a detailed manual, standard forms, and a robust electronic consultant services software tool	• The CSU should formally roll-out the new manual (e.g., through training or "lunch-and-learn" sessions) to project managers responsible for consultant oversight.
Contract Negotiation and Award	▲	• Adequate contract negotiation processes are in place to ensure consultant services are obtained at a fair and reasonable price. • MDOT maintains standard contract templates that have undergone review and approval by the MDOT Legal Division and FHWA.	Same as above

Area of Inquiry	How is MDOT performing?	Key Observations	Recommendations
Section 3.3: Consultant Contract Administration			
Cost Control Measures	▲	• MDOT has implemented a robust consultant progress reporting process, which allows for detailed tracking of work completed and progress achieved against the approved project management plan.	MDOT should assess the feasibility of extending some of the best practices successfully implemented on consultant contracts to the construction program. For example, larger construction contracts would benefit from: • Development of project management plans • Earned-value progress monitoring and reporting

▲ MDOT meets or exceeds industry leading practices
● Potential for improvement
■ Policy or market condition largely out of MDOT's control

3.2 Hiring Consultants

Procurement Methods

1. MDOT, like many public owners, has long recognized the significant role played by designers and engineers in determining a project's overall construction and whole-life costs, and therefore focuses on selecting the most-qualified firms (not those that submit the lowest bid) to design projects.

2. As summarized in Table 3.2-1, MDOT has four methods by which it can select consultants to provide professional services, all of which emphasize identifying qualified individuals or firms to perform the specific scope of work required.

Table 3.2-1: Methods Available to MDOT to Hire Consultants

Method	Applicability
Competitive Negotiation (Qualifications-Based Selection) – an open and competitive procurement process under which the most appropriate professional or firm is selected on the basis of non-price factors, such as their demonstrated competence, qualifications, and experience to provide the type of professional services required. Price negotiations only commence once the top-ranked firm has been selected.	All engineering and design-related services in excess of the federal simplified acquisition threshold defined in 48 CFR 2.101 (currently $250,000) and for which there is adequate competition
Small Purchase – a streamlined process which bypasses open advertisement and instead allows for the selection of a consultant out of a minimum of 3 qualified firms considered. Price negotiations commence once a consultant has been selected.	Engineering and design-related services and other professional services for contracts less than the federal simplified acquisition threshold (currently $250,000)
Noncompetitive – selection of a preferred consultant without consideration of other firms. This method may only be used if contract award under the competitive negotiation or small purchase procedures are not feasible.	Applicability is limited to the following circumstances and requires written justification of need: • Sole Source (only one source can provide the required service) • Emergency (circumstances do not allow the time necessary to conduct competitive negotiations) • Inadequate competition
Alternative Methods, including best value processes which consider both price and non-price factors (e.g., qualifications, time, etc.)	Non-engineering and non-design professional services

Key Takeaway: Unlike the procurement of construction services (in which price serves as the primary criterion for selection), the hiring process for consultants generally focuses on finding the most qualified and experienced firms to perform the services required, in recognition of the significant role played by designers and engineers in determining a project's overall construction and whole-life costs.

3. Of the methods identified in Table 3.2-1, MDOT most commonly applies the Qualifications-Based Selection (QBS) process to procure engineering and design-related services (consistent with the Brooks Architect-Engineer's Act [40 USC 1101 *et seq.*]).

Congress passed the Brooks Act in 1972 to establish a qualifications-based approach to procuring design services for public projects; this approach continues to serve as a model for most State and public agencies, including MDOT.

   a. QBS is designed to allow procurement officials to identify the most appropriate professional or firm based on qualifications (e.g., knowledge, skill, experience, and other project-specific factors), rather than on the cost of their services. Fair and reasonable fees are then negotiated with the top-ranked firm for an agreed-upon scope of services.

   b. Not considering price or fees in the *initial* selection process helps to ensure the public receives a high quality and safe design by removing any pressure for firms to reduce design standards and/or limit the level of service provided to be price-competitive in a low-bid contest (e.g., by using less experienced personnel, evaluating fewer alternates, developing plans with minimal details that leave decision-making to the contractor, etc.).

Placing the focus on qualifications allows MDOT to select the consultant best suited for the task at hand.

   c. Under QBS, pricing is not eliminated from the procurement process; it simply is deferred until after the most qualified firm has been identified and a detailed scope of work has been jointly developed by MDOT and the selected firm. Even then, if a fair and reasonable price cannot be negotiated, MDOT can terminate the negotiations and begin discussions with the second ranked firm.

4. QBS processes provide organizations considerable latitude to select engineers and architects using a wide range of criteria. Given the potential subjectivity involved, it is essential for the selection process to be standardized to the extent possible and managed by fully trained and qualified procurement professionals to ensure that the process is consistently carried out in accordance with laws and best practice.

5. To this end, MDOT has implemented the following best practices designed to prevent abuse and/or favoritism, ensure a fair and competitive process, and provide the best value to the taxpayer:

MDOT's Consultant Services Unit (CSU) provides effective oversight of consultant procurement, management, and administration activities , ensuring processes are consistently carried out in accordance with laws and best practice.

   - Establishment of a centralized Consultant Services Unit (CSU) to assist the Divisions and Districts with the procurement, management, and administration of engineering and design-related services;

   - Development of a detailed manual to describe the processes and procedures MDOT has implemented to ensure a qualified consultant is obtained through a fair and transparent selection process;

   - Development and implementation of a robust electronic software system (referred to as the "Consultant Services Tracking System" [CSTS]) to streamline the consultant procurement and management process; ensure the necessary reviews and authorizations take place; and support the documentation and recordkeeping of proposal evaluations, consultant work assignments, and post-performance evaluations, among other features;

   - Use of standardized forms (incorporated into the CSTS software tool) to document the need for consultant services; to estimate the level of effort,

schedule, and costs of those services (for use in subsequent fee negotiations); and to document and provide an audit trail of the proposal evaluation process;

- Formal briefings of personnel assigned to evaluate proposals (i.e., to serve on a "Selection Committee") on selection procedures and the importance of an objective and impartial selection process;

- Adoption of standards of conduct to identify and avoid potential conflicts of interest by MDOT employees involved in consultant selection and/or contract administration activities; and

- Requirements for consultants to disclose in writing any information concerning potential conflicts of interest.

---

6. As described in Table 3.2-2, MDOT has three main contract types from which to choose when retaining consultants. The CSU has the flexibility to apply the contact type that best aligns with project-specific needs.

Contract Negotiation and Award

Table 3.2-2: Contract Types Used by MDOT

Contract Type	Benefit
Project-Specific – contract for the performance of services and a defined scope of work related to a specific project.	Allows for the competition of a narrowly defined scope of work and the selection of a consultant best suited to complete that scope of work
Multiphase – a project-specific contract in which services are divided into phases	Allows for the incremental development, negotiation and authorization of work as the project progresses and more information regarding project needs becomes available
Indefinite Delivery / Indefinite Quantity (IDIQ) – master contracts, awarded under a competitive negotiation process, under which work assignments are issued to consultants on an as-needed or on-call basis	Although the original selection of the IDIQ consultants may be resource-intensive, thereafter the work order assignment process provides MDOT with an efficient means of quickly awarding projects to qualified firms, particularly when time is of the essence

MDOT has the flexibility to select the contract type that is best suited for the services required.

7. For each contract type, MDOT maintains standard contract templates that have undergone review and approval by the MDOT Legal Division, the Deputy Executive Director – Chief Engineer, and FHWA.

    a. Maintenance of standard contract forms is a best practice that:

        - Reduces the administrative burden of having to develop and review contract documents for specific projects;

        - Ensures that required contract provisions (e.g., those pertaining to federal regulations, when federal funding is used) are not inadvertently omitted; and

        - Provides consultants with a comfort level that competitors are not subject to different or more favorable contract terms.

b. MDOT's standard contract language also provides strong protection to the State in the event of errors or omissions or negligent acts by consultants.

8. MDOT also has the flexibility to select from among the following compensation structures to find the payment method that best balances cost certainty against any risks in the scope and level of effort needed to accomplish project-specific goals.

Table 3.2-3: Payment Methods Used by MDOT

Payment Method	Applicability
Cost Plus Fixed Fee – consultant is reimbursed for all eligible direct and indirect costs (e.g., labor hours and expenses) plus a negotiated fixed fee (i.e., profit margin)	Used for most design contracts when the full scope of service and level of effort required are difficult to define at the time of negotiation and contract execution
Labor Hour/Unit Price - consultant is paid based on the negotiated not-to-exceed rate per hour or unit of work performed	Use is limited to contracts for specialized or repetitive support-type services for which the consultant is not in direct control of the number of hours worked, such as construction engineering and inspection
Lump Sum/Firm Fixed Price – consultant performs a strictly defined scope of work for an agreed upon price that is not subject to subsequent adjustments (thus incentivizing the consultant to control costs)	Use is limited to circumstances under which the full character, scope, complexity, and duration of the work can be adequately established at the time of negotiation

9. Regardless of the contract type or payment method used, MDOT engages in a formal contract negotiation process to ensure consultant services are obtained at a fair and reasonable price. This process includes the following general steps:

Negotiations are strictly limited to scope and price/fee discussions; standard contact terms and conditions are non-negotiable (i.e., consultants cannot take exception to standard contract language.)

a. MDOT and the consultant conduct a project scoping meeting during which the parties jointly establish project parameters (e.g., scope, required deliverables, schedule, etc.)

b. MDOT prepares an independent state estimate of the work to be performed, based on historical data and an assessment of the scope, complexity, and risks involved in the work.

c. The selected consultant is asked to provide its own cost estimate to perform the agreed upon scope of work.

d. The MDOT project manager reviews the consultant's estimate to ensure:

- The proposed level of effort (i.e., labor hours) and staffing categories/personnel are consistent with MDOT's understanding of the work required and the proposed schedule (i.e., do not suggest over- or under-staffing of the project to meet the defined deliverable dates).

- The proposed fixed fee (for cost-plus-fixed fee arrangements) is acceptable, given the size, scope, complexity, duration, and degree of risk involved in the work.

e. Meetings may be held to discuss and resolve any discrepancies between MDOT's independent estimate and that proposed by the consultant. Assuming agreement is reached, the MDOT project manager prepares

and submits a Negotiation Recap Form, along with supporting documents (e.g., draft contract documents, consultant cost estimate, independent State estimate, etc.,) to the CSU for review.

f. The CSU reviews the negotiation package to ensure:

- The final scope of work clearly identifies and describes the consultant's responsibilities and required deliverables, and is consistent with the original solicitation documents, if applicable;
- Consultant's overhead rate has been approved by the MDOT Audit Division;
- Wage rates relative to job classifications are reasonable; and
- Cost fee breakdown is calculated correctly, and the fixed fee (if applicable) and direct expenses (e.g., travel, equipment, etc.) comply with State and Federal policies.

g. The CSU archives the records of the completed negotiations.

10. For cost-plus-fixed-fee contracts, a key cost control measure is the fixed fee percentage (i.e. profit margin) established as part of the contract negotiation process described above. According to the CSU's manual, fixed fee can range from 7 to 15%, considering the size, scope, complexity, duration, and degree of risk involved in the work. Based on interviews with MDOT staff, the typical fee is 12%, which is generally in line with that seen in other DOTs. For example:

    a. The capital program of the Louisiana DOTD is comparable to that of MDOT and thus provides a good source of comparison. The DOTD's Consultant Contract Services Manual specifies a base profit percentage of 15% for general engineering services and 12% for CEI services.

    b. A legislative audit of the Wisconsin DOT published in January 2017 revealed that the profit rates on the DOT's engineering contracts ranged from 7 to 8.9 percent. Bearing in mind that the capital program of Wisconsin DOT is almost twice that of MDOT (with payments for construction services alone exceeding $1 billion in 2017), the lower fees (in comparison to MDOT and LaDOTD) are presumably balanced by the higher volume of work awarded to consultants.

The fixed fee on MDOT consultant contracts is typically set at 12%, which is generally in line with that seen in other DOTs. Given the relatively small size of the MDOT program and lower volume of work available to consultants, the fee must remain attractive enough for consulting firms to maintain high-level staff with the capabilities needed to produce high quality and specialized work.

11. As described above, the CSU effectively oversees contract negotiations, providing assurance that outcomes are consistent with MDOT's overarching policies, needs, and goals.

12. The CSU similarly oversees the post-negotiation execution of the contract documents, ensuring the appropriate reviews and approvals are obtained (including that of the FHWA, if appropriate).

    a. All contracts, including supplemental agreements (i.e., subsequent changes to the original contracts) must be approved by the Commission prior to execution by the MDOT Executive Director.

b. Only upon receiving a fully executed contract may the CSU draft and issue a Notice to Proceed to the Consultant.

3.3 Contract Administration

Capital Outlay – Consultant Services

1. The oversight processes described above are important given MDOT's growing reliance on consultants to provide the design and related services needed to support the capital construction program.

2. As summarized in Table 3.3-1, from July 2016 to June 2018, MDOT awarded 489 contracts (including work assignments under IDIQ master agreements) for a total commitment of over $100 million.

Table 3.3-1: Consulting Contracts/Work Assignments awarded during Fiscal Years 2016 to 2018

Division	Total Contract Value	Number of Contracts	Average Contract Value
Bridge Design	$32,995,349.22	189	$174,578.57
Roadway Design	$23,201,830.21	104	$223,094.52
US49 Construction Engineering/Inspection	$19,319,245.96	1	$19,319,245.96
Planning	$9,117,910.93	34	$268,173.85
Traffic Engineering	$4,644,311.05	25	$185,772.44
Research	$3,883,160.24	23	$168,833.05
Maintenance	$1,358,769.46	8	$169,846.18
Materials	$1,153,836.38	13	$88,756.64
Environmental	$951,675.27	27	$35,247.23
Geotechnical Branch	$822,818.92	6	$137,136.49
Architectural Services	$731,521.65	18	$40,640.09
State Surveyor	$716,547.37	4	$179,136.84
Office of Civil Rights	$558,655.75	9	$62,072.86
Programming	$487,840.32	17	$28,696.49
Local Public Agencies	$429,948.65	4	$107,487.16
Consulting Contractual Services	$276,989.91	3	$92,329.97
Construction	$224,669.25	2	$112,334.63
District 5	$99,263.47	1	$99,263.47
Grand Total	**$101,004,257**	**489**	**$206,553**

Key Takeaway: During FY2016-2018, MDOT awarded 489 contracts (including work assignments under IDIQ agreements), totaling over $101 million. The average contract value was $206,552. (Excluding the US49 construction engineering contract as an outlier, the average value was $167,387)

3. The largest contract amount, which exceeded $19 million, entails construction engineering and inspection services for the multi-year reconstruction of US 49.

Although substantial, the amount of this contract is in line with the size and complexity of the associated construction project, which entails an accelerated schedule requiring multiple shifts of inspectors and night work. The contract was awarded to a team of consulting firms led by Michael Baker International after an open competition involving a who's who of Mississippi consulting firms.

4. As could be expected given the staffing challenges addressed in Chapter 2 of this report, the primary need for consultants came from the Bridge and Roadway Design divisions, which executed contracts/work assignments totaling over $56 million during this three-year period, or 55% of the total contract value awarded to consultants.

5. Tables 3.3-2 and 3.3-3 identify the top ten consulting firms retained by the Bridge and Roadway Divisions, respectively, by total contract value. As shown, the work is distributed across several firms, suggesting that the controls MDOT has put into place to impart fairness into its consultant selection process have been effective.

Table 3.3-2: Top 10 Bridge Consultant Firms in terms of Total Contract Value (FY 2016-2018)

Division	# of Contracts	Average Contract Value	Total Contract Value
Garver, LLC	38	$156,483.08	$5,946,357.16
HNTB Corporation	20	$257,035.69	$5,140,713.74
Stantec Consulting Services Inc.	15	$253,645.83	$3,804,687.51
AECOM Technical Services, Inc.	11	$222,976.33	$2,452,739.58
Michael Baker International, Inc.	14	$145,613.35	$2,038,586.85
Pickering Firm, Inc.	10	$182,264.34	$1,822,643.44
Mendrop Engineering Resources, LLC	20	$80,309.14	$1,606,182.78
URS Corporation	8	$196,661.96	$1,573,295.67
Gresham, Smith and Partners MS, P.C.	6	$251,907.10	$1,511,442.58
Hardesty & Hanover, LLC	2	$635,223.96	$1,270,447.92

Table 3.3-3: Top 10 Roadway Consultant Firms in terms of Total Contract Value (FY 2016-2018)

Division	# of Contracts	Average Contract Value	Total Contract Value
Neel-Schaffer, Inc.	19	$518,581.81	$9,853,054.40
Garver, LLC	14	$221,285.23	$3,097,993.15
Michael Baker International, Inc.	9	$268,687.93	$2,418,191.38
Stantec Consulting Services Inc.	15	$134,716.74	$2,020,751.14
Gresham, Smith and Partners MS, P.C.	7	$210,677.58	$1,474,743.07
Fisher & Arnold, Inc.	12	$107,019.78	$1,284,237.38
Gresham Smith MS, P.C.	3	$189,842.83	$569,528.50
Pickering Firm, Inc.	2	$229,357.97	$458,715.93

Division	# of Contracts	Average Contract Value	Total Contract Value
A. Garner Russell & Associates, Inc.	1	$372,791.79	$372,791.79
Volkert, Inc.	3	$91,486.45	$274,459.34

Key Takeaway: Consultant services contracts are dispersed across several firms, suggesting that MDOT has implemented fair and effective consultant selection procedures.

6. Out of the 489 contracts identified in Table 3.3-1, 401 were completed at the time of the writing of this report. As summarized in Table 3.3-4 below, out of the $59,362,726 committed for these completed contracts, $51,035,429 (or 86%) was expended.

Table 3.3-4: Completed Consultant Contracts by Division executed between Fiscal Year 2016 to 2018

Division	Total Expended	Total Contract Value	Number of Contracts	Average Expended Per Contract	% of Total Contract Value Used
Bridge Design	$24,168,409.17	$28,448,444.83	163	$148,272.45	85%
Roadway Design	$13,274,529.90	$15,089,971.16	84	$158,030.12	88%
Planning	$3,479,889.62	$4,056,770.44	26	$133,841.91	86%
Traffic Engineering	$3,724,165.07	$4,029,753.48	23	$161,920.22	92%
Research	$1,521,465.46	$1,708,482.97	13	$117,035.80	89%
Materials	$846,198.90	$1,135,400.91	12	$70,516.58	75%
Environmental	$601,418.96	$889,837.66	24	$25,059.12	68%
Geotechnical Branch	$513,996.07	$715,838.42	5	$102,799.21	72%
Maintenance	$493,842.83	$584,461.81	5	$98,768.57	84%
Office of Civil Rights	$514,248.73	$558,655.75	9	$57,138.75	92%
Architectural Services	$494,001.21	$544,574.46	12	$41,166.77	91%
State Surveyor	$493,637.60	$519,388.70	1	$493,637.60	95%
Programming	$444,666.12	$487,840.32	17	$26,156.83	91%
Consulting Contractual Services	$152,150.32	$276,989.91	3	$50,716.77	55%
Construction	$124,734.02	$124,734.02	1	$124,734.02	100%
District 5	$97,921.96	$99,263.47	1	$97,921.96	99%
Local Public Agency	$62,405.23	$62,405.23	1	$62,405.23	100%
District 3	$27,748.31	$29,912.92	1	$27,748.31	93%
Grand Total	**$51,035,429**	**$59,362,726**	**401**	**$127,270**	**86%**

Key Takeaway: The lack of cost growth seen on these contracts reflects the effectiveness of MDOT's consultant management procedures.

Cost Control Measures

7. The lack of cost growth seen on the completed consultant contracts (see Table 3.3-4 above) can be attributed to the rigorous monitoring procedures MDOT has implemented to track consultant progress.

a. Once a consultant contract is executed, MDOT requires the consultant to prepare a project management plan based upon the approved project schedule and budget. The management plan is to include all tasks identified in the contract fee schedule, including each task's start date, end date, and estimated budget. The plan is to be submitted for MDOT approval within 10 days of the notice to proceed.

b. Once the project commences, the consultant must submit progress reports, based on its approved management plan, supporting each invoice. The reports include actual tasks performed and hours expended against each task, as well as the percentage of fees earned for each task. MDOT provides guidance to the consultant by providing sample Microsoft Excel-based templates for reporting and calculating the hours expended against each task, the percentage fee associated with each task and the "earned fee" for the particular line item.

MDOT has implemented a robust consultant progress reporting process, which allows for detailed tracking of work completed and progress achieved against the approved project management plan.

c. The MDOT CSU reviews all consultant invoices to confirm the rates and calculations, and then sends the invoice to the MDOT project manager for final review to validate that the costs billed are appropriate for the work accomplished during the billing period. Should the invoiced cost appear to exceed the work effort believed to be completed, MDOT reserves the right to withhold payment until the consultant provides evidence to support the work accomplished and the costs billed.

d. The MDOT consultant progress reporting process is very robust and allows detailed tracking of work completed and progress achieved against the management plan. As engineering is the critical precursor to the letting of construction contracts, the timeliness and quality of engineering deliverables is essential to MDOT's ability to commence and complete its capital construction program each year.

3.4 Summary

The analysis above indicates that MDOT has implemented effective processes to ensure:

- Consultant contracts are awarded to the most qualified firm, at a fair and reasonable cost, and in accordance with the applicable Federal and State guidelines and best practice.

- Engineering deliverables are submitted on time, in accordance with the agreed upon scope of work and project management plan, and in support of the planned construction schedule.

Moving forward, MDOT should assess the feasibility of extending some of the best practices successfully implemented on consultant contracts to the construction program. For example, larger construction contracts would benefit from enhanced project control measures similar to the management plans and earned-value reporting process now used to monitor consultant progress and performance.

This page is intentionally left blank

4. Delivery of Capital Construction Projects

4.1 Introduction

Historically, capital outlays (i.e., payments to contractors for construction services) have constituted MDOT's greatest expenditure category. In FY 2018 alone, capital outlays totaled over $603 million, approximately 54% of MDOT's total spending for the year. Budgets for FY 2019 and FY 2020, which project capital outlays of approximately $548 million and $542 million, respectively, suggest that construction contracts will continue to comprise the largest share of MDOT's expenditures.

The processes MDOT employs to deliver its capital construction program are therefore essential to ensuring the efficient use of funds. MDOT has adopted several best practices to help control construction costs – chief among these being the strategic management of contract lettings to encourage competition in a challenging market that often lacks multiple bidders. As explored in Section 4.2, long-standing market conditions can cost MDOT on average $6 million a year in bid premiums. Without MDOT's careful planning and oversight of the bidding and award process, lack of competition may have generated even greater waste.

Underpinning MDOT's ability to effectively evaluate construction bids is the accuracy and reliability of its State Estimates. Section 4.3 reviews MDOT's estimating processes, including how it accounts for project risks and uncertainties.

Section 4.4 takes a closer look at the on-time and on-budget performance of MDOT's capital construction program to assess MDOT's operational efficiency in monitoring and controlling the construction and closeout of projects.

Finally, Section 4.5 addresses MDOT's construction quality assurance program and practices, as set forth in its specifications and construction and materials manuals, and identifies potential enhancements to these practices that may offer opportunities for cost savings, time savings, improved resource allocation of personnel, and the possibility of improved risk sharing with industry.

Overview

This chapter assesses MDOT's ability to control construction costs through:

- Strategic management of the bid and award process to help promote competition
- Development of accurate and reliable State Estimates
- Active management of project cost and time performance
- Implementation of a well-designed construction quality assurance program to assure the public gets the constructed products and services it pays for

Chapter Highlights

Area of Inquiry	How is MDOT performing?	Key Observations	Recommendations
Section 4.2: Procuring Construction Services			
Procurement Process	▲	• MDOT solicits and evaluates bids in a fair and transparent manner. • MDOT is developing a performance-based contractor prequalification system to help incentivize quality construction.	MDOT should continue to: • Provide effective oversight of the bid solicitation and contract award process • Pursue performance-based prequalification to help achieve the best value for the public
Market Conditions & Competition	■	• Analysis of bid data from 2016-2018 indicates: – Competition, particularly on pavement projects (which by $ value represent 75% of MDOT's program), can be poor. – All Districts experience some lack of competition.	• MDOT should continue to monitor the market and macroeconomic conditions that can affect bid pricing. • MDOT should consider a formal contractor outreach program to enhance competition in the regions of the State with the lowest competition.

Area of Inquiry	How is MDOT performing?	Key Observations	Recommendations
		– The lack of competition among paving contractors is driven by the location and ownership of asphalt plants. • Potential cost savings could be achieved if contracts attracted more bidders. – Just over half of the projects let attracted two or less bids. – Most single bids are +7-9% over the State Estimate. – If MDOT had received at least 2 bids on 67 contracts that only attracted one bidder, it may have realized **savings of approximately $18M** in construction costs.	
Cost Control Measures	▲	MDOT has actively taken steps to mitigate the impact of poor competition by: • Preventing unwarranted price creep over time by carefully identifying and managing the outlier pricing contained within its database of historical bid pricing • Re-advertising projects when appropriate (a practice which resulted in approximately **$4.5M in savings** from 2016 – 2018) • Strategically managing project lettings to increase the number of bidders (e.g., by monitoring industry capacity and deferring non-critical projects if competition is expected to improve in the future)	In addition to continuing to implement the strategies already proven to be effective in controlling contract award costs: • MDOT should monitor the potential for any emerging opportunities for improved competition related to seasonal differences in bidding patterns and project packaging (in case such factors, which currently do not appear to have an appreciable effect on competition in the State, become more prevalent in the future).
Section 4.3: Cost Estimates			
Estimate Accuracy	▲	• Since 2011, MDOT has consistently met FHWA's guideline for estimate accuracy, with the State Estimate being within +/-10% of the low bid for at least 50% of the projects awarded each year. • Best practices implemented by MDOT to ensure estimate accuracy and reliability include: – Maintenance of a historical cost database – Dedicated team of experienced Staff Estimators – Use of a uniform structure for preparing and presenting estimates	MDOT should consider standardizing how assumptions used in developing the estimate are documented (e.g., through a Basis of Estimate document).

Area of Inquiry	How is MDOT performing?	Key Observations	Recommendations
Contingency Estimates	●	MDOT's co-mingling of construction engineering costs with construction contingency funds masks the potential variability and perceived uncertainty in the cost estimate.	• MDOT should impart more rigor to its estimating process by assessing project-specific risks and uncertainties for the purpose of establishing appropriate risk-related project contingency. • MDOT should monitor and report contingency expenditures to increase the visibility of remaining contingency funds.
Section 4.4: Construction Administration			
Cost Performance	●	• Analysis of the 249 completed projects within the 3-year study period revealed: – 52% were completed within budget. – 48% were completed over budget resulting in a total overrun of $29M. – Of the overrun projects, more than half (67) were within 10% of the original contract price, which is considered within industry norms. – The underrun projects (119) appear to be driven by overly conservative quantity estimates in the bid documents. This practice resulted in the inefficient allocation of more than $23M, or on average roughly $7M a year. • Inconsistent documentation of quantity variances and changes may prevent MDOT from identifying root causes and making potential improvements (e.g., to scoping and quantity estimating processes) to reduce the potential for future project cost variances.	• MDOT should strive to impart more precision into its development of quantity estimates and discipline into its real-time monitoring and forecasting of potential overruns/underruns. • As an initial step, MDOT District Offices should require Project Engineers to: – Enhance the controls by which they *actively* track quantity variations – Develop and use a standard template for tracking reasons for change orders – More consistently document the reasons for quantity variations • Implementation of the practices above could then be used to: – Derive lessons learned for the preparation of future project scopes and estimates – Develop a more formal risk identification and management process – Assist with management of the contingency line item and forecasting of final quantities, which could allow for the earlier release of unneeded moneys to fund other projects • As a future consideration for the delivery of large projects, with sensitive schedules and potential constructability challenges (i.e., similar to the active US 49 project), MDOT should consider requesting statutory authorization to use the CM/GC method.

Area of Inquiry	How is MDOT performing?	Key Observations	Recommendations
Schedule Performance	●	• Analysis of the 249 completed projects within the 3-year study period revealed: – Schedule growth is closely correlated to project size. – Schedule delays are more likely to occur on completion date contracts, with only 75% of the 120 completion date contracts finishing within the original contract time. • The use of A+B bidding to motivate contractors to minimize construction time and delays appears to be yielding only mixed results and may not warrant the administrative challenge of managing such contracts.	• On MDOT completion date contracts, MDOT should impart more discipline into its real-time monitoring and forecasting of potential delays.
Section 4.5: Materials Management and Construction Inspection			
Quality Assurance Policies and Procedures	▲	• Internal inspection and testing efforts amount to approximately 3-4% (or $20 million) of MDOT's annual construction budget of approximately $600 million. • MDOT has several long-standing procedures and detailed guides for inspection and materials sampling and testing that meet MDOT standards and FHWA regulations (23 CFR 637). • MDOT's QA requirements are generally reasonable, efficient, not overly restrictive, and allow the agency to remain cost effective while still providing the requisite assurance of the quality of the materials and manufactured products incorporated into work.	Potential enhancements to MDOT's current practices that could improve their efficiency or effectiveness and/or achieve cost savings include the following: • Using more performance-oriented acceptance criteria, particularly for asphalt and concrete specifications, that directly relate to the performance of the as-installed product • Moving towards a risk-based sampling and testing approach to focus resources on critical items of work • Converting to a system-based approach to Independent Assurance • Using alternative measurement and payment methods for selected items or features of work (e.g., plan quantities or lump sum items) that can be accepted without the need for detailed field measurements

▲ MDOT meets or exceeds industry leading practices
● Potential for improvement
■ Policy or market condition largely out of MDOT's control

4.2 Procuring Construction Services

Project Delivery Methods

1. Project delivery methods refer to the overall processes by which a project is designed and constructed.

2. MDOT primarily delivers projects through the traditional low bid, design-bid-build (DBB) project delivery system.

    a. Under DBB, contractors competitively bid projects based on completed designs provided by the DOT.

    b. The DOT's bid documents list each construction item (e.g., asphalt pavement, excavation, etc.) needed to complete the project along with their estimated quantities.

    c. To prepare its bid, a contractor will propose a price for each unit of a given item (e.g., a ton of asphalt), and multiply this unit cost by the item's estimated quantity (as provided in the bid documents). The contractor's overall bid amount is calculated by summing the totals for all items.

    d. The DOT then evaluates the bids received and awards the contract to the lowest responsible and responsive bidder.

3. MDOT also has authority to deliver projects using the design-build (DB) method. DB is an alternative project delivery method that combines both project design and construction under one contract. The design-builder both designs and constructs the project according to design parameters, performance criteria, and other requirements established by the DOT. As MDOT has had only limited experience with DB, the audit focused almost exclusively on MDOT's DBB program.

Process for Soliciting Bids and Awarding Construction Contracts

The procedures by which a DOT solicits and awards construction contracts are an essential part of the competitive bidding process.

4. MDOT solicits and evaluates bids in a fair and transparent manner that has been streamlined through the implementation of Info Tech's Bid Express® service.

    a. BidExpress is a sealed, secure Internet bidding system used by many DOTs and other agencies across the country to electronically exchange bid information with bidders and to receive bids from contractors and other vendors.

    b. Electronic bidding systems such as BidExpress have been found to offer several perceived benefits, such as their ability to:

        - Increase awareness of opportunities to a wider audience of potential bidders
        - Reduce avoidable errors (by automating calculations and alerting contractors to bid errors and omissions)
        - Save time (by minimizing the handling of paper documents and manual processing)

- Increase the efficiency by which owners can process and evaluate bids (by automating some of the bid analysis techniques used to inform the decision to award or reject bids)

5. The State Estimate, which is based upon MDOT's database of historical pricing, serves as the benchmark in MDOT's analysis of the bids received. (see Section 4.3 for more details on the development of the State Estimate)

    a. Given that the bid documents provide fixed quantities for bidding purposes, contractors primarily compete on item pricing (though for schedule-critical projects, MDOT may also compete a time parameter to incentivize faster completion).

    b. Bidding software provides graphs of contractor item pricing in relation to the State Estimate, which facilitates the identification of pricing anomalies or instances where the bidders perceived the work differently than the DOT (e.g., restricted access, traffic constraints, night work, etc.).

    c. As discussed further in Paragraphs 27 and 28 below, MDOT will reject bids when re-advertisement is in the public interest (e.g., for non-critical projects that receive higher than anticipated low bids).

6. MDOT's current low-bid procurement process serves to control initial construction price, which does not automatically translate to the best value for the public. Recognizing that a purely low-bid process does little to incentivize quality construction, MDOT has begun to develop, in consultation with the Mississippi Division Office of the Federal Highway Administration (FHWA), a performance-based contractor prequalification program.

MDOT's efforts to implement a performance-based contractor prequalification system should be encouraged. Such systems help public owners achieve the best value for money.

    a. MDOT's current pre-qualification system, like that of several other public owners, is based on a contractor's financial capacity and ability to obtain performance bonds from the surety industry, not on any demonstrated ability to provide adequate workmanship. This system thus indirectly rewards poor performers by not penalizing low-quality construction work.

    b. Performance-based prequalification systems incorporate measurable non-price factors in the bid calculation (e.g., a firm's history of completing projects on-time, providing quality workmanship, etc.) to provide a competitive edge to contractors with a history of excellent performance (and to thereby motivate poorer performers to improve).

    c. Growing the bidding pool of quality-conscious firms could also ultimately lower MDOT's administrative burden, as theoretically high-performing contractors should require less oversight and be entrusted with assuming a larger role in quality management.

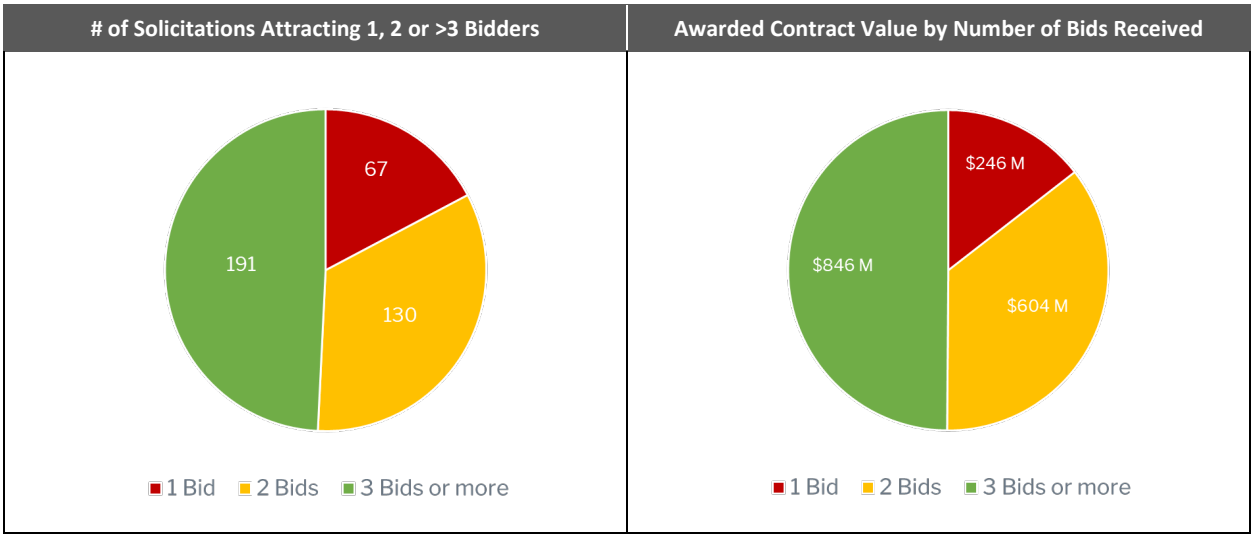
    d. Once implemented, a performance-based prequalification system could also be considered as an alternative to performance bonds. Performance bonds, which are required by state statute, tend to increase the cost of construction, as contractors will build the bond premium (typically 2% of the contract value) into their bid amount. For small, low risk projects, MDOT should consider seeking a waiver from performance bond requirements.

Level of Competition

7. Despite the open and transparent manner by which MDOT solicits for bids, projects often fail to attract reasonable competition, as measured both by the number of bids received and how closely the wining low bid aligns with the State Estimate.

8. As shown in Figure 4.2-1 below, less than half (191 or 49%) of the 388 contracts MDOT awarded between January 2016 and November 2018 attracted more than two bidders. 67 contracts, totaling $246 million, received only one qualifying bid each.

Figure 4.2-1: Number of Bidders



Just over half (197 or 51%) of the 388 contracts awarded between January 2016 and November 2018 received two or less bids, which equates to $850 million in awarded contract value. (Analysis only includes "qualifying" bids, i.e., those that met all of requirements of the solicitation.)

9. The level of competition a project attracts is an important cost control consideration, as it is generally well understood that as the number of bidders competing for a contract increases, the resulting bid prices tend to decrease.

Competition is an integral part of a successful capital construction program.

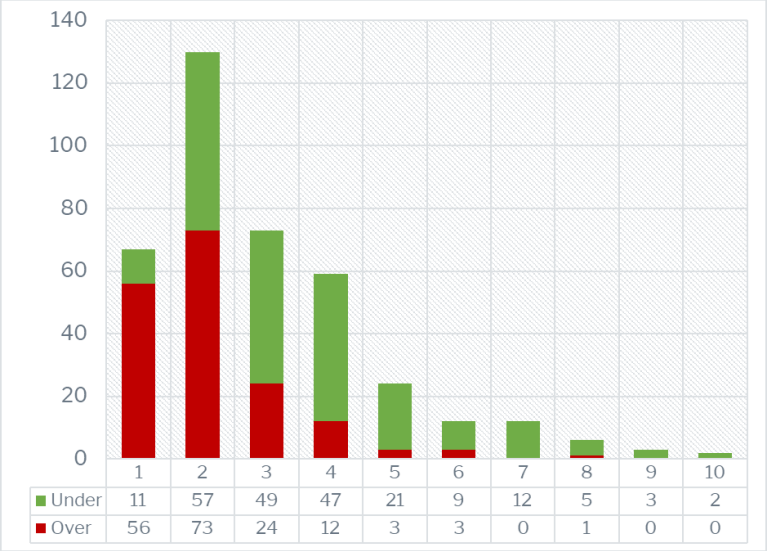
10. This axiom holds true when the winning bids for the three-year sample of 388 MDOT projects are compared to the corresponding State Estimates. As illustrated in Figure 4.2-2:

    a. Of the 67 contracts that received only a single bid, 56 (or 84%) exceeded the State Estimate.

    b. When a second bidder is introduced, the percentage of contracts exceeding the State Estimate drops to 56% (73 out of 130).

Figure 4.2-2: Wining Bids Compared to the State Estimate

Data from the 3-year, 388-project sample set shows that as the number of bidders increases, it becomes more likely that the winning bid will be less than the State Estimate.



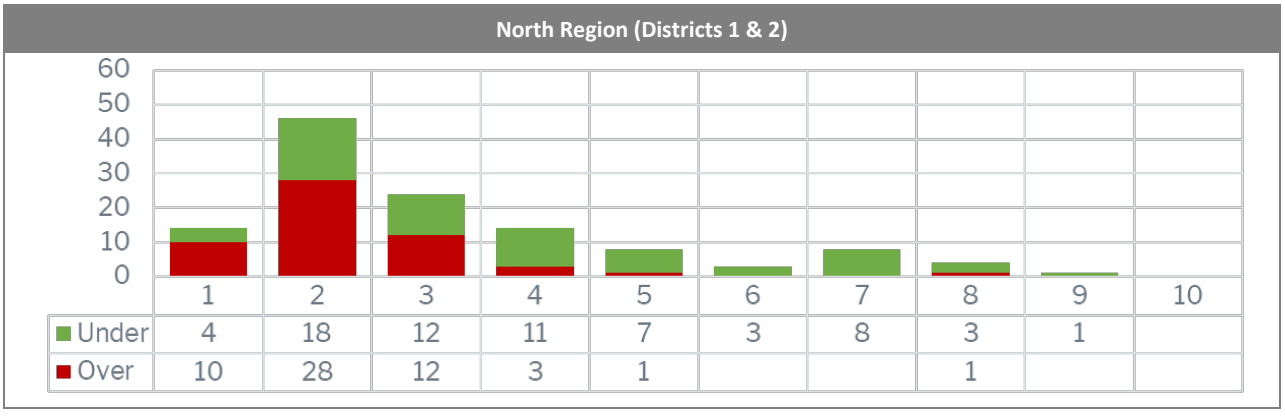
11. It is also important to note that this trend is not necessarily isolated to a specific region of the State.

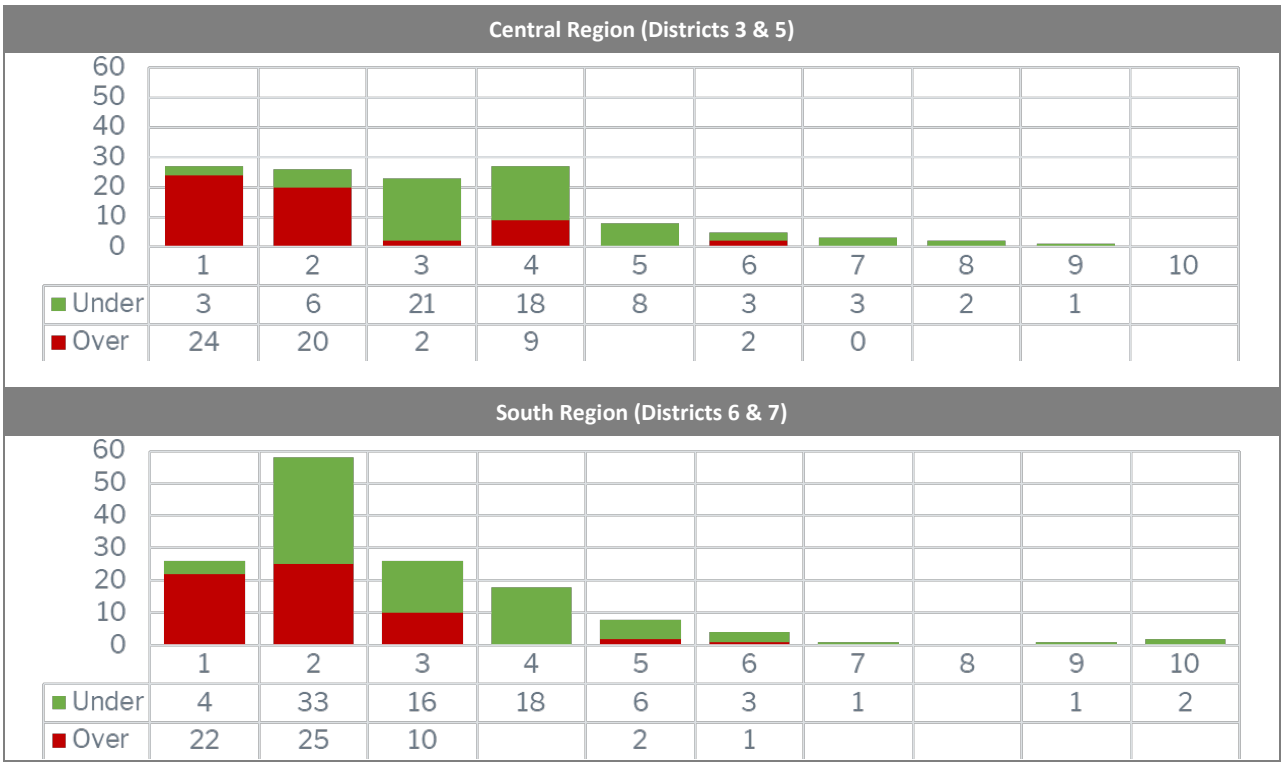
    a. Figure 4.2-3 separates the information previously shown in Figure 4.2-2 according to the MDOT Regions in which the projects took place.

    b. As shown, all Districts are affected to some extent by a lack of competition, with the Central Region receiving the most single bids (22% of the projects undertaken in the Region, versus 11% and 18% of the projects in the North and Southern Regions, respectively).

    c. All Districts experienced a similar percentage of bids exceeding the State Estimate (45%, 47%, and 42% for the North, Central, and Southern Districts, respectively).

Figure 4.2-3: Regional Bidding Patterns (Winning Bids Compared to State Estimate)
(Contracts Awarded between January 2016 and November 2018)





Key Takeaway: All Districts experience a lack of competition to some extent.

12. The figures above clearly demonstrate that as more bidders elect to compete, the likelihood of the winning bid being lower than the amount estimated by MDOT increases. This suggests that cost savings could be achieved by attracting more bidders.

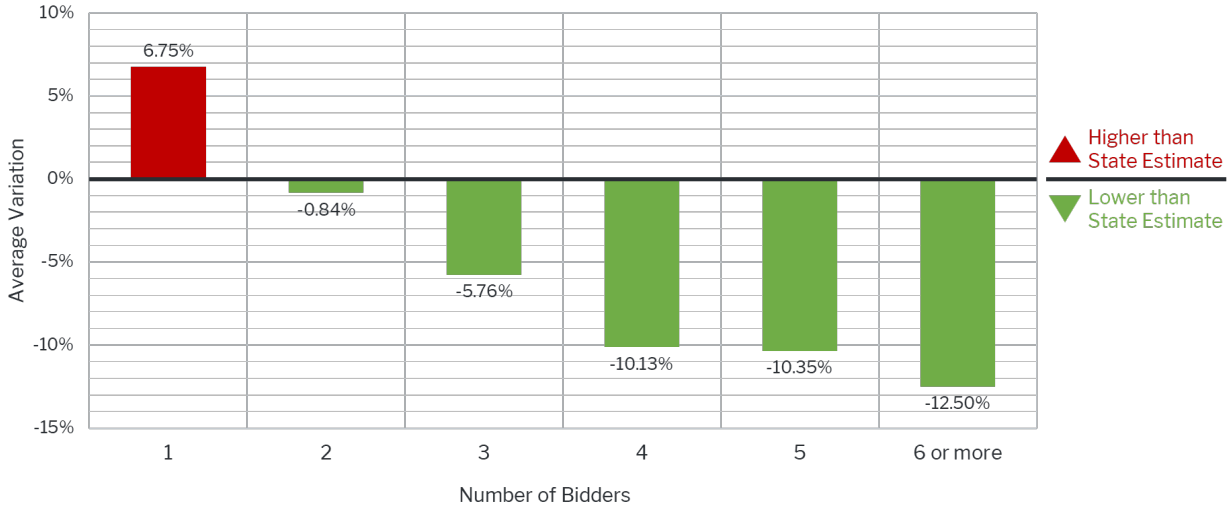
Cost savings could be achieved by attracting more bidders.

13. To provide a sense of the potential savings involved, Figure 4.2-4 presents the average variation of the winning bid from the State Estimate by the number of bidders.

    a. As shown, the winning bid for a construction contract that received only one bid was, on average, 6.75% *more* than the State Estimate.

    b. In contrast, the winning bids for contracts that received more than one bid were lower, on average, than the estimates.

Figure 4.2-4: Average Variation of the Winning Bid from the Estimated Amount, by Number of Bidders
(Contracts Awarded between January 2016 and November 2018, with the exclusion of US 49 as an outlier)



Key Takeaway: The average winning bid for contracts that received only one bid was 6.75% more than the State Estimate. In contrast, the winning bids for contracts that received more than one bid were lower, on average, than the estimates.

MDOT could potentially have saved approximately $18 million over three years if it had received at least two bids on the 67 contracts that actually received only one bid each.

14. The aggregated contract value of the 67 contracts that attracted only one bidder was $245.98 million. It is impossible to know what these winning bids would have totaled if MDOT had instead received multiple bids.

    a. However, if MDOT had received just one more bid on each of these contracts, and the average bid had been 0.84% less than the estimated amounts (which totaled $229.32 million), MDOT could potentially have awarded these contracts for approximately $18 million less than it had.

    b. Similarly, if MDOT had received three bids for these contracts, and the average bid had been 5.76% less than the estimated amounts, the savings would have reached approximately $30 million.

Market Conditions

15. Although MDOT cannot directly control the number of bidders it receives on projects, it has taken steps to help foster more competitive behavior. To help understand the basis for such cost control measures, it is important to first identify the market conditions that influence competition (or the lack thereof) for Mississippi highway construction work.

16. As summarized in Table 4.2-1, lack of competition appears to be limited to pavement-related projects. Such projects receive just over two bidders per project on average, in contrast to bridge-related construction/repairs and other project types (e.g., earthwork, vertical buildings, lighting, bike paths, etc.), which receive, on average, three or more bidders.

Table 4.2-1: 1 Number of Bidders by Project Type

Project Type	Number of Projects	Total Awarded Contract Value	Average # of Bids Received
Pavement	215	$ 1,251,598,413.34	2.16
Bridge	110	$ 376,583,903.01	4.49
Other	63	$ 68,967,099.64	3.10
Total	388	1,697,149,415.99	2.97

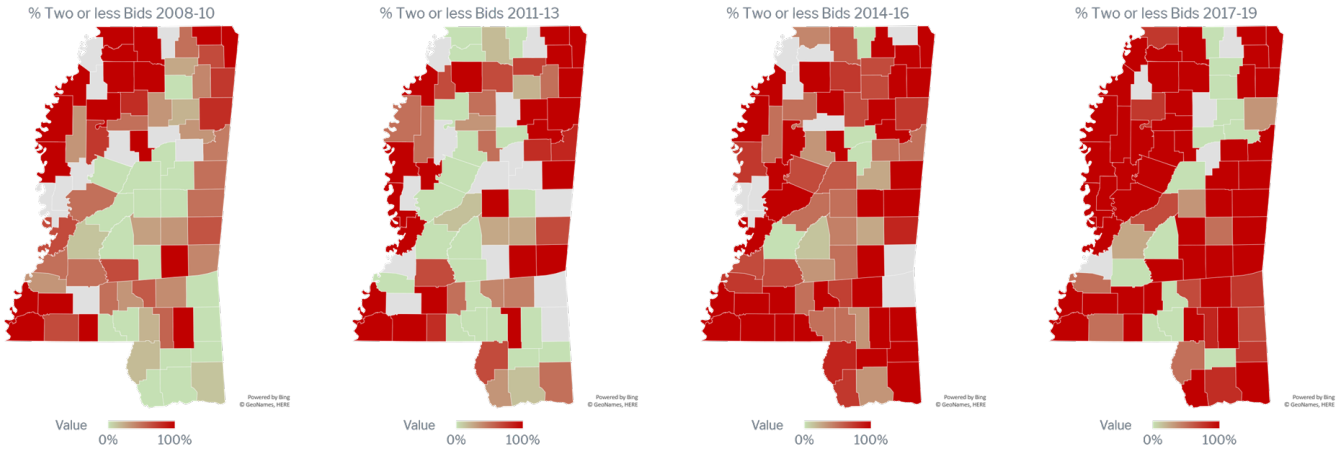
Difficulty in attracting competition is largely limited to pavement projects, which by dollar value, represent nearly 75% of MDOT's capital construction program.

17. The issue of poor competition among paving contractors is not necessarily new, but one that has progressively grown worse over the last decade.

    a. Figure 4.2-5 looks beyond the three-year data set around which the bulk of this audit is focused to obtain a historic perspective of bidding patterns across the State.

    b. As indicated by the red shading, there is a pronounced trend over time towards work in more counties being dominated by just one or two bidders, presumably the result of the local asphalt paving industry contracting to align with MDOT's programmatic shift away from new capacity projects towards system preservation.

Figure 4.2-5: Historic Pavement Bidding Patterns in Three-Year Increments
(Pavement Contracts Awarded between 2008 and 2019)



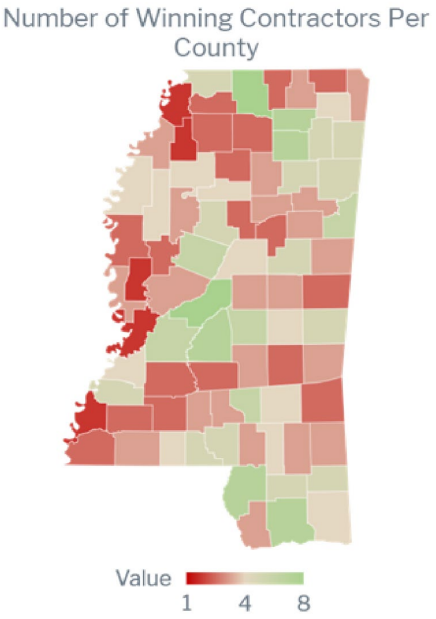
Dark red shading indicates that 100% of the work bid in the county (over the 3-year increment indicated) received no more than two bids. Counties shaded with greener tones received more competition (as measured by the percentage of projects receiving three or more bidders). Counties with gray shading had no paving work bid and awarded in the time period indicated.

Key Takeaway: The data show a pronounced trend over time towards more counties receiving just one or two bids per contract– most likely an unintended consequence of MDOT's programmatic shift away from any new construction/expansion to almost exclusively system preservation. The asphalt industry appears to have consolidated to align with MDOT's shrinking program.

18. To further illustrate just how tightly controlled the asphalt paving industry is in certain areas of Mississippi, Figure 4.2-6 identifies how many unique contractors won pavement-related work in each county over the period from 2008 through 2019. As shown by the red shading, work in several counties has been dominated by just a few firms.

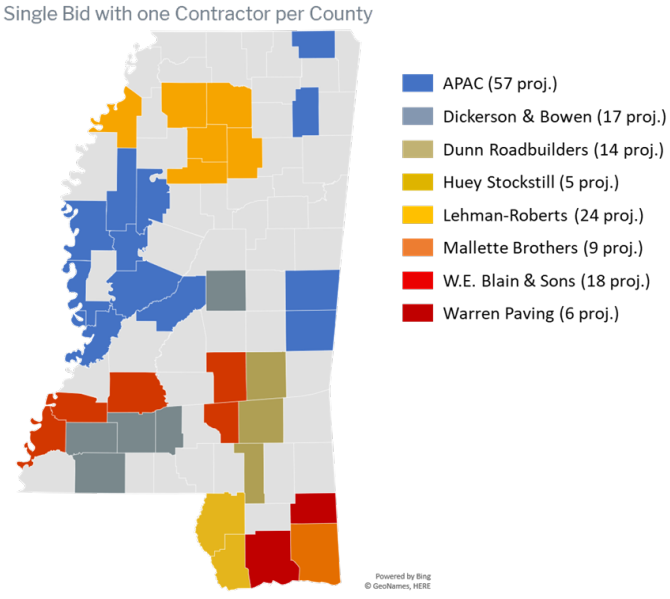
Figure 4.2-6: Number of Unique Contractors Winning Work in each County
(Pavement Contracts Awarded between 2008 and 2019)

Work in several counties has been dominated by just one or two firms since 2008, as indicated by the red shading.



19. Figure 4.2-7 further dissects this data to highlight where some of the State's largest paving contractors have been successfully winning work on projects for which they were the sole bidder.

Figure 4.2-7: Concentrations of Single Bid Pavement Work by Contractor
(Pavement Contracts Awarded between 2008 and 2019)



20. The figure above, in conjunction with the asphalt plant locations identified on Figure 4.2-8, suggests that contractors appear to be reliably winning single-bid pavement contracts in locations where they control the local hot mix asphalt plant. Conversely, areas of the State that are home to multiple plants generally experience more competition. This result suggests:

    a. The size of MDOT's current capital program and focus on system preservation are not providing enough work to entice industry to build more permanent plants.

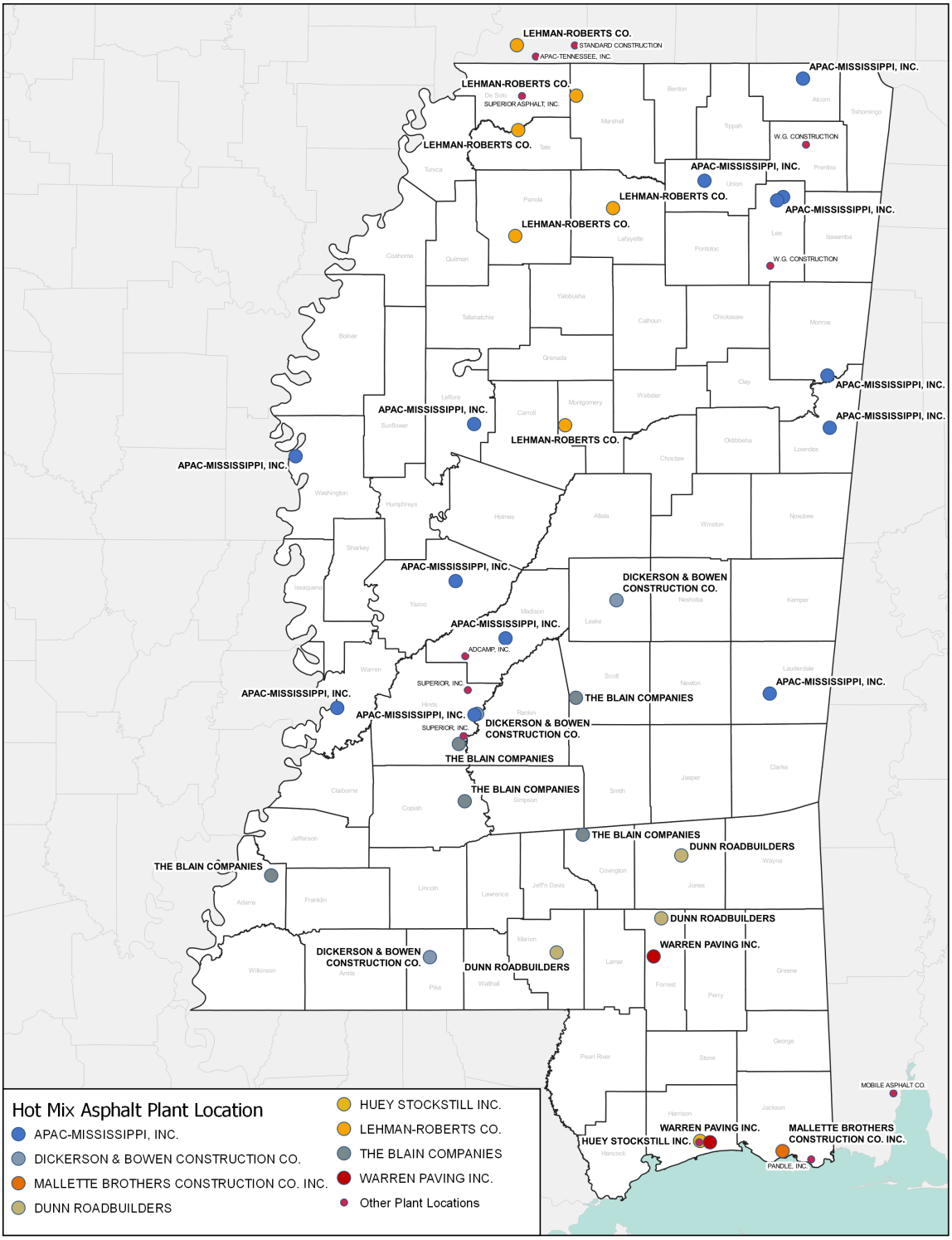
    b. Individual projects are not large enough to make hauling over a certain distance and/or the use of a portable asphalt plant economically feasible.

    c. Until MDOT significantly expands its capital program, asphalt plant locations and capacity will continue to act as a key market constraint, responsible for driving higher bid pricing.

The lack of competition for asphalt pavement projects is being driven by:

- The location and ownership of asphalt paving plants.
- The size and focus of MDOT's capital construction program, which is not large enough to entice industry to build competing plants.

Figure 4.2-8: Hot Mix Asphalt Plant Locations



The locations and ownership of hot mix asphalt plants align with the successful single-bid information shown in Figure 4.2-7, suggesting that contractors are reliably winning single-bid pavement contracts in locations where they own the only hot mix asphalt plant in the vicinity of the work. Conversely, areas of the State that are home to multiple plants generally experience more competition.

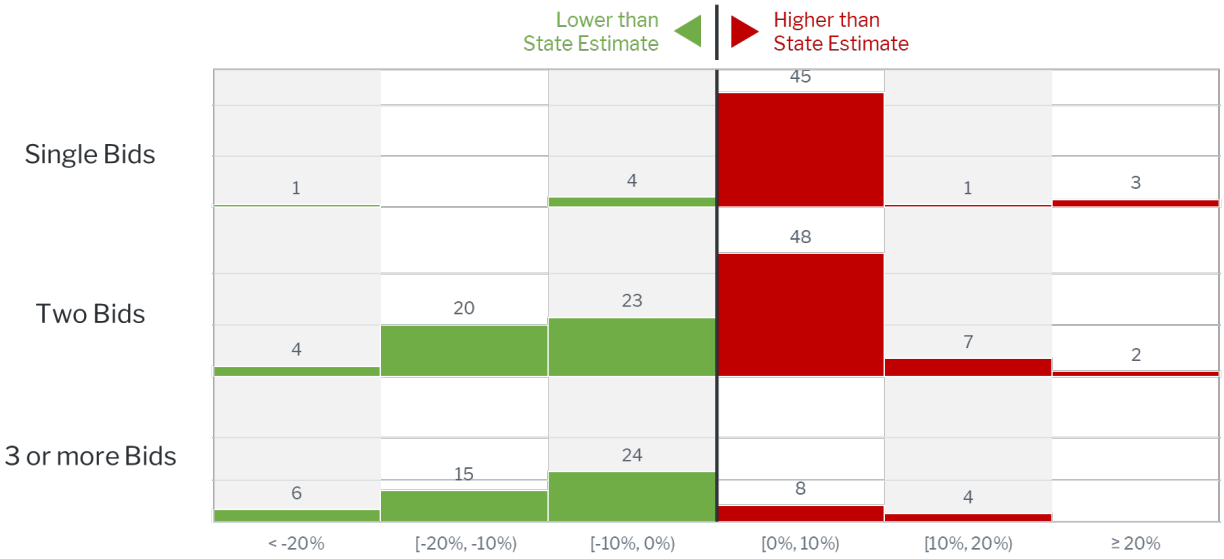
21. Given that pavement preservation, reconstruction, and improvement projects currently comprise the bulk of MDOT's capital construction program (almost 75% by dollar value), the effect of poor competition among paving contractors can be particularly costly.

22. Focusing on just the 215 pavement-related projects in the data set from January 2016 to November 2018, Figure 4.2-9 presents the distribution of bids as compared to the State Estimate.

    a. As shown, when only one bidder competes on a contract, most bids (45 out 54 contracts, or 83%) exceed the State Estimate by 0 to 10 percent.

    b. This +10% range acts as an upper threshold of sorts, as awards to low bids greater than 10% over the State Estimate must undergo a review and justification process (if MDOT does not choose to rebid these contracts outright).

Figure 4.2-9: Winning Bids Compared to the State Estimate
(For 215 Pavement Contracts Awarded from January 2016 through November 2018)



Key Takeaway: When only one bidder competes on a contract, most bids (45 out 54 contracts, or 83%) exceed the State Estimate by 0 to 10 percent. As more bidders enter the fray, the likelihood of estimates being lower than the State Estimate increases. 45% of the winning bids in the two-bidder situation, and 79% of those when three or more bidders compete, were less than the State Estimate.

23. Figure 4.2-10 further refines the single-bidder pavement data presented above to show how closely the winning bids approach the +10% ceiling. That most single bids fall within the +7-9% range presents a compelling case as to how market conditions and the level of sophistication of the local bidding community can combine to raise bid prices and thus the cost of construction.

    a. As demonstrated above, the geographical dominance of certain contractors has historically been well-established and would most likely

factor into the decision process of potential bidders as they consider whether to submit a bid.

b. Contractors will therefore have some insight into the likelihood of facing independent bidders for a project versus simply competing against the State Estimate.

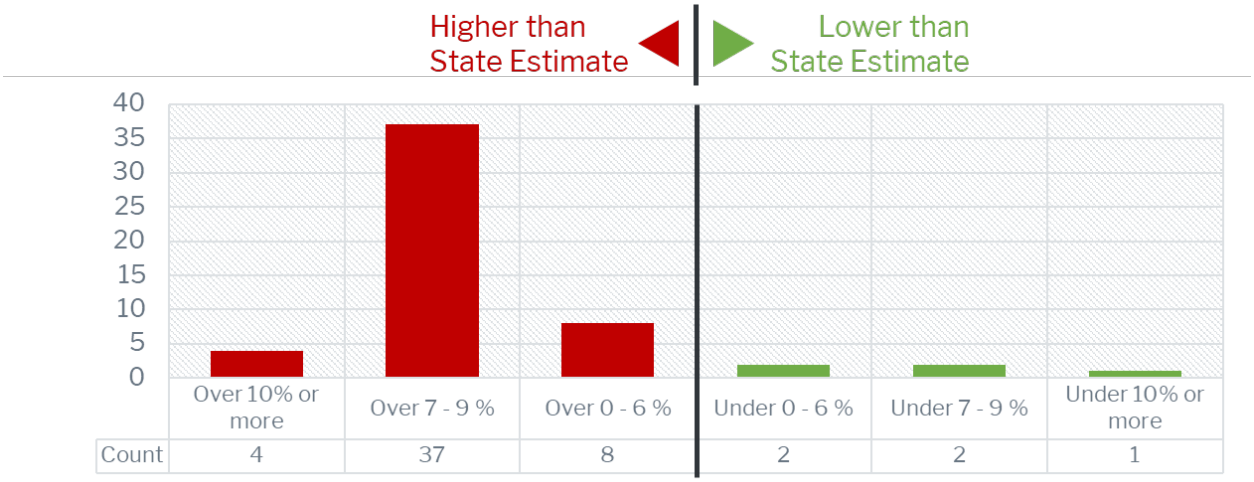
c. The projects MDOT lets to bid are also often small, representative of routine work, and largely comparable to work performed in the past (particularly given the DOT's current focus on system preservation).

d. Considering the factors above and the fact that most projects won by single bidders fall within the +7-9% range over the State Estimate, one may conclude:

- It is not difficult for bidders to anticipate the State Estimate, especially given the availability of national commercial databases which, for a subscription fee, provide users access to public agency bid data.

- When contractors can reasonably assume they will only be bidding against the State Estimate, they will attempt to maximize their profitability while staying within the +10% range (so as not to automatically trigger a justification or rebid process).

Figure 4.2-10: Winning Bids Compared to the State Estimate
(For Single-Bid Pavement Contracts Awarded from January 2016 through November 2018)



Key Takeaway: Most pavement projects won by single bidders fall within the +7-9% range over the State Estimate, suggesting that contractors will attempt to maximize their profitability while staying within the +10% range so as not to automatically trigger a justification or rebid process

Cost Control Strategies

24. As discussed above, until MDOT significantly expands its capital program, the location, ownership, and capacity of asphalt plants will likely continue to act as a key market constraint, responsible for driving higher bid pricing. (Ownership of

aggregate sources, although not reviewed in depth as part of this audit, likely also acts as a limiting factor in MDOT's ability to attract viable competitive bids.)

25. As demonstrated both in interviews with MDOT staff responsible for project programming, and by a review of the bid data itself, MDOT not only has a thorough understanding of the market conditions facing its construction program, but has also actively taken steps to help mitigate the impact of poor competition, particularly for pavement projects. As discussed further in this section, these practices include:

    - Protecting the State Estimate from the effects of non-competitive pricing
    - Re-advertising projects when appropriate
    - Strategically managing project lettings to increase the number of bidders

26. Given how closely market pricing tracks to the State Estimate (see Figure 4.2-10 above and the discussion regarding the consistency by which single bidders fall within the +7-9% range over the State Estimate), it is critical for MDOT to protect the independence of its State Estimates from the effects of noncompetitive pricing.

    a. As discussed further in Section 4.3, MDOT maintains a historical database of bid prices, which serves as a key input into the DOT's development of project estimates.

    b. When preparing estimates, MDOT takes care to exclude outlier pricing attributable to noncompetitive bidders or small quantities.

    c. Although it is difficult to quantify the savings this practice produces, identifying, understanding, and managing pricing anomalies when developing State Estimates helps ensure average item prices do not unnecessarily skew upwards over time.

MDOT helps prevent unwarranted price creep over time by carefully identifying and managing the outlier pricing contained within its database of historical bid pricing.

27. A more quantifiable cost savings practice often implemented by MDOT entails the re-advertisement of work when the low bid is appreciably higher than the State Estimate.

    a. Based on its review of the bid history data maintained in BidExpress for the contracts MDOT awarded between January 2016 and November 2018, the consulting team identified at least 23 occasions when MDOT did not accept the first low bid, and instead opted to re-advertise the work at a later date.

    b. For 10 of these 23 rebids, competition (as measured by the number of bidders responding) increased when compared to the original bid results. (The pool of bidders remained identical for all but one of the remaining 13 projects rebid.)

    c. More telling, for 18 of the 23 rebids, the low bid decreased when compared to the original, generating a total of $4.5 million in savings.

MDOT saved at least $4.5 million from 2016 to 2018 by rebidding projects.

Rejection of higher than anticipated low bids also helps to reinforce MDOT's confidence in its State Estimates, which, in turn, helps keep a check on unit pricing.

28. Despite the potential for savings, circumstances may not always render rebidding to be in the public interest (which is why MDOT often opts to provide justification for awarding projects that exceed the State Estimate by more than 10%). Such

cases, as identified by FHWA in "Guidelines on Preparing Engineer's Estimate, Bid Reviews, and Evaluation" (2004) include:

- Safety projects necessary to correct hazardous conditions
- Emergency repairs or replacements of damaged facilities
- Projects to close gaps in otherwise completed facilities to allow opening to traffic
- Projects that are critical to a staged or phased construction schedule, where a delay (as would result from a subsequent advertisement and award process for a rebid) would substantially impact the completion date of the facility.

29. Similarly, rebidding may not be appropriate or practical if:

    - Upon receipt of bids, MDOT recognizes that the higher item pricing is attributable to a project or market constraint that was not adequately considered in the original State Estimate.
    - Based on market and macroeconomic conditions (e.g., current and foreseeable contractor workload, resource availability, material pricing etc.), an appreciable change in the low bid is unlikely and does not warrant delaying the project further.

In the case of the US 49 project, for which the low bidder was 34% over the State Estimate, MDOT initially underestimated productivity impacts related to restricted access, the number of driveways/businesses, and the phasing of the project.

30. MDOT's strategic planning of contract lettings, with consideration given to the market and macroeconomic conditions that may impact bid prices, has also helped MDOT foster a more competitive bidding environment.

31. Foremost amongst these measures, particularly for pavement-related projects, is MDOT's monitoring of the work already under contract by each firm and at each asphalt plant to assess industry's ability and willingness to respond to bid advertisements.

    a. Contractors are more likely to respond to project advertisements and to submit competitive (i.e., lower) pricing when they are in need of additional work. Conversely, if a firm already has a large backlog and/or has fully committed its resources, it may opt not to compete at all or may submit higher unit prices.

    b. Based on its assessment of the availability and capacity of contractors, MDOT will defer non-critical projects to a time when the potential for competition improves.

MDOT balances the projects in a particular letting with industry capacity, and will defer non-critical projects if competition is expected to improve in the future.

32. Project letting practices other owner organizations have found to be effective entail:

    - Packaging projects to make them more attractive to bidders (e.g., bundling or combining small projects or splitting apart larger projects)
    - Scheduling lettings to take advantage of any seasonal differences in competition

33. However, as demonstrated below, competition in Mississippi appears to be largely immune to these measures.

a. Table 4.2-2 summarizes bid results by project size for 215 pavement-related projects awarded between January 2016 and November 2018. Contrary to the experience of some other agencies, larger projects do not, on average, attract appreciably more bidders than smaller projects. This suggests that MDOT's current packaging of projects is already right-sized to the capabilities and bonding capacity of local firms.

Project Size	Number of Projects	Average # of Bids Received (excluding irregular)
Less than $1M	19	2.16
Between $1M & $2.5M	89	2.07
Between $2.5M & $5M	64	2.11
Greater than $5M	43	2.42
Total	215	2.16

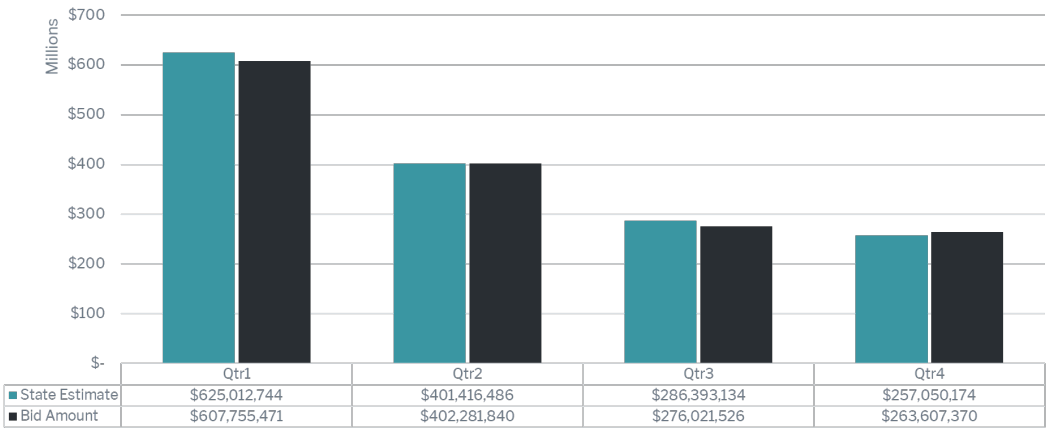
Table 4.2-2: Effect of Project Size on Competition
(For 215 Pavement Contracts Awarded from January 2016 through November 2018)

Project size does not have an appreciable effect on competition.

b. MDOT's Standard Specifications (Section 102-11, Combination Bids) also allows contractors to selectively bid two or more individual projects in combination – a practice recommended in the AASHTO Practical Guide to Cost Estimating (2013) as a means to potentially award pooled projects at a lower cost than the estimated sum of the individual projects. That few contractors have acted upon this clause reinforces the conclusion that larger projects will not attract more competition.

c. Other agencies have benefited from marked seasonal differences in bidding patterns. This effect is less pronounced in Mississippi. As shown in Figures 4.2-11 and 4.2-12, MDOT may experience only a marginal benefit by bidding work in the first and third quarters of the calendar year.

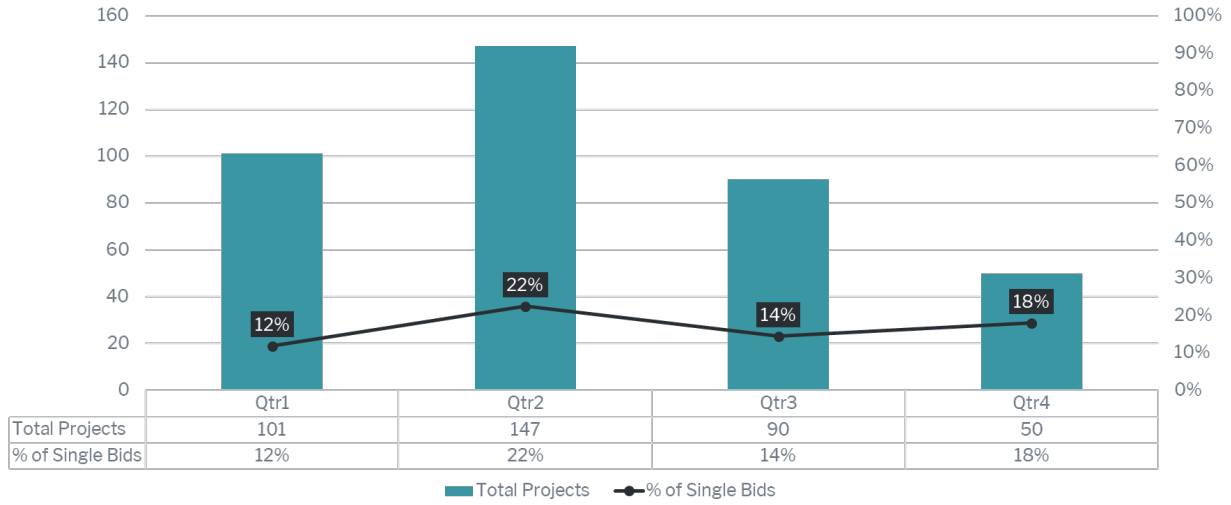
Figure 4.2-11: Effect of Seasonality on Competition, Comparison of Winning Bids to State Estimates
(For 215 Pavement Contracts Awarded from January 2016 through November 2018)



(Graphic excludes the US 49 project as an outlier)

Key Takeaway: Bids in total were less than the State Estimate during the first and third quarters of the calendar year. This suggests MDOT may experience a marginal benefit by advertising projects in this timeframe.

Figure 4.2-12: Effect of Seasonality on Competition, % of Single Bidders
(For 215 Pavement Contracts Awarded from January 2016 through November 2018)



Graphic excludes the US 49 project as an outlier)

Key Takeaway: MDOT may see a marginal benefit by bidding work in the first and third quarters of the calendar year, when projects have a slightly higher chance of attracting more than one bidder.

4.3 Cost Estimates

Estimate Accuracy

1. A DOT's ability to produce realistic estimates of project cost is critical to ensuring informed financial decision-making and effective review and comparison of bids received.

    a. Under-estimating can cause costly project delays as additional funding is arranged to cover the contract costs.

    b. Over-estimating may result in inefficient allocation of already scare funding that could have been applied to other projects.

    c. Consistent under- and/or over-estimating can erode the public's confidence in the DOT's ability to assess the fair and reasonable cost of construction.

2. Best practices implemented by MDOT to help ensure estimate reliability include:

    - Maintenance of a historical cost database, which is used to support the development of State Estimates

    - Dedicated team of experienced Staff Estimators who can identify project characteristics and constraints that require adjustments to historical bid prices (e.g., to account for difficult site conditions, quantity differences, etc.)

- Use of a uniform structure for preparing and presenting estimates, which aligns with the level of detail provided by contractors and facilitates the evaluation of bids and the monitoring of item costing over time

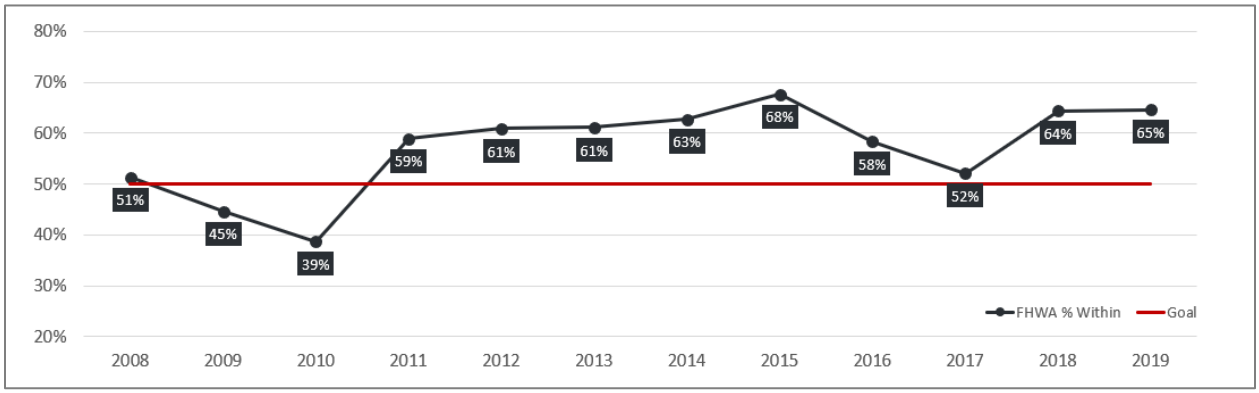
3. The successful implementation of these best practices by MDOT is evidenced by the accuracy of its State Estimates.

    a. According to FHWA guidelines[4,5], estimate accuracy should be measured by comparing the State Estimate against the low bid.

    b. As a performance measure of estimate accuracy, FHWA recommends that the State Estimate (also referred to as the "Engineer's Estimate" in some DOTs), should be within +/- 10% of the winning bid for at least 50% of the projects bid over a certain period of time.

    c. Testing MDOT's historic performance against this measure, Figure 4.3-1 indicates that MDOT produces credible estimates, with only two years (2009-2010) out of the past 12 failing to meet this threshold. (The 2-year anomaly is likely attributable to the receipt of ARRA funding, which led to a sudden increase in projects and more work than the market could readily support.)

Figure 4.3-1: Percent of Awarded Bids within +/- of the State Estimate



Key Takeaway: Since 2011, MDOT has consistently met FHWA's guideline for estimate accuracy, with the State Estimate being within +/-10% of the low bid for at least 50% of the projects awarded each year.

Estimating Contingency

4. Where MDOT could impart more rigor to its estimating process entails its consideration of project-specific risks and uncertainties for the purpose of establishing appropriate cost contingencies (in anticipation of potential cost impacts that may occur due to changes in project scope, site conditions, market conditions, etc.).

[4] "Guidelines on Preparing Engineer's Estimate, Bid Reviews and Evaluation". Federal Highway Administration. January 20, 2004.
[5] "FHWA Lacks Adequate Oversight and Guidance for Engineer's Estimates". US Department of Transportation, Office of Inspector General. March 13, 2019.

MDOT could impart more rigor to its estimates by assessing specific project risks.

a. Construction estimates will always contain some level of uncertainty attributable to potential variability in bid prices or quantities, and/or potential risk events, such as differing site conditions that could increase the cost of construction.

b. When securing funding for the work, a simple way owners often account for this uncertainty is to establish an appropriate contingency amount to be added to the base estimate. As the project proceeds, contingency usage is carefully monitored to ensure the unused balance is sufficient to address the remaining project risks.

c. Techniques used to establish project contingencies range from quantitative risk-based cost modeling to more simplified applications of direct percentages of estimated construction cost.

5. A review of MDOT's project funding requests reveals that MDOT applies a line item for "Engineering & Contingencies", calculated as a percentage of total construction cost, to arrive at the total project cost used for funding purposes. Where this approach differs from that used by other agencies is the co-mingling of costs meant to cover construction engineering (a tangible and necessary cost of construction) with that meant to cover risk (which a project may or may not incur).

MDOT's co-mingling of construction engineering costs with construction contingency funds masks the potential variability and perceived uncertainty in the cost estimate.

a. Construction engineering entails the cost of activities associated with a DOT's administration and oversight of a project's construction phase (i.e., from award through final acceptance or closeout of the work). Depending on the agency, this may include labor and expense costs accrued by the DOT (and/or third-party consultant) in performing inspection, material testing, contract administrative functions, and similar tasks.

b. DOTs often calculate construction engineering as a percentage of total construction costs, which may vary with the type, complexity, and size/$ value of the project. Even though this approach may be similar to how such agencies also estimate risk-related contingency, construction engineering and risk-related contingency are still managed as distinctly different line items.

c. MDOT's co-mingling of construction engineering costs with construction contingency funds masks the potential variability and perceived uncertainty in the cost estimate, and as discussed further in Section 4.4, makes it difficult to effectively manage cost growth attributable to quantity variations and changes.

4.4 Construction Administration

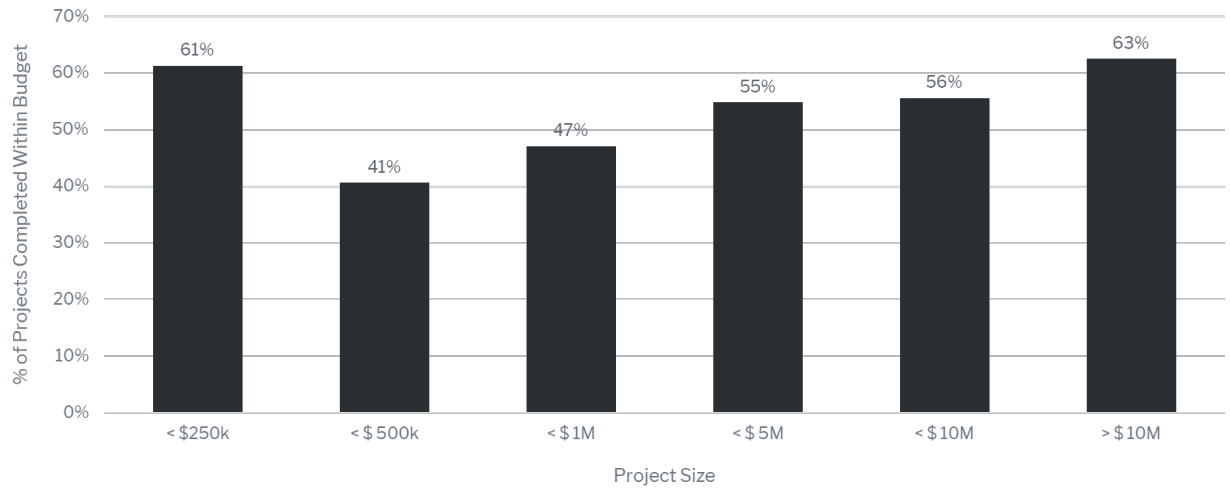
This section explores MDOT's accountability and success as a steward of public resources in managing the delivery of the 249 projects that reached substantial completion between 2016 and 2018. To evaluate MDOT's operational efficiency in constructing projects, the consultant team evaluated the cost growth (award to final construction cost) and schedule growth exhibited on these completed projects.

Cost Performance

1. 52% of these 249 projects were completed within the original contract award price.

2. As shown in Figure 4.4-1, cost performance in general does not appear to be driven by project size. However, as a future consideration for the delivery of large projects, with sensitive schedules and potential constructability challenges (i.e., similar to the active US 49 project), MDOT should consider requesting statutory authorization to use the Construction Manager/General Contractor (CM/GC) method. FHWA, based on the promising results achieved by other DOTs, has been promoting the use of this delivery method to improve cost control and reduce risk (though better design and contractor involvement during the preconstruction phase).

Figure 4.4-1: Construction Projects Completed within Budget
(For 249 projects completed between January 2016 and November 2018)



Key Takeaway: Based on 249 projects completed in 2016-2018, project size does not appear to have an appreciable effect on cost performance (as measured by comparing the construction contract award price to final construction costs).

3. Further parsing the project cost data, Figure 4.4-2 presents the distribution of cost overruns and underruns.

   a. As shown, more than half of the 119 projects that experienced overruns stayed within 10% of the original contract price.

   b. Taken in total, the project overruns during this three-year period reached over $29 million (see Table 4.4-1).

   c. At first glance, the fact that 130 projects, or 52% of the sample, were completed under budget could be looked upon favorably. However, due to these underruns, more than $23 million was inefficiently allocated.

More than half of the overrun projects were within 10% of the original award value, which aligns with industry norms.

Figure 4.4-2: Variance Between Final Construction Cost and Initial Contract Award Price
(For 249 projects completed between January 2016 and November 2018)

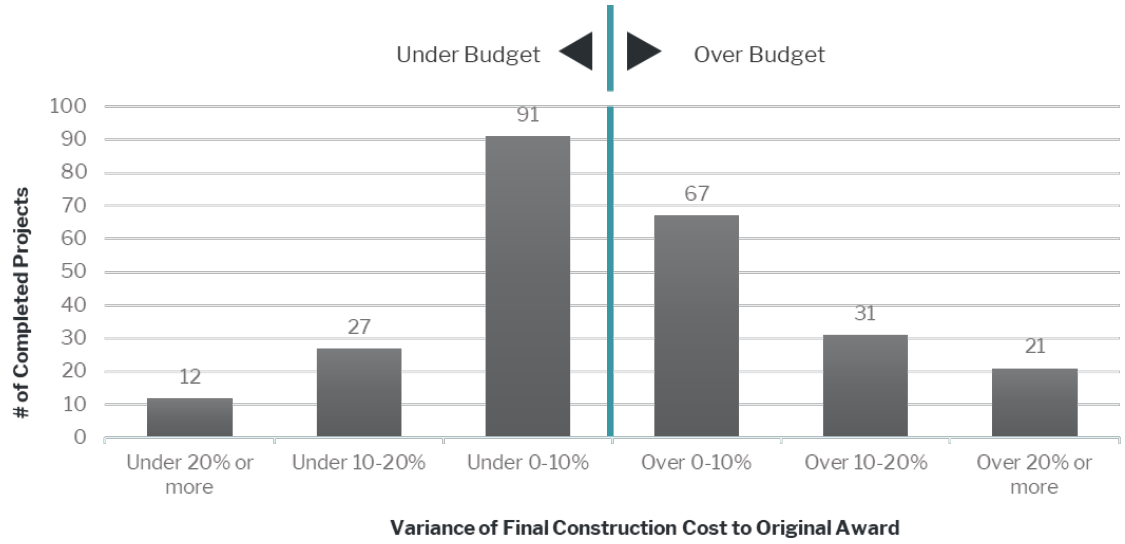


Table 4.4-1: Final Cost to Initial Contract Award Price Variance Analysis

Variance Between Contract Award and Final Cost	Number of Projects	Total Overrun (Underrun)
Under-run (Final Cost < Contract Award)		
More than 20% under budget	12	$ (2,373,013.58)
Between 10 and 20% under budget	27	$ (8,453,407.64)
Between 0 and 10 % under budget	91	$ (9,659,864.24)
Over-run (Final Cost > Contract Award)		
Between 0 and 10 % over budget	67	$ 4,831,420.68
Between 10 and 20% over budget	31	$ 14,982,920.90
Over 20% over budget	21	$ 9,526,706.83

Overly conservative estimates that lead to substantial underruns can be just as problematic as overruns. As summarized in the table, more than $23 million, or on average roughly $7 million a year, was inefficiently allocated to projects.

Quantity Variations

4. The large variances seen in Table 4.4-1 above appear to be symptoms of a larger issue surrounding MDOT's ability to accurately estimate quantities.

    a. The bulk of MDOT's construction program is based on unit price contracts (i.e., the original contract price is developed by multiplying MDOT's estimate of quantities by the winning contractor's bid item pricing and summing the total of all items).

    b. Quantity variations on such contracts are to be expected. However, the consistency by which projects seem to be underrunning the original contract amount suggests that MDOT is being overly conservative in its development of quantity estimates.

c. This conservatism appears to stem, at least in part, from including quantities in the bid documents to cover uncertain items (e.g., erosion control, excavation, and similar items that can be highly variable due to site conditions). This practice can help avoid the administrative burden of adding items to the contract through the change order process once the project is underway, as well as the premiums a contractor may otherwise charge if such items were to be added via change order rather than through the competitive bidding process.

d. Substantially overestimating quantities can also lead to overpayments of lump sum dependent items, such as mobilization and maintenance of traffic, which contractors generally price as a percentage of their overall initial contract price. When quantities substantially underrun, the potential exists for contractors to secure additional profits through such dependent items, which generally are not adjusted to reflect the actual cost of the work.

5. Moving forward, MDOT should strive to impart more precision into its development of quantity estimates and discipline into its real-time monitoring and forecasting of potential overruns/underruns.

a. As an initial step, MDOT District Offices should require Project Engineers to enhance the controls by which they *actively* track quantity variations.

b. MDOT's SiteManager software generates a recap of the final contract quantities on the Form CSD-200, Final Report of the Project Engineer, placing an asterisk beside pay items for which the final quantity varies by more than +/- 10% (or +/- $10,000) of the original contract amount.

c. According to MDOT's Construction Manual, all items marked with an asterisk (i.e., those that experienced significant over/underruns) "require an explanation by the Project Engineer as to why the item overran or underran."

d. Based on its review of a sample of these CSD-200 forms, the consultant team found several examples where such explanations were not provided.

e. If such explanations were provided with greater consistency in the future, they could be used to derive lessons learned and a better understanding of the project conditions that may lead to substantial quantity variations. This understanding could then be applied to inform MDOT's future project scoping and quantity estimation efforts.

f. Similarly, such information could also be used to help MDOT develop a more formal risk identification and management process. Clearly capturing the potential quantity variability as a risk (i.e., to be accounted for in the contingency added to the base estimate) would provide greater internal visibility to quantity uncertainties.

g. Moreover, active management of the contingency line item and forecasting of final quantities could allow for the earlier release of unneeded moneys to fund other projects. (Currently, unused project

It should be noted that as part of the final payment process, items do undergo a rigorous check to ensure that all recorded quantities are traceable to in-place work. The issue is not of final cost accounting, but of a lack of active project management that could be used to inform real-time decision-making.

Inconsistent documentation of quantity variances may prevent MDOT from identifying root causes and making potential improvements (e.g., to scoping and quantity estimating processes) to reduce the potential for future project cost variances.

funds are not released back into the program until after final payment to the contractor.)

Change Management

6. In addition to quantity variations, the total costs expended during a project's construction phase can also exceed the initially contracted amount as a result of mutually agreed upon changes to the contract via "Supplemental Agreements". Supplemental Agreements could entail:

    - Alterations or changes to the original plans and executed contract
    - Extra work that needs to be added to the plans for which there are no existing specifications and/or no existing contract pay items
    - Extensions to the original contract time

7. MDOT's Construction Manual sets forth a formal process by which project changes or alterations are to be reviewed, evaluated, processed and approved.

8. To assess MDOT's adherence to this process, the consultant team focused on a smaller subset of 45 projects, selected to provide a representative cross-section of project scope (pavement rehabilitation, overlays, and bridge rehabilitation/replacement), delivery method (design-bid-build, design-build; working day vs. fixed completion), size or cost, and geographical location.

9. Review of a sample of the executed Supplemental Agreements on these projects did not reveal any substantive issues with the approved contract changes themselves, on the basis that:

    - The work covered by the Supplemental Agreement constituted a valid change to the contract.
    - The Supplemental Agreement was supported by adequate documentation to justify the resulting cost/schedule adjustment.
    - MDOT appeared to have followed the standard administrative approval process set forth in the Construction Manual.

10. An aspect of the change management process that MDOT could enhance (staff resources permitting) entails more active management and forecasting of contingency usage (both for changes and quantity variations as discussed earlier).

    a. As identified in Table 4.4-2 below, 14 (or 31%) of the projects included in our subset of 45 projects exceeded not only the initial construction contract amount, but also the contingency MDOT added to this award amount to generate the Government Estimate used for funding purposes.

    b. This result suggests that the processes MDOT used to estimate contingency failed to recognize the actual level of risk facing the project and/or the level of uncertainty in the quantity estimates. To help avoid similar outcomes in the future, MDOT could either spend more time in the project scoping phase to minimize uncertainties or should develop a more rigorous risk-based approach to estimating contingency needs.

As previously recommended in Section 4.3, MDOT, particularly for larger projects, should take a more proactive approach to identifying, analyzing, and managing project risks.

c. The consultant team also recommends that MDOT improve its progress reporting practices (e.g., by maintaining a running log of approved and pending contract changes) to ensure project cost information is kept up-to-date, and forecasts better reflect the expected cost at completion. Better tracking of contingency usage will also help alert the Project Engineer to any upcoming need to prepare and submit a modified Government Estimate.

Table 4.4-2: Contingency included in MDOT Estimates vs. Actual Contract Overruns

Contract ID	Contract Award	Initial Contingency added to Award Amount	Construction Contract Paid to Date	Actual Construction Contract Overrun
CSP0022040601	$2,779,998.50	10%	$3,157,618.56	14%
CER1164000141	$976,417.15	10%	$1,143,339.78	17%
CEXB0008011111	$8,478,537.02	15%	$10,453,589.77	23%
CMP3000001061	$3,492,033.70	5%	$4,032,156.59	15%
CHSIP0079010321	$2,156,817.88	10%	$2,686,690.35	25%
CMP2000080801	$2,524,239.40	5%	$3,558,584.21	41%
CMP6589370101	$1,890,622.00	5%	$2,432,879.19	29%
CMP2000490781	$3,640,544.25	5%	$4,323,797.31	19%
CNH0079020171	$8,248,688.37	10%	$9,329,423.96	13%
CSTP0049010381	$2,806,562.25	10%	$3,917,469.82	40%
CBR0055022471	$1,814,184.00	10%	$2,106,476.98	16%
CNH0003011951	$3,730,330.30	10%	$4,834,248.43	30%
CSP0032010222	$1,514,614.00	5%	$2,230,537.73	47%
CER0063040061	$4,365,176.25	10%	$5,067,509.19	16%
CMP3049670161	$2,380,314.05	5%	$3,359,515.93	41%

Key Takeaway: The standard contingencies that MDOT adds to its project estimates to address unknowns (which typically range between 5 and 20%) are often insufficient to cover the actual cost growth experienced. This suggests that MDOT needs to either spend more time in the project scoping phase to minimize uncertainties and/or should develop a more rigorous risk-based approach to estimating contingency needs.

Project Cost Breakdown

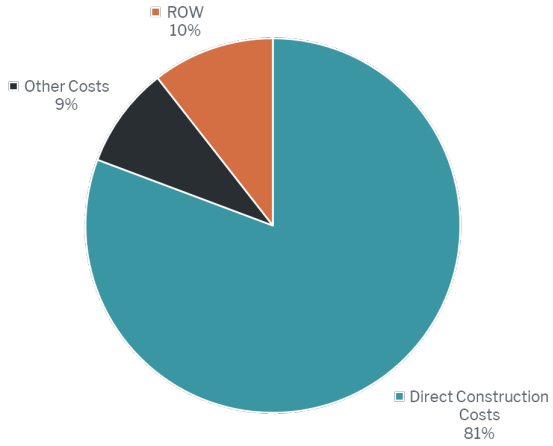
11. As an additional measure of the efficiency by which MDOT delivers the capital program, Figure 4.4-3 aggregates the total direct and indirect costs expended on completed projects within the sample subset of 45 projects.

    a. As shown, indirect or "soft costs" related to preliminary engineering, design, and other pre-construction services unrelated to right-of-way acquisition, amounted to 9% of the overall project cost.

    b. This figure aligns with industry norms and suggests that MDOT is controlling the cost of design, which is often outsourced to consultants. (See Chapter 2 for details on consultant contracts)

Figure 4.4-3: Comparison of Direct vs. Indirect Costs

Indirect project costs related to preliminary engineering, design, and other pre-construction services unrelated to ROW acquisition, amounted to 9% of the overall project cost, which is within industry norms.



Schedule Performance

12. MDOT generally sets a contract's schedule by either estimating the number of working days in which the contractor may complete the work, or specifying a completion date by which time the contractor shall have completed the work.

    a. As shown in Figure 4.4-4, MDOT has in recent years shown a greater preference for working day contracts, which mirrors MDOT's programmatic shift towards less time-sensitive, system preservation work.

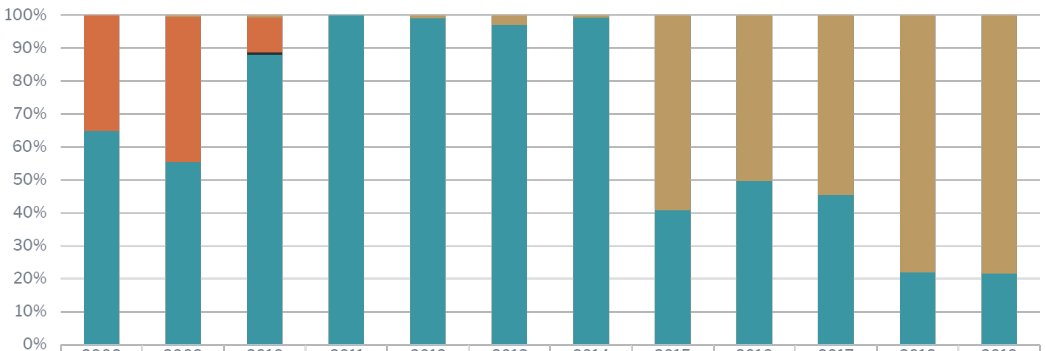
    b. Perceived benefits of working day contracts include their potential ability to:

        - Better allocate risk associated with adverse weather (and thereby mitigate the possibility of contractors including weather-related risk premiums in their bids)

        - Allow more scheduling flexibility for MDOT and contractor staff

    c. On projects requiring completion by a certain date, or where a large volume of traffic may be affected, MDOT continues to use specified completion date contracts.

Figure 4.4-4: Contract Time Requirements, Working Day vs. Specified Completion Date



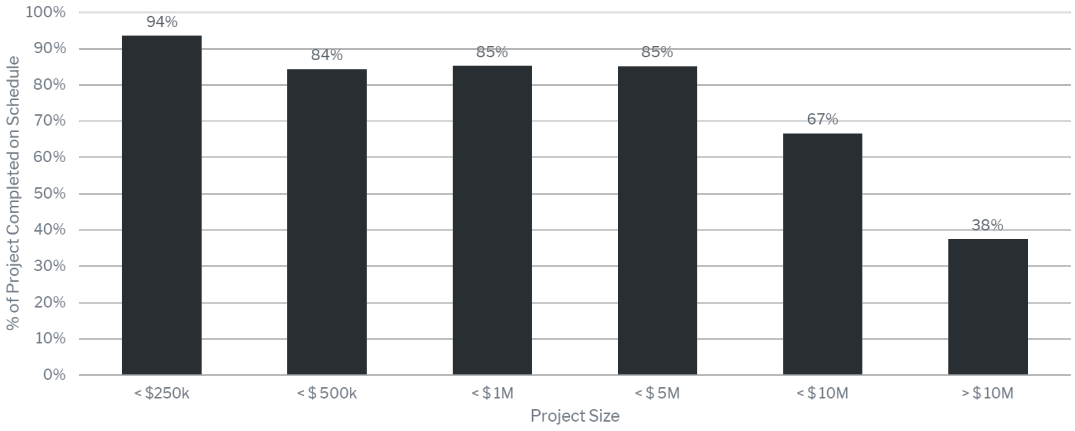
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Working Days		1	1		1	3	1	77	75	65	103	91
Time Units	39	74	15									
Productive Days			1									
Completion Date	72	93	125	95	109	100	128	53	74	54	29	25

Key Takeaway: A pronounced shift has occurred in MDOT's capital program towards greater use of working day contracts.

13. To evaluate on-time performance, the consultant team looked at completed projects for which the contract's final completion date was either the same as, or earlier than, the original completion date (or, for working day contracts, the number of working days used was equal to, or less than, the originally authorized number of working days).

14. As shown in Figure 4.4-5, project delays appear to be particularly problematic for larger, presumably multi-season, projects.

Figure 4.4-5: Construction Projects Completed on Schedule
(For 249 projects completed between January 2016 and November 2018)



Key Takeaway: Unlike cost growth (see Figure 4.4-1), schedule growth (or delays to the original contract completion time) appears to be closely related to project size.

15. Schedule delays, as summarized in Table 4.4-3, are more likely to occur on completion date contracts, with only 75% of the 120 completion date contracts finishing within the *original* contract time (i.e., not accounting for any time extensions approved via Supplemental Agreement). Conversely, 92% of the 129 working day contracts were completed within the original contract time.

    a. This result is not surprising, as working day contracts generally provide MDOT and contractors greater flexibility to manage times when weather and other project conditions would preclude the work from progressing.

    b. It should be noted, however, that completion date contracts are more commonly used across the industry, and are generally perceived as being a better motivator for timely contractor performance, particularly when time is of the essence.

Table 4.4-3: Comparison of Schedule Performance for Completion Day vs. Working Day Contracts

Schedule delays are more likely to occur on completion date contracts, with only 75% of the 120 completion date contracts finishing within the original contract time

Time Performance	Completion Date Contracts	Working Day Contracts
Completed on Schedule	75%	92%
Contract time exceeded by 0-10%	8%	1%
Contract time exceeded by 10-20%	7%	4%
Contract time exceeded by more than 20%	10%	3%

16. As a means to improve the on-time performance of completion date contracts, MDOT has experimented with A+B bidding provisions in an attempt to incentivize contractors to complete the work in a timely manner.

    a. Under the A+B method, a bid will have two components:

        - The A component is the traditional dollar amount equating to the contractor's estimate to complete the work.

        - The B component reflects the number of calendar days the contractor proposes to complete the work.

    b. The B factor is only used to determine the lowest bid for award purposes (i.e., not for payment).

    c. If the contractor fails to complete the work within the time established in its bid, the contractor is assessed a disincentive in addition to the standard liquidated damages.

17. The intent of A+B bidding is to motivate contractors to minimize construction time and delays.

a. However, as shown in Table 4.4-4, the on-time performance of the completed A+B contracts within our sample set was not superior to that of the completion date contracts that did not include this provision.

Table 4.4-4: On-time Performance of A+B Contracts

Time Performance	Specified Completion Date, without A+B provision	Specified Completion Date, with A+B provision
Completed on schedule	87 projects (76%)	3 projects (43%)
Contract time exceeded	26 projects (23%)	4 projects (57%)

A+B bidding does not appear to be achieving the desired effect of improved on-time performance.

b. Although the sample of completed A+B contracts is too limited to draw definitive conclusions, the tabulated results above, coupled with the administrative challenges (e.g., shift work, night work, etc.) of managing a contractor with an aggressive schedule, suggests that increased use of A+B bidding may not help MDOT achieve the desired effect of improved on-time performance.

c. As an alternative, as MDOT continues to develop the performance-based prequalification system discussed in Section 4.2, it should consider incorporating a factor related to contractors' history of completing projects on time.

4.5 Materials Management and Construction Inspection

1. A well-designed quality assurance (QA) program provides confidence that the materials and workmanship incorporated into a project are in reasonably close conformance to the approved plans and specifications. MDOT's construction inspection and materials testing practices are therefore vital to assuring that the public gets the constructed products and services that it pays for.

2. Internal inspection and testing efforts amount to approximately 3-4% (or $20 million) of MDOT's annual construction budget of approximately $600 million. This section investigates MDOT's materials management and inspection program to identify any strategies that could improve the effectiveness or efficiency of MDOT's quality assurance practices and/or achieve cost-savings.

A well-designed QA program can identify and resolve any potential construction quality issues that could increase the risk of reduced design life, increased maintenance costs, service interruptions, and/or safety hazards.

Construction Specifications and Manuals

3. MDOT's standard specifications and associated construction and materials manuals set forth its requirements for quality management.

4. Based on a review of these documents, MDOT's QA requirements are generally reasonable, efficient, not overly restrictive, and allow the agency to remain cost effective while still providing the requisite assurance of the quality of the materials and manufactured products incorporated into the transportation network (in accordance with the Federal Code of Regulations, specifically, CFR 23 CFR 637, Construction Inspection and Approval).

a. Focusing on two of the most widely used materials in transportation construction, a well-designed quality management system for asphalt pavements and structural concrete is in place.

Title 23, Code of Federal Regulations, Part 637 requires each DOT to develop and implement a QA program designed to assure that the materials and workmanship incorporated into Federal-aid highway construction projects on the National Highway System (NHS) conform to the requirements of the approved plans and specifications.

b. Producers and suppliers are generally required to participate in industry association quality programs, such as:

- The National Ready Mixed Concrete Association's (NRMCA) Inspection program
- The NRMCA QC Manual QC checklist
- The Precast/Prestressed Concrete Institute's (PCI) plant certification program, and the latest edition of the PCI Quality Control Manual
- The American Concrete Pipe Association (ACPA)
- The National Precast Concrete Association (NCPA)

c. Materials technicians are required to hold various certifications from either MDOT, or equivalent programs (such as the American Concrete Institute) for the type of work or testing being performed.

Manufactured Materials

5. Some agencies have found opportunities to streamline their QA processes, particularly for fabricated and manufactured materials (e.g., reinforcing steel, piping, raised pavement markers, etc.) that are produced under generally controlled conditions. (This is in contrast to project-produced materials, such as hot mix asphalt, which often require a high level of testing and inspection to control variability and assure performance.)

6. MDOT similarly has implemented practices to optimize the acceptance of manufactured materials. For example, some manufactured materials and products are pre-inspected at the source and have permanent markings, tags, or other types of approval methods to assure they meet specification requirements prior to being shipped to the project site.

    a. Many of these material approval processes are handled by MDOT's central Materials Division, minimizing the QA required in the field to a simple visual inspection (rather than full sampling and testing).

    b. Systems such as this allow for a more efficient and expeditious flow of work on project sites while providing assurance that specifications are met or exceeded.

7. MDOT participates in the AASHTO National Transportation Product Evaluation Program (NTPEP).

    a. NTPEP pools resources of AASHTO member DOTs to evaluate commonly used materials, products and devices, and provide cost effective evaluations and test data for agencies to determine if they are appropriate for use in the agency's approved product listing.

b. Using NTPEP has the potential to save time and effort by eliminating duplicate testing. NTPEP provides test data to participating agencies for their review and provides facility auditing of the producer's manufacturing quality management system.

c. Tennessee Department of Transportation (TDOT) uses NTPEP's national audit program to certify producers wishing to remain on TDOT's approved products list. In return for its annual $20,000 contribution to the NTPEP, TDOT has realized savings approaching $1,000,000 in reduced testing and auditing costs and streamlined product acceptance.[6] TDOT developed a special provision requiring producer participation in a NTPEP facility audit as part of its product approval process.

Tennessee DOT reported a significant return on investment approaching $1,000,000 by requiring participation in NTPEP by its producers for product approvals.

8. MDOT also currently maintains an "Approved Sources of Materials" list.

   a. The procedures for getting products on this MDOT list appear to be clear and not an onerous process.

   b. More frequent reliance on this process could potentially save time and effort for both contractors and the Department, as it would minimize the need for additional field sampling and/or testing at the project site.

Performance Specifications

9. Like those maintained by most DOTs, MDOT's Standard Specifications for Road and Bridge Construction are predominately prescriptive or "recipe" specifications that require contractors to use specific materials, equipment, and methods to complete the work.

   a. The prescribed requirements are typically based on materials and methods that have historically produced satisfactory results, thereby eliminating risk associated with newer, less proven methods and risk associated with varying contractor performance.

   b. A possible drawback to this approach is the lost opportunity associated with using alternative materials or sources that could result in superior performance or time or cost savings.

NCHRP Synthesis 492, Performance Specifications for Asphalt Mixtures found that approximately 80% of DOTS were using or experimenting with asphalt mixture performance tests. The most common tests were for predicting moisture damage (including MDOT), fatigue resistance, and thermal cracking. The perceived advantages are reduced maintenance costs and longer service life to major maintenance intervals.

10. Moving away from prescriptive specifications towards more performance-oriented specifications has several desirable advantages including shifting some of the responsibility (and risk) to the contractor, thereby allowing the contractor to use its knowledge of local materials and its equipment and methods to optimize its operations to meet the specified performance requirements.

11. For example, with regard to concrete, MDOT specifications currently specify a maximum water to cementitous material ratio. Specifications of some other DOTs are instead moving towards specifying a minimum cement content to provide the contractor increased flexibility in proportioning the concrete in a manner that meets requirements in a more economical and efficient manner. (An added protection against cracking potential limits the maximum cementitous material for certain classes of concrete.)

[6] http://www.ntpep.org/Documents/What%20is%20NTPEP/2019%20NTPEP%20Annual%20Meeting%20Big%20Sky%20MT-D.%20Lane.pdf

12. In the asphalt area, the traditionally used materials acceptance properties (e.g., asphalt content, gradation, air voids, VMA, etc.) may not provide the best indication of long-term performance. More modern specifications for asphalt mixtures are beginning to incorporate more performance-based properties including fatigue cracking, moisture damage, stiffness, and dynamic modulus.

13. MDOT personnel are aware of the current progress being made in both asphalt pavements and structural concrete related to standards and test methods that are more directly related to performance.

    a. MDOT personnel are willing to explore these performance-oriented methods that could extend service life of pavements and structures and reduce maintenance costs.

    b. For example, MDOT is currently evaluating the cost-effectiveness of performance-based asphalt cracking tests and how they relate to performance in Mississippi.

14. To continue to move forward with performance specifications, MDOT should explore opportunities to get involved with national coordinated efforts by AASHTO and FHWA in both asphalt pavement and concrete. Such participation would allow MDOT to have a voice in how the national standards are developed.

Optimization of Acceptance Testing and Inspection

15. MDOT has several long-standing procedures and detailed guides for inspection and materials sampling and testing that meet MDOT standards and FHWA regulations (23 CFR 637). These are excellent guides that fully describe what facets of an item require sampling, the sample size, who does the sampling, who does the testing, what items require additional paperwork or certifications, or if only a visual inspection is required.

Optimization of CE&I and Material Testing using risk-based inspection and testing and other strategies can significantly reduce costs and resources needed for acceptance of the work.

16. While these guides provide an excellent resource, MDOT should conduct a thorough review of its inspection and sampling frequencies to optimize sampling and testing and inspection efforts, targeting those items having a greater risk of negative impacts if not tested or inspected more frequently.

    a. A classic example is testing concrete for an incidental item such as non-structural concrete for sidewalks or median barriers, especially in a location such as Mississippi that experiences minimal freeze thaw cycles.

    b. Moving towards a risk-based sampling and testing approach could result in significant cost savings and improved allocation of staff resources, allowing for a more intensive sampling, testing, and inspection focus on items of work that are more critical.

17. MDOT undertook an internal study addressing risk-based optimization of construction engineering and inspection (CE&I) related to its administration of Local Public Agency (LPA) projects.

    a. Based on the research findings, MDOT recommended that inspection and testing frequency be calibrated to the perceived level of risk inherent in the project work item or materials (e.g. full-time inspection and standard testing frequencies for safety critical or higher risk items, and part-time or intermittent inspection and lower testing frequencies for low risk work or materials).

    b. The long-term recommendations associated with the study were to optimize the staffing levels for projects including CE&I and materials inspection and testing based on the project-level risks.

    c. Additional considerations towards achieving optimal efficiency should include levels of effort required for project administration, time spent on pay item documentation, and appropriate qualifications levels of staff to perform CE&I.

18. As DOTs are transitioning to the use of statistically-based QA specifications and alternative contracting methods, more DOTs are using contractor QC test results in their acceptance decisions.

    a. The use of contractor QC test results can further reduce the frequency of MDOT testing need to accept items of work that require tests for acceptance.

    b. Based on a review of MDOT's Inspectors Handbook, it appears that MDOT is using contractor test results for selected asphalt mixture property acceptance; this practice can potentially be extended to other items of work or materials requiring testing for acceptance.

19. MDOT may also wish to consider converting to a system-based Independent Assurance program for certain items. Such an approach can result in better utilization of qualified sampling and testing personnel and the avoidance of duplication of sampling and testing effort.

20. As an additional consideration related to optimization of inspection and materials management, MDOT District personnel have acknowledged that a significant level of time and effort is expended compiling quantities for payment instead of focusing on more critical QA inspection duties.

    a. The MDOT District personnel indicated that retaining and training staff is a serious issue and bridge and roadway inspection duties on time-sensitive projects with night shifts can overextend already short-handed District inspection staff.

    b. Opportunities to mitigate this issue could include using streamlined methods for acceptance of the work as suggested by the District staff. These strategies include structuring the inspection by using a Lump Sum or Plan Quantities approach to payment for more items (e.g., bridge decks, pier caps, surface area of paving, etc.) in lieu of adding up tickets, measuring items, or other means of determining the quantities. Such

NCHRP 838, Guidelines for Optimizing the Cost and Risk of Materials QA Programs (2017) provides a framework for adjusting materials QA practices to achieve an optimal balance of QA effort based on the risks of nonconformance.

A TXDOT Synthesis of Construction Inspection Workload Reduction Strategies (2009) determined that the use of Lump Sum or Plan Quantity take-offs for payment was the 2nd highest ranked strategy for inspector workload reductions. Other workload reduction strategies included:

- Greater reliance on contractor QC testing and inspection
- Greater use of certification for plant-produced materials/products
- Outsourcing specialty inspections

approaches can significantly reduce the time inspection staff spend on measurement and quantity verification for payment.

4.6 Summary

HKA's analysis of MDOT's processes for the delivery of capital construction projects has identified several opportunities to improve the overall management of the capital program to achieve budget efficiencies and lower construction costs. These recommendations fall into several categories including:

- Increasing competition in the procurement of construction contracts,
- Improving accuracy of estimating of construction costs and risks,
- More rigorous monitoring and reporting of the cost and schedule performance of contractors, and
- Reducing inspection and testing costs related to quality management and payment.

These recommendations are more difficult to estimate in terms direct cost savings. However, HKA's analysis of the data of prior projects demonstrates the opportunities for achieving lower bid prices and the opportunity to improve budget efficiency resulting in more projects with the same allocated budget.

Recommendations	Potential Benefit
1. Continue to pursue performance-based prequalification of bidders to help achieve the best value to the public.	Budget Efficiency
2. Improved competition will save costs. Re-advertising projects when appropriate saved **$4.5 million** between 2016 and 2018. If MDOT had received at least 2 bids on 67 contracts that only attracted one bidder, it may have realized **savings of approximately $18M** in construction costs. As market conditions change or the program expands, MDOT should consider a formal contractor and supplier outreach program to enhance competition in the regions of the State with the lowest competition.	Lower Construction Costs
3. Improve contingency estimating by assessing project-specific risks to establish appropriate risk-related project contingency and separately track contingency risk costs from construction engineering costs.	Improved contingency estimates
4. MDOT should strive to impart more precision into its development of quantity estimates and discipline into its real-time monitoring and forecasting of potential overruns/underruns. An analysis of 249 completed projects revealed that 52% were completed within or below budget and 48% were completed overbudget **resulting in a total overrun of $29M.** Of the underrun projects 119 appear to be driven by overly conservative quantity estimates in the bid documents. This practice resulted in the **inefficient allocation of more than $23M, or on average roughly $7M a year.**	Improved cost controls and efficiency of annual budget expenditures

Recommendations	Potential Benefit
5. Improve schedule performance for completion date contracts, through real-time schedule monitoring and forecasting of potential delays	Realize time and indirect cost savings
6. Quality Management a. Move towards using a risk-based approach to inspection and sampling and testing to focus limited inspection resources on critical items of work. b. Converting to a system-based Independent Assurance program for certain items can result in better utilization of qualified sampling and testing personnel and avoid duplication of sampling and testing effort. c. Use alternative measurement and payment methods for selected items or features of work (e.g., plan quantities or lump sum items) that can be accepted without the need for detailed field measurements.	Reduced inspection and testing costs for quality management and payment

This page is intentionally left blank

5. Maintenance

5.1 Introduction

This chapter investigates MDOT's maintenance program to determine what MDOT is doing well and to identify any strategies that could improve the efficiency or cost-effectiveness of the maintenance function.

The maintenance program comprises a significant portion of MDOT's overall expenditures, totaling over $188.6 million in FY 2018.

Program	FY2018 Actuals
Construction	$ 759,592,348
Maintenance	$ 188,624,517
Administration, Equip. & Buildings	$ 47,453,520
Enforcement	$ 14,528,055
Aero, Rails, Tran & Ports	$ 34,879,897
Debt Service	$ 74,547,603
Total	$ 1,119,625,940

MDOTs FY 2018 budget report summarized these expenditures in various maintenance categories including roadways, bridges, shoulder, drainage, roadside, traffic services, and other categories such as buildings and rest areas. Most expenditures ($51 million) were for PCA 230 - Routine Non-contract State Highway & Bridge Maintenance. The next largest category of expenditures ($17 million) were for PCA 760 – Service Center Maintenance. Given that the majority of MDOTs current construction program is dedicated to preservation of existing highway and bridge assets, a significant percentage of Maintenance Projects ($182 million in FY 2018) were let to Contract under the Construction program of which approximately 90% were overlay projects and 9% were for preventative maintenance.

MDOT was an early DOT implementer of a performance-based program for Maintenance Management. MDOT's Accountability in MDOT Maintenance Operations (AMMO) system (AMMO) system, which has been in place since 2010, is being used by the Districts primarily to track quantities, labor, and cost performance. The intent of the system had been to identify and prioritize maintenance needs based on Level of Service (LOS) targets and determine the appropriate level of in-house maintenance resources needed. If the level of effort exceeds in-house capabilities, then in theory MDOT contracts out for these services.

MDOT District staff are responsible for management and administration of the maintenance program. This includes performing surveys and inspections prioritizing maintenance needs, putting together the 3-year maintenance plan and budget, and determining what maintenance work to perform in-house and what to outsource. The priority of projects and budget is based on a 3-year plan that that is updated annually based on existing asset conditions.

District management staff indicated that certain maintenance services are kept in-house because they are difficult to contract out (i.e. small or emergency projects, specialty work,

Overview

This chapter assesses the following aspects of MDOT's maintenance program:

- Implementation of Performance-based Maintenance
- Outsourced maintenance vs. self-performance of similar work
- Alignment of MDOT's self-performed maintenance with optimized fleet and equipment inventory

indefinite quantities, etc.) whereas other more predictable or well understood scopes of work (mowing, litter control, pavement preservation, and rest area maintenance) are contracted out. Based on each District's maintenance plan, District management also must determine projected maintenance staffing and related equipment and resource requirements to perform the maintenance work and administer the program.

Three areas of interest arose from a review of the program documentation and interviews with MDOT Central Office and District staff:

- Section 5.2 assesses MDOT's implementation of its performance-based management system to determine the extent to which the collected data is used to determine what maintenance activities to perform inhouse vs. what to contract out, and plan what levels of staffing are needed for the maintenance program.
- Section 5.3 addresses whether self-performance or outsourcing of certain maintenance functions is more cost-effective especially given staff turnover and the recommendations associated with optimization of the fleet (Note that it is MDOT's opinion that its self-performance helps keep contractor pricing in line).
- Section 5.4 addresses rest area optimization and whether efficiencies can be obtained by closing or leasing rest areas to reduce maintenance and operating costs.

Chapter Highlights

Area of Inquiry	How is MDOT performing?	Key Observations	Recommendations
Performance-Based Maintenance	▲	• MDOT uses a performance-based maintenance management system (AMMO) and was an early implementer of a performance-based maintenance management. • Some MDOT districts use the AMMO performance-based maintenance system primarily as a retrospective tracking tool for quantities, labor, and cost performance for specific maintenance activities, but not as a planning and resourcing tool.	• Expand the capabilities of the AMMO system to be used as a planning tool for resources, equipment and commodities for more predictable maintenance activities. Provide additional training and support as needed for the expanded use of AMMO. • Tie performance-based LOS targets to budgeting and planning and scheduling estimates for maintenance activities to determine the most effective deployment of maintenance staff to meet targets.
Outsourcing of Maintenance	▲	• Given staffing and budget constraints, MDOT outsources selected maintenance activities or work that is commercially attractive, predictable and competitively priced. • MDOT uses a quote system to further streamline procurement and save costs for minor maintenance works.	• Continue to selectively outsource maintenance work that can be demonstrated to be reasonably competitive and cost effective compared to retaining permanent in-house staff and equipment.

Area of Inquiry	How is MDOT performing?	Key Observations	Recommendations
Optimization of Rest Areas	●	• Rest areas and welcome centers are costly to maintain and operate. • Other DOTs have investigated closing rest areas in the vicinity of privately-run commercial alternatives. (For example, Ohio DOT estimated $7.2 million in annual savings if it were to close 21 rest areas.)	• MDOT should carefully evaluate its welcome centers and rest areas and close selected rest areas with available alternate private commercial facilities or reduce service unless (or until) rest areas are needed for emergencies. Comparable studies have identified significant savings in janitorial and operational costs.

▲ MDOT meets or exceeds industry leading practices
● Potential for improvement
■ Policy or market condition largely out of MDOT's control

5.2 Performance-based Maintenance Management

1. Performance-based highway maintenance and operations (M&O) management has been the subject of active research and industry exchanges since the early 2000s. The focus of these efforts has tended to emphasize performance-based elements, or the "tools of the trade": for example, condition assessment, measures of performance, definitions of levels of service (LOS), establishment of LOS thresholds, and incorporation of these elements within existing, modified, or new maintenance management systems (MMSs).

2. In 2008 MDOT was an early implementer of a new performance-based MMS referred to by the agency as Accountability in MDOT Maintenance Operations (also called AMMO).

    a. MDOT followed a multi-staged trial and evaluation process in acquiring the software and building in desired performance-based capabilities.

    b. MDOT conducted a needs analysis and business process review to identify the current process and potential future improvements.

    c. MDOT customized AMMO based on the needs identified, and the system was tested and implemented in multiple stages. It included several modules/functionalities including Work Planning, Work Order Management, Remote Processing and GIS capability. This new way of managing maintenance was expected to serve a number of performance-related tasks; for example, to track highway system condition and performance; develop needs-based estimates; help prioritize M&O needs and actions; develop and support budget requests; allocate resources among districts; and quantify relationships between LOS parameters and cost.

3. Based on discussions with MDOT District personnel, ten years after the introduction of the AMMO system, some Districts are primarily using the system as a tracking tool rather than as the intended planning tool.

    a. Furthermore, AMMO is not used the same way in every District. While some Districts appear to use the AMMO system to schedule work and create a backlog of work orders, other Districts use it as a Daily Work Report and tracking tool or a tool to retrospectively look at usage costs.

    b. While some districts log all information regarding work hours, materials, and resources, others do not.

4. AMMO is a valuable tool that is providing MDOT with data on how the M&O work is distributed and the costs associated with specific tasks. The tool would be even more powerful if its use were standardized across all Districts and used as a planning tool for predicting the maintenance resources needed to meet LOS targets for specific maintenance activities.

    a. This would allow more useful comparisons using operational performance metrics for planning purposes.

    b. For example, cost efficiency in activities like mowing is tracked in the maintenance budget summary based on costs per acre. Further, costs per acre for routine in-house tractor mowing can be compared to contract

mowing. Districts can then determine how much and what types of work can more effectively be contracted out and what level of District staff and equipment should be retained for specific maintenance activities during a construction season.

5.3 Self-performance of Maintenance vs. Outsourcing

1. District staff generally indicated that maintenance staff self-perform work that is not commercially attractive or practical. This self-performed work may include more difficult mowing, selected pavement preservation (chip seals, thin lifts, potholes and patching, crack repairs, etc.), bridge maintenance and repairs, drainage and roadside, traffic service maintenance (striping, signs, lighting), and various emergency repairs.

2. District staff perform condition assessments or inspections of assets, prioritize based on the severity of deterioration, and break scopes of work into packages or maintenance sections based on age and design parameters.

3. From a budgeting perspective, District management indicated that there is an incentive to package and push planned maintenance work into the bid process (outsourcing) because of budget limitations and other staffing constraints. The work that is more predictable and quantifiable is outsourced to include mowing (less difficult areas), pavement preservation (overlays and thin lifts), rest area maintenance, bridge painting, and work packages with fixed or known quantities that are large enough to attract bidders.

4. Work typically performed by in house maintenance staff includes first responder accident response and emergency repairs (e.g., guardrails, signage, pavement washouts less than 100' or emergency pothole repairs), specialty high mast lighting, or other smaller projects.

5. Districts also use a "Quote" system to outsource commodities or minor maintenance work that do not need formal plans, studies, or procurement safeguards (i.e. bonding).

    a. The quote system significantly lowers costs and expedites procurement using emails to a preselected group of contractors to obtain quotes and make selections.

    b. The quote system is similar to a more formal job order contracting or Indefinite Delivery Indefinite Quantity (IDIQ) contracting processes promoted by FHWA and used by many DOTs for minor maintenance, emergency repairs, overlays or other types of seasonal maintenance work.

6. District staff have also indicated that studies have been done to assess whether leasing of equipment, mowing services, litter pickup, and maintenance of rest areas or other facilities would be more cost-effective. While some districts conclude that in-house maintenance, for example building maintenance in 10 counties, is much more cost-effective, other Districts outsource because they do not have or cannot retain the in-house staff needed to perform the work.

7. Retaining DOT maintenance staff is generally a major issue as noted in the Chapter 2 staffing assessment. Salaries were apparently not competitive with similar county positions in the state. In 2019, the average experience level of maintenance staff in one district was four months. Given this shortage, the capacity and capability of a District's staff also may dictate whether outsourcing is more practical or the only solution.

8. Given MDOT's current challenges with retaining in-house maintenance staff, it should continue to selectively outsource maintenance work that can be demonstrated to be reasonably competitive and cost effective compared to retaining permanent in-house staff and equipment.

9. In conjunction with recommendations to reduce underutilized vehicles and equipment in the MDOT fleet, MDOT should explore opportunities to negotiate leases with favorable terms for specific bundled maintenance services and equipment for scopes of work that are well understood and attractive to private maintenance providers.

5.4 Rest Area Optimization

1. Rest areas were singled out by District staff as being costly or candidates for private development/leasing in that they are mostly underutilized except during floods and hurricane evacuations but required 24-hour security and janitorial services.

2. Rest area optimization is a common cost-saving measure for state DOTs. In the last few years, states including Arizona, California, Connecticut, Kentucky, Maine, Missouri, Michigan, Texas and Virginia have looked at rest area closures as a cost saving measure. Most states that research rest areas focus on similar criteria, such as distance between alternative stopping opportunities and the utilization of existing areas. States that have evaluated rest area closure have reached various conclusions.

    a. For example, Michigan concluded that it was not necessary to close any rest areas whereas Connecticut decided that the private sector offered enough alternatives to allow for the closure of all DOT-maintained rest areas.

    b. Ohio DOT conducted a study that recommended reducing the number of rest areas on its state highway system based on the availability of equivalent private facilities in the vicinity of the rest areas. It also assessed the viability of having a private partner operate selected facilities. It was estimated that closing 21 rest areas having alternative stopping opportunities nearby, would save ODOT approximately $7.2 million annually.

3. MDOT should carefully evaluate its welcome centers and rest areas to assess the viability of closure based on available alternate private commercial facilities.

5.5 Summary

Based on the above discussion, HKA observes and recommends the following:

- AMMO is a valuable tool that is providing MDOT with data on how the M&O work is distributed and the costs associated with specific tasks. The tool would be even more powerful if its use were standardized across all Districts and used as a planning tool for predicting maintenance resources needed to meet LOS targets for specific maintenance activities.

- MDOT should continue to selectively outsource maintenance work that can be demonstrated to be reasonably competitive and cost effective compared to retaining permanent in-house staff and equipment.

- MDOT should carefully evaluate welcome centers and rest areas and close selected rest areas with available alternate private commercial facilities or reduce service unless (or until) rest areas are needed for emergencies.

These recommendations are based on industry practices and successful initiatives implemented by other DOTs. MDOT should conduct a more in-depth analysis of their current performance-based maintenance and processes for outsourcing or optimizing maintenance activities to test the recommendations and assess the extent of potential cost savings.

This page is intentionally left blank

6. Fleet Management

6.1 Introduction

Overview

During fiscal years 2017 through 2019, MDOT expended approximately $29 million (or an average of $9.6 million annually) to operate and maintain its fleet of vehicles (considering fuel, preventative maintenance, and repair costs). During the same period, MDOT spent over $18.5 million to acquire new vehicles. The processes by which MDOT operates, maintains, and upgrades its fleet are therefore essential to ensuring the efficient use of funds. As discussed in this chapter, potential opportunities exist to generate savings and/or improve efficiency through the implementation of fleet optimization strategies, including:

- Eliminating or repurposing underutilized vehicles,
- Establishing an optimal asset management-based vehicle replacement strategy,
- Right-sizing fleet maintenance staffing,
- Strategic use of leasing,
- Maximizing the benefits of GPS, and
- Standardization of the fleet.

To provide a basis for these strategies, Section 6.2 first characterizes MDOT's current fleet inventory in terms of:

- Vehicle classes (passenger vs. work),
- Location (District Office vs. Central Office),
- Assigned usage (commuting vs. non-commuting),
- Vehicle type (pickup trucks, specialty vehicles, cars, SUVs, etc.), and
- Age and miles driven

Section 6.3 then determines the extent to which any vehicles in these categories are over- or under-utilized. Building upon this utilization analysis, Section 6.4 recommends a vehicle replacement strategy intended to improve the cost effectiveness of MDOT's fleet, in line with recent asset management practices implemented by similar agencies, including the Alabama, Missouri, and Ohio DOTs. Section 6.5 proceeds to evaluate MDOT's fleet maintenance staffing, considering national standards and other strategies to right-size the fleet. In the context of MDOT's current practices, Section 6.6 explores additional strategies to optimize fleet management, including leasing, use of GPS devices, and vehicle standardization.

Chapter Highlights

Area of Inquiry	How is MDOT performing?	Key Observations	Recommendations
Section 6.3: Utilization Analysis – Fleet Rightsizing			
Non-Commute Vehicles	●	• MDOT's fleet includes a significant number of older vehicles that appear to be both underutilized and costly to maintain. • 365 non-commute vehicles were identified as potentially underutilized.	• MDOT should take incremental steps to eliminate vehicles from the fleet that are consistently underutilized. • **Savings of up to $13M in future acquisition costs are projected.**

Area of Inquiry	How is MDOT performing?	Key Observations	Recommendations
Commute Vehicles		• 38 commute vehicles were identified as being potentially underutilized based on falling below the general usage guidelines provided by the DFA for making purchasing decisions (15,000 miles per year).	• MDOT should conduct further analysis on commuting vehicles identified as potentially underutilized (< 15,000 miles/year) and consider reassigning or repurposing underutilized vehicles. • **Savings of up to $895K in future acquisition costs are projected.**
Section 6.4: Optimal Replacement Strategy			
Fleet Replacement Strategy		• MDOT's current fleet replacement strategy (7 years and 150,000 miles) has resulted in an aging fleet (9.8 yrs. on average) with relatively high operating and maintenance costs. • MDOT's average return on investment (18%) is low compared to that achieved by other state DOTs that have adopted an asset management approach to fleet replacements.	• MDOT should implement a more optimal replacement strategy for major categories of vehicles and equipment in the fleet (both on-road and off-road) with the goal of reducing the overall age of the fleet and maximizing the salvage value. • Looking at just the pickup fleet with more than 150,000 miles, **projected savings may approach $4.2M.**
Section 6.5: Fleet Maintenance Staff			
Fleet Mechanics		• MDOT's current in-house fleet maintenance staff includes 80 employees across six Districts covering approximately 2,278 vehicles, 633 pieces of heavy equipment, and 630 tractors. • Assuming MDOT's current 1:44 mechanic-to-vehicle ratio is in line with the needs of its aging fleet, a reduction in vehicles would call for a commensurate reduction in fleet mechanics.	• MDOT should right size in-house vehicle maintenance staff in proportion to any reductions in fleet inventory. • For example, reducing the number of mechanics by 20% could lead to **projected savings of up to $600,000 annually**.
Section 6.6: Other Optimization and Cost Reduction Strategies			
Leasing or Renting		• MDOT has explored vehicle and equipment rental and leasing as an option to reduce fleet size and save on ownership costs. • MDOT has used rental contracts for mowing and for certain specialty equipment (e.g., heavy road working equipment, bucket trucks, mini excavators), and increased the equipment rental vendor list.	• MDOT should continue to consider rental and lease options for specialty vehicles or equipment where financing terms are favorable, and costs are lower compared to equipment or vehicle purchases or mileage reimbursements.

Area of Inquiry	How is MDOT performing?	Key Observations	Recommendations
GPS	▲	• In Spring 2017, MDOT began installing GPS devices on all fleet vehicles. MDOT is now able to track among other things, idle time, speed alerts, harsh cornering, harsh braking, rapid acceleration, and similar information, and track if the issue occurred during working hours or not. • Conservatively assuming 10 percent fuel savings due to GPS implementation, MDOT is **likely saving upwards of $450,000 annually** based on typical annual fuel expenditures of $4.5 million.	• The MDOT Central Office should develop a consistent set of metrics around GPS (e.g., location, idle time, speeding, harsh braking/accelerating, mpg, etc.) and standard policies governing GPS across all Districts to maximize the benefits and leverage the data to track vehicle usage patterns or identify underutilized vehicles.
Standardization	■	• MDOT uses 15 different manufacturers to cover their fleet needs. • With different makes and models for each type of asset, maintaining the assets and their parts can create challenges and drive up costs.	• If it were able to narrow its fleet operations to a few standard vehicle types or critical components, MDOT could potentially realize savings on parts, maintenance, repairs, and training, in addition to minimizing down time. • When purchasing new vehicles, total life-cycle cost savings should be considered when comparing the price of a standard model with any new model.

▲ MDOT meets or exceeds industry leading practices
● Potential for improvement
■ Policy or market condition largely out of MDOT's control

6.2 Classifying MDOT's Fleet Inventory

Vehicle Classes

1. MDOT follows the Mississippi State Department of Finance and Administration's (DFA) standard policies for managing its vehicle fleet.

    a. DFA budget categories define "vehicles" as "any piece of equipment with an odometer."

    b. The DFA Fleet Manual (October 2018) then classifies vehicles into the following two usage categories:

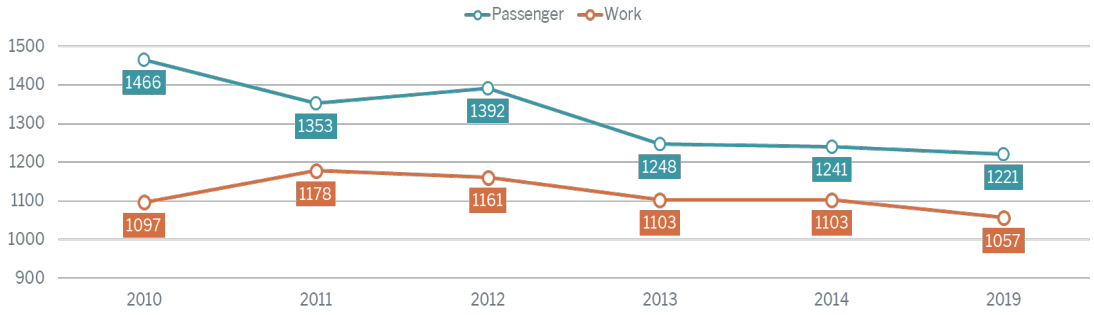
    - *Passenger Vehicles* are "used primarily in transporting agency personnel and the agency's equipment from one location to another".

    - *Work Vehicles* are "used primarily to perform a work assignment or tasks while incidentally transporting agency personnel and agency equipment from one location to another".

2. Focusing on these two categories, Figure 6.2-1 summarizes trends in MDOT's vehicle inventory since 2010.

Figure 6.2-1: MDOT's Inventory of Passenger and Work Vehicles
(MDOT Vehicle Data as of November 2019)

Between 2010 and 2019, the total number of passenger and work vehicles in MDOT's fleet declined by approximately 17 percent and 4 percent, respectively.



    a. As shown, there has been approximately a 17 percent decrease in the number of passenger vehicles and a 4 percent decrease in work vehicles between 2010 and 2019.

    b. In the last 9 years, the total fleet number, combining both passenger and work vehicles, decreased from a high of 2,563 total vehicles in 2010 to 2,278 vehicles by November 2019, for an overall reduction of over 10 percent.

    c. The total number of vehicles remained relatively stable from 2010 through 2012, averaging 2,549 vehicles. The downward trend thereafter can be attributed in part to a measure enacted by the State Legislature in FY 2012 (Bill Number SB 2917), which:

    - Placed a moratorium on the acquisition of motor vehicles by any state agency for one year, and

    - Required that any state agency with more than 40 vehicles to reduce the total number of vehicles in the fleet by 2 percent for

each fiscal year between July 1, 2013 and June 30, 2016 (excluding law enforcement and emergency vehicles).

Assigned Location

3. Table 6.2-1 further classifies the vehicle data according to its assigned location. As shown, most of the fleet (84%) is distributed across the District Offices, with the remainder being used by Central Office staff and the Law Enforcement program.

Table 6.2-1: MDOT's Fleet Inventory by Location
(MDOT Vehicle Data as of November 2019)

Location	Passenger	Work	Grand Total
District 1	157	145	***302***
District 2	145	184	***329***
District 3	134	140	***274***
District 5	221	187	***408***
District 6	170	190	***360***
District 7	108	141	***249***
Central Office	147	68	***215***
Enforcement	139	2	***141***
Grand Total	**1221**	**1057**	***2278***

The majority of MDOT's current fleet (84 percent) is used by the District Offices. As could be expected, given the role played by Districts in performing highway maintenance activities and construction oversight, they generally have a higher proportion of work vehicles than seen in the Central Office and the Law Enforcement program.

Assigned Usage
(Commute vs. Non-Commute)

4. In addition to distinguishing between passenger and work vehicles, DFA also requires every vehicle to be assigned to one of the following three categories: law enforcement, commute, and non-commute.

    a. Table 6.2-2 summarizes these classifications, and their usage restrictions, as defined in the DFA Fleet Manual.

Table 6.2-2: Description of Commute vs. Non-Commute Vehicles
(Source: DFA Office of Purchasing, Travel and Fleet Management, Rules and Regulations, Fleet Manual, October 2018)

	Commute	Non-Commute	Law Enforcement
Description	A state-owned vehicle assigned to be driven from an employee's primary place of work to an employee's residence as needed. Authorization for a commute vehicle assignment requires clear justification to the DFA that providing the user a vehicle would be a cost saving to the agency and the State.	A state-owned vehicle assigned to be driven to and from an employee's primary place of work to any temporary place of work and then returned to the primary work location on a daily basis. Non-commute vehicles include both of the following: • **Motor Pool** vehicles that are available for use by any authorized user of the agency • **Individual Non-Commute** vehicles that are assigned to a single individual for use in the performance of their job duties during their scheduled work hours	A state-owned vehicle assigned to a sworn law enforcement officer whose position requires daily performance of the duties of a sworn law enforcement officer. Copy of supporting certification must be provided to DFA prior to approval of Law Enforcement vehicle assignment.

	Commute	Non-Commute	Law Enforcement
Usage Restrictions	A commute vehicle: • May not be used in a commuting capacity solely by virtue of the user's job title or position • Cannot be part of a compensation or administrative package • Requires clear justification to the DFA that providing the user a vehicle would be a cost saving to the agency and the State	Non-commute vehicles must not be driven to and from the employee's residence unless the employee has been authorized by his or her agency to utilize the vehicle in "travel status."	An employee who is a sworn law enforcement officer as defined in Section 45-6-3 of the MS Code or a law enforcement trainee as defined in Section 45-6-3(e) of the Code, and whose position requires him or her to daily perform the duties of a sworn law enforcement officer may drive a vehicle if use of the vehicle is essential for the employee to carry out their daily job duties

b. Table 6.2-3 classifies MDOT's current fleet according to these commute- vs. non-commute categories. As shown, commute vehicles make up only 10 percent of the fleet, with the remainder being returned to the primary work location at the conclusion of each working day, if used at all.

Table 6.2-3: Commute vs. Non-Commute Assignments
(MDOT Vehicle Data as of November 2019)

Commute vehicles make up only 10 percent of MDOT's fleet

Location	Commute	Non-Commute		Law Enforcement	Grand Total
		Individual	Pool		
District 1	17	12	273	-	**302**
District 2	23	49	257	-	**329**
District 3	14	12	248	-	**274**
District 5	20	41	347	-	**408**
District 6	27	136	197	-	**360**
District 7	20	34	195	-	**249**
Central Office	30	70	115	-	**215**
Enforcement	-	-	56	85	**141**
Grand Total	**236**	**354**	**1688**	**85**	**2278**

Vehicle Type

5. Another way to classify the vehicles included in MDOT's fleet is by vehicle type.

a. Table 6.2-4 identifies and describes the various vehicle types included in MDOT's current inventory.

Table 6.2-4: Vehicle Types in MDOT's Current Fleet
(MDOT Vehicle Data as of November 2019)

Vehicle Type	Vehicle Model/Description
Pickup trucks	Pickups less than 1-ton without a specialized use. For example, an F-150, Chevy Silverado, etc.
Specialty trucks	Pick-ups greater than 1-ton and work vehicles with specific uses such as a tractor, aerial bucket, asphalt paver etc. These tend to be larger models such as the F-450, F-550.
Dump trucks	Dump trucks with 2 to 16 cubic yards capacity depending on use

Vehicle Type	Vehicle Model/Description
SUV	Sport Utility Vehicles, including the Chevy Tahoe, Ford Explorer, Ford Escape etc.
Sedans	Automobiles, including the Chevy Impala, Ford Taurus, Dodge Charger etc.
Vans	Models such as the Dodge Grand Caravan, Ford E-150 etc.

b. Table 6.2-5 then classifies MDOT's fleet according to these vehicle types.

Table 6.2-5: Classification of MDOT's Fleet by Vehicle Type
(MDOT Vehicle Data as of November 2019)

Location	Pickup Truck	Specialty Truck	Dump Truck	SUV	Sedans	Van	Grand Total
District 1	176	57	65	2	-	2	**302**
District 2	159	72	94	-	1	3	**329**
District 3	128	58	76	6	1	5	**274**
District 5	219	93	81	3	-	12	**408**
District 6	183	78	89	6	1	3	**360**
District 7	126	59	59	-	2	3	**249**
Central Office	77	53	-	11	45	29	**215**
Enforcement	52	1	-	71	16	1	**141**
Grand Total	**1120**	**471**	**464**	**99**	**66**	**58**	**2278**

Key Takeaway: Almost half of MDOTs current fleet consists of pickup trucks. Most SUVs, passenger sedans, and vans are assigned to the Central Office and the Law Enforcement program.

---

c. As shown in Table 6.2-5, almost half of MDOT's current fleet consists of pickup trucks, with specialty trucks and dump trucks being the other two major vehicle categories.

d. The table also reveals differences in the composition of vehicles assigned to District Offices versus the Central Office and Enforcement program. As could be expected, given the role played by the Districts in performing highway maintenance and construction oversight, the fleet makeup at the District level primarily consists of pickups, specialty vehicles, and dump trucks. In contrast, the Central Office fleet consists of mostly SUVs, passenger sedans, and vans, in addition to pickup trucks.

Age, Miles Driven, & Repair Costs

6. MDOT follows the DFA's standard policies and minimum replacement criteria for its vehicle fleet.

a. Under this policy, vehicles become eligible for replacement once they reach 7 years of service and an odometer reading of over 150,000 miles.

---

b. In adhering to this policy, agencies may practice some discretion to:

- Replace vehicles sooner if there are excessive maintenance and repair costs, or
- Retain vehicles longer if maintenance and operating costs are unusually low.

According to State policy, MDOT generally cannot replace a vehicle until both of the following criteria are met:

- 7 years of services

  AND

- 150,000 miles driven

7. Reviewing MDOT's current fleet data in the context of this replacement policy reveals the following:

   a. The current fleet ranges from 1 to 34 years in service, with an average age of 9.8 years.

   b. 59 percent of the fleet is more than 7 years old.

   c. 26 percent of the fleet exceeds the 150,000 miles driven threshold.

   d. 34 percent of the fleet is more than 7 years old but has less than a 150,000-mile odometer reading.

   e. 25 percent of the fleet (569 vehicles) qualify for replacement (based on exceeding 7 years of service and 150,000 miles driven). These vehicles include 280 passenger vehicles and 289 work vehicles.

8. Figure 6.2-2 presents the distribution of MDOT's current fleet based on age and miles driven.

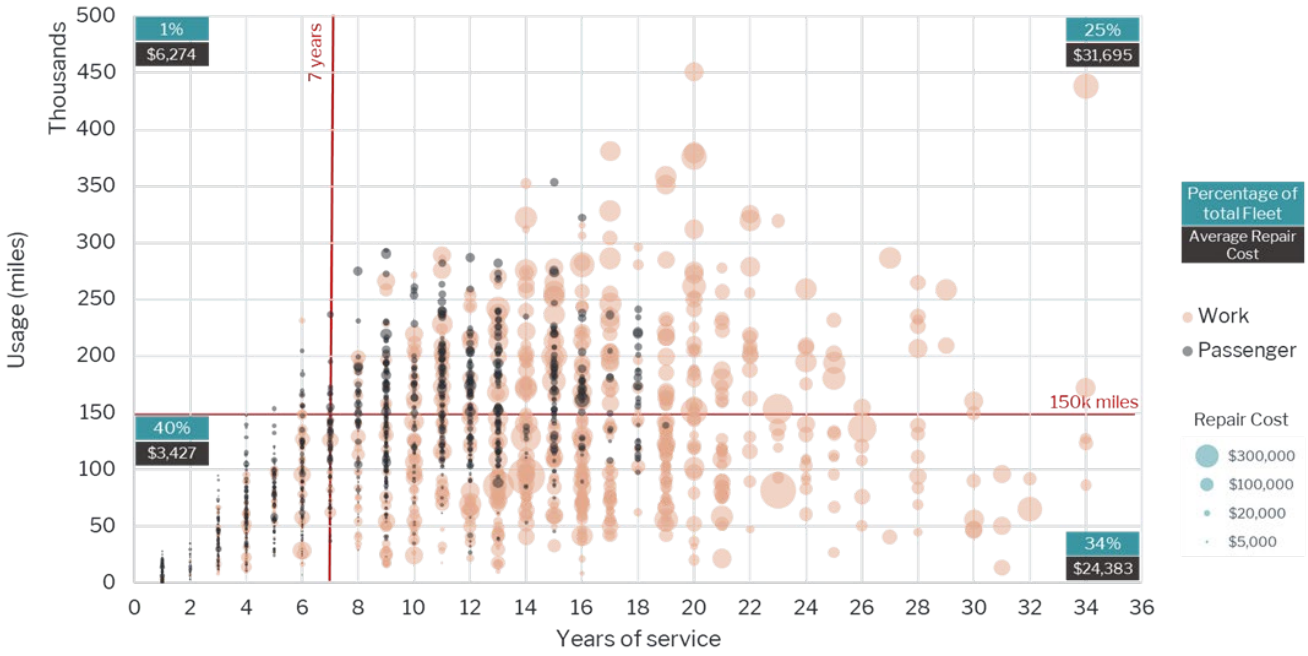
   a. The red lines visualize the replacement threshold set by the State, dividing the chart into four quadrants.

   b. The upper right quadrant represents those vehicles that currently exceed the replacement threshold (i.e., are older than 7 years and have more than 150,000 miles).

   c. As shown, the vehicles in this quadrant represent 25% of the total fleet and have, over their lifetime, incurred an average repair cost of over $31,000.

   d. Also noteworthy is the lower right quadrant, representing vehicles that are more than 7 years old, but have less than 150,000 miles. Such older vehicles (which represent 34 percent of the fleet) may be underutilized, while also accruing high lifetime repair costs (as reflected in the relative size of the data points in the graphic).

Figure 6.2-2: Distribution of Passenger and Work Vehicles in MDOT's Fleet based on Years of Service and Usage
(MDOT Vehicle Data as of November 2019)



The figure presents the distribution of MDOT's current fleet based on age and miles driven. The figure also depicts lifetime repair costs, which range from $300,000 to less than $5,000, as represented by the relative size of the data points. The red lines visualize the replacement threshold set by the State, dividing the chart into four quadrants. The upper right quadrant represents those vehicles that currently exceed the replacement threshold (i.e., are older than 7 years and have more than 150,000 miles). As shown, the vehicles in this quadrant represent 25% of the total fleet and have, over their lifetime, incurred an average repair cost of over $31,000.

Key Takeaway: MDOT's fleet is aging. 25% of the fleet exceeds the 7-year, 150,000-mile threshold and would qualify for replacement. 34% of the fleet is more than 7 years old, but has less than 150,000 miles, suggesting that many older vehicles may be underutilized, while still accruing high lifetime repair costs (as reflected in the relative size of the data points).

9. Figure 6.2-2 also reveals differences in the average age and repair costs of the passenger and work vehicles in MDOT's fleet.

    a. On the whole, the passenger vehicle fleet is far younger than that of the work vehicles. Of the passenger vehicles, 52 percent were purchased within the last 7 years. In contrast, 72 percent of work vehicles were purchased more than 7 years ago.

    b. As could be expected given the differences in vehicle ages, the average lifetime repair cost for work vehicles ($32,177) is much higher than that of passenger vehicles ($5,194).

    c. These trends can be traced in part to fundamental differences in the makeup and function of the passenger and work vehicle fleets. In contrast to traditional passenger vehicles, work vehicles, which include dump trucks, tractors, aerial bucket trucks and similar specialty

equipment used for roadway repairs and routine maintenance (e.g., mowing operations), tend to:

- Have a much longer lifespan
- Incur less mileage (i.e., are used according to need not as a daily ride)
- Have larger acquisition costs (the average acquisition cost for work vehicles is $62,415 compared to $19,409 for passenger vehicles)

6.3 Utilization Analysis – Fleet Rightsizing

34% of MDOT's fleet is over 7 years of age, has less than 150,000 miles, and has incurred, on average, over $24,000 in lifetime repair costs.

1. As discussed above, MDOT's fleet includes a significant number of older vehicles that appear to be both underutilized and costly to maintain. With reference to Figure 6.2-2 above, 34 percent of MDOT's fleet is over 7 years of age, has less than 150,000 miles, and has incurred, on average, over $24,000 in lifetime repair costs.

2. Utilization is not the only metric by which the need for vehicles can be measured. Despite having low mileage, certain vehicles may be essential to MDOT's operations both as a highway maintenance provider and as a first responder in the event of an emergency. Nevertheless, underutilization, particularly of non-essential vehicles, represents a potential unnecessary drain to MDOT's resources (considering maintenance, operation, and future replacement costs).

3. This subsection therefore presents a high-level utilization analysis of first the non-commute fleet and then the commute fleet. (Note that this analysis is for illustration purposes only; MDOT should conduct a more rigorous utilization study to identify vehicles that could potentially be eliminated from the fleet.)

Utilization of Non-Commute Vehicles

4. Although no national standard exists for fleet utilization, guidance can be found in the criteria and metrics used by other organizations.

    a. Some federal agencies require a minimum utilization for sedan vehicles of 8,000 miles per year.

    b. The Commonwealth of Pennsylvania requires 6,000 miles per year for permanently assigned vehicles.

    c. Providing for a more nuanced assessment approach, Colorado DOT uses 50 percent of the average utilization for each class of vehicle as the minimum threshold.

5. Given the variety of vehicle classes with potentially different utilization rates in MDOT's fleet, HKA adopted the Colorado DOT approach to assess utilization (i.e., setting the minimum threshold at 50 percent of the average utilization for each vehicle class). Performing this assessment included the steps described below.

    a. First, the fleet data for fiscal year 2019 was reviewed to identify possible exceptions that could skew analysis results. For example, HKA excluded from the analysis:

- Vehicles that were acquired during the fiscal year 2019, as their usage will be much lower than the average

- Vehicles and equipment that are tracked based on operating hours, rather than mileage

b. Commuting vehicles were also excluded and are analyzed separately in the next subsection. This exception was made because the DFA's general guidelines for making purchasing decisions indicate commuting vehicles are used a minimum of 15,000 miles per year, which provides a more appropriate measure by which to assess the utilization of this portion of the fleet.

c. HKA then separated the remaining vehicles into 10 major categories, as identified in Table 6.3-1, and calculated the average utilization for each group for fiscal year 2019. The average mileage serves as an indication of the expected usage for that vehicle group during a typical year.

d. Next, any vehicle achieving less than 50 percent of the group average can be considered underutilized and a candidate for removal or repurposing. (It should be noted that a more detailed study would be needed to assess other factors that may also influence the removal/repurposing decision, including maintenance operations that may require multiple vehicles for traffic control; specialty vehicles required for specific roadwork operations that may not be readily available for lease when needed; and similar considerations.)

Table 6.3-1: Utilization by Vehicle Category
(MDOT Vehicle Cost and Usage Data for Fiscal Year 2019)

Vehicle Category	# of Vehicles	FY19 Avg. Usage (miles)	Threshold (50% below the avg.) (miles)	# of Vehicles below the threshold
Pickup Truck 1/2T or less	707	11,180	5,590	**127**
Dump Truck 8CY or less	245	7,147	3,574	**100**
Dump Truck 12CY or more	170	7,378	3,689	**50**
Pickup 3/4T or more	135	12,976	6,488	**26**
Tractor Trucks	61	9,545	4,773	**16**
Van	54	11,389	5,695	**14**
Utility Truck	39	14,217	7,108	**10**
Passenger Cars	59	8,772	4,386	**8**
Truck Flatbed	37	13,617	6,808	**8**
Truck Spreader	10	3,273	1,637	**6**
Total	**1517**			**365**

Key Takeaway: Almost a quarter (24%) of the 1,517 vehicles included in the analysis fell below the usage threshold (set at 50% of the average for each vehicle category) and could be considered underutilized.

6. As indicated in Table 6.3-1, 365 vehicles (or 24 percent) of the 1,517 included in the analysis fell below the usage threshold and could be considered underutilized.

7. As shown in Table 6.3-2 below, the acquisition cost of these underutilized vehicles was not insignificant, reaching over $13 million.

    a. Moving forward, MDOT should evaluate whether these vehicles should be kept (for essential or emergency services), repurposed, or disposed.

    b. If the underutilized vehicles below the 50% threshold were disposed, it could result in significant savings for MDOT in salvage value, avoidance of repair costs, and future replacement purchases.

    c. Additional potential savings, not accounted for in this analysis, include maintenance and operation costs.

Table 6.3-2: Average Acquisition Cost based on Vehicle Categories in MDOT Fleet
(MDOT Vehicle Cost and Usage Data for Fiscal Year 2019)

Vehicle Category	Vehicles below the threshold	Average Acquisition Cost	Total Acquisition Cost Per Group
Pickup Truck 1/2T or less	127	$16,190	**$2,056,114**
Dump Truck 8CY or less	100	$48,489	**$4,848,940**
Dump Truck 12CY or more	50	$67,946	**$3,397,312**
Pickup 3/4T or more	26	$23,756	**$617,655**
Tractor Trucks	16	$69,547	**$1,112,754**
Van	14	$57,147	**$800,052**
Utility Truck	10	$23,860	**$238,602**
Passenger Cars	8	$19,389	**$155,111**
Truck Flatbed	8	$36,861	**$294,889**
Truck Spreader	6	$42,863	**$257,176**
Grand Total	**365**		**$13,778,605**

Key Takeaway: A significant percentage of vehicles in various categories (365 in total) are underutilized based on being 50% below the average mileage for each category. MDOT can potentially reduce the number of vehicles, repurpose them into pooled vehicles, and save on acquisitions. If MDOT reduced the number of underutilized vehicles, it could potentially save up to $14 million in future acquisitions. MDOT should conduct a more rigorous utilization study to identify those vehicles that can be eliminated from the fleet without impacting the Department's ability to carry out its core functions.

Utilization of Commute Vehicles

8. The above represents only a high-level analysis of potential savings that could stem from fleet rightsizing. MDOT should conduct a more rigorous analysis to first identify and account for essential vehicles that cannot be eliminated or leased (i.e., those needed for MDOT to carry out its normal workload and to serve as a first responder in the event of an emergency) and then dispose of (and not replace) low use, non-essential vehicles.

9. In contrast to the non-commute vehicles evaluated above, commute vehicles can be assessed against the utilization threshold established in the DFA Fleet Manual.

    a. General guidelines offered by DFA in the purchasing decision section of the Fleet Manual indicate that commute vehicles should be used a minimum of 15,000 miles annually. As stated in the DFA's manual,

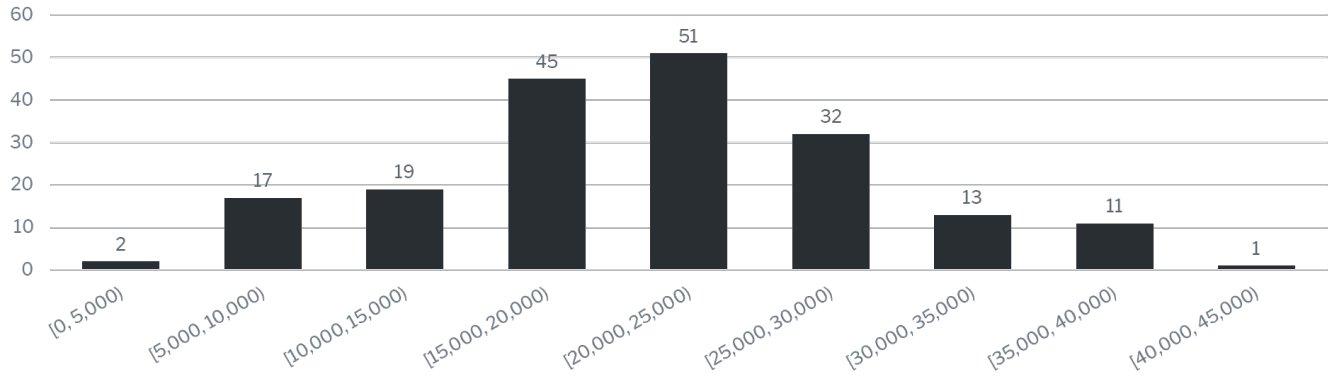
        In most cases, it is not financially wise to purchase a vehicle for an agency that does not expect to use the vehicle 15,000 miles or more annually for agency business purposes.

    b. In fiscal year 2019, a total of 191 assigned commute vehicles were included in MDOT's fleet, excluding vehicles that were acquired during fiscal year 2019, as their usage is much lower than the average and could skew results.

    c. As shown in Figure 6.3-1, 38 of these 191 vehicles (or almost 20 percent of the commute vehicle category) did not meet the annual mileage guideline offered by DFA. Consequently, MDOT should consider potentially reassigning these vehicles to the non-commute fleet (i.e., the motor pool), leading to savings over time by not purchasing replacement vehicles. The total acquisition cost for these 38 vehicles was $895,441.

In FY2019, almost 20% of the commute vehicle fleet did not meet the general guidelines offered by DFA.

Figure 6.3-1: Distribution of 191 Commute Vehicles in MDOT Fleet
(MDOT Vehicle Cost and Usage Data for Fiscal Year 2019)



Key Takeaway: Almost 20 percent of the commute vehicles (38 out of 191) are underutilized based on the annual usage guidance provided by DFA (15,000 miles). Stricter adherence to the DFA guideline would allow MDOT to reassign such vehicles to the motor pool, leading to savings over time by not purchasing replacement vehicles.

6.4 Optimal Replacement Strategy

1. Given the importance of having a reliable fleet to maintain the state highway system and the relatively large investment associated with such fleets, many DOTs have adopted replacement strategies that optimize the cost of ownership (including costs to acquire, operate, maintain, and replace the fleet) over time.

This section evaluates the savings MDOT could obtain if allowed to adopt a more optimal fleet replacement strategy.

a. The goal is to apply a data-driven asset management approach to fleet purchases that:

- Reduces the average age of the fleet,
- Improves the efficiency of operations (cost/mile), and
- Maximizes the return on investment.

b. The savings derived from such an approach can then be applied to purchase newer vehicles to further optimize reliability and performance. Ancillary benefits include improved safety technology, fuel savings, reduced maintenance and repair expenditures, and lower insurance premiums.

Average Return on Investment

2. As stated previously, MDOT adheres to DFA's fleet replacement policy.

   a. Under this policy, vehicles become eligible for replacement after reaching 7 years of service and 150,000 miles.

   b. A vehicle must be disposed of, if replaced, within 90 days of each new acquisition (i.e., 1:1 acquisition to disposal requirement).

   c. Agencies have some discretion to replace vehicles sooner if there are excessive maintenance and repair costs, or retain vehicles longer if maintenance and operating costs are unusually low.

3. Adherence to this policy has resulted in a skewed distribution of vehicles within MDOT's fleet towards older vehicles (average age of 9.8 years). Furthermore, this policy has also resulted in a poor return on investment, when considering the low salvage value of aged equipment.

   a. As summarized in Table 6.4-1, in five years, from July 1, 2014 and June 30, 2019, MDOT disposed of a total of 686 vehicles with an average acquisition cost of $24,926.62 (for a total of $17,099,663) and an average disposal amount of $4,069.99 (for a total of $2,792,016).

   b. This resulted in a relatively low total return on investment of approximately 18%.

Table 6.4-1: Average Fleet Acquisition and Disposal Costs
(MDOT Vehicle Acquisition and Disposal Data for FY15-FY19)

Vehicle Category	Disposed of Vehicles	Average Acquisition Cost	Average Disposal Amount	Average Odometer Mileage	Average Years in Service	Average % Return
Sedans	83	$18,131.44	$3,517.87	143,508	8.3	21%
Dump Trucks	66	$39,874.54	$6,404.00	193,231	18.9	15%
Pickup trucks	348	$14,959.68	$2,905.81	181,554	11.2	19%
Specialty Trucks	145	$43,567.11	$6,634.89	201,832	13.9	16%
SUVs	15	$24,878.14	$4,003.01	191,167	10.4	16%
Vans	29	$36,781.45	$1,518.74	132,195	9.4	6%
Grand Total	**686**	**$24,926.62**	**$4,069.99**	**180,484**	**12.1**	**18%**

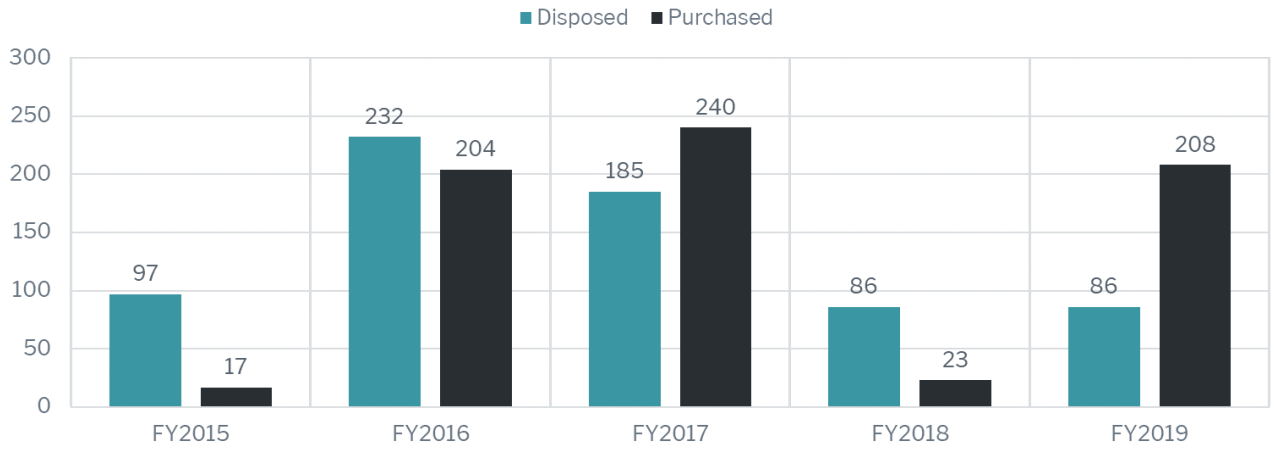
Key Takeaway: MDOT's fleet replacement strategy is yielding a low return on investment.

4. As shown in Figure 6.4-1, over the last five years MDOT has disposed of a total of 686 vehicles while purchasing 692 vehicles. With further reference to Table 6.4-1 above,

    a. 51 percent of the disposed vehicles were pickup trucks, with an average of 11.2 years in service.

    b. Sedans were disposed of at an average age of 8.3 years and yielded the highest return on investment (salvage value) at 21 percent.

Figure 6.4-1: MDOT Vehicle Disposals and Purchases
(MDOT Vehicle Acquisition and Disposal Data for FY15-FY19)



Key Takeaway: Over the last 5 years, MDOT has disposed of a total of 686 vehicles while purchasing 692 vehicles.

5. To provide more insight into MDOT's current replacement strategy, Table 6.4-2 summarizes MDOT's disposals and acquisitions during fiscal years 2015 to 2019. Comparing the type of vehicles disposed to the vehicles acquired, it appears that MDOT prioritized the purchase of passenger pickups and SUVs over sedans and vans, and dump trucks over specialty trucks.

Table 6.4-2: Disposal/Acquisition Trends by Vehicle Category
(MDOT Vehicle Acquisition and Disposal Data for FY15-FY19)

Vehicle Category	Disposed	Acquired	Difference
Sedans	83	16	-67
Dump Trucks	66	89	+23
Pickup trucks	348	412	+64
Specialty Trucks	145	112	-33
SUVs	15	50	+35
Vans	29	13	-16
Grand Total	686	692	+6

6. Another approach to fleet optimization used by the City of Columbus (Ohio) Fleet Management Division is to tie vehicle replacements to a cost model that considers both maintenance and acquisition costs. As applied by the City of Columbus, if the lifetime maintenance costs exceed 50 percent of the vehicle acquisition costs, the vehicle is a candidate for replacement.

    a. A similar cost model can be generated for MDOT's fleet, by taking the lifetime maintenance cost for each vehicle (as calculated by adding the total repair and preventative maintenance costs) and dividing by the acquisition cost of each vehicle.

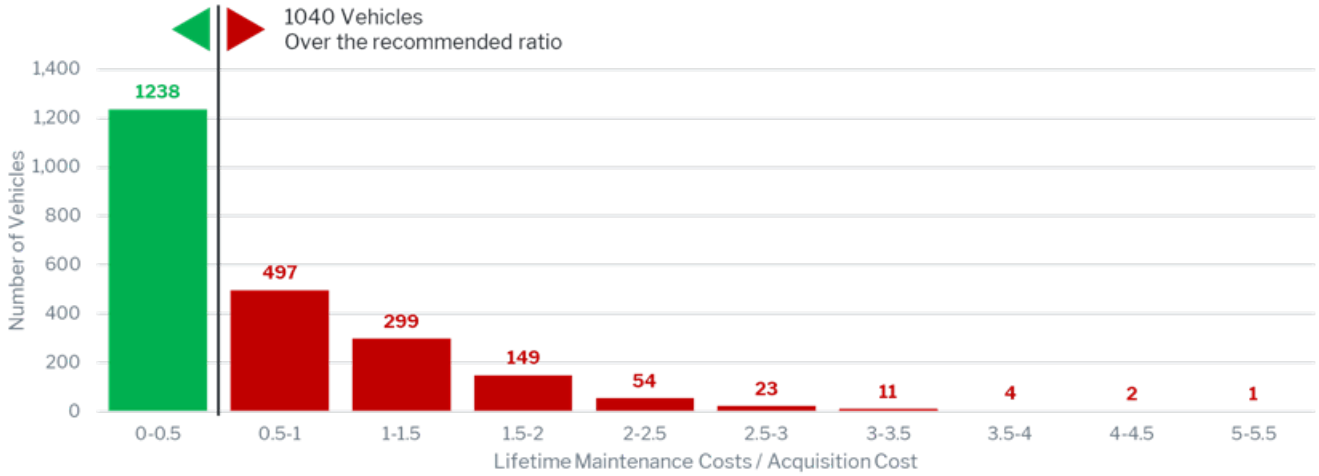
    b. The resulting ratio of maintenance to acquisition costs can be used to establish a more rational replacement policy. For example,

        - A ratio of 0.5:1 means that maintenance costs have reached 50 percent of the initial acquisition cost (similar to the threshold set by the City of Columbus).

        - A ratio of over 1:1 means that maintenance costs have exceeded the initial acquisition cost.

    c. As shown in Figure 6.4-2, 46 percent of the fleet, or 1,040 vehicles, exceed the 0.5 threshold. Of these, 543 vehicles (or 24 percent of the current fleet) exceed the 1:1 ratio, meaning that MDOT has paid more to maintain these vehicles than it did to originally purchase them. This is another indication that MDOT's fleet is aging and vehicles with relatively high maintenance costs should be evaluated for replacement based on a more rational replacement schedule.

Figure 6.4-2: Distribution of Ratio of Lifetime Maintenance Costs to Acquisition Cost
(MDOT Vehicle Data as of November 2019)



Key Takeaway: 1,040 vehicles in MDOT's current fleet have lifetime maintenance costs that exceed half of their initial purchase price. 543 vehicles (or 24 percent of the current fleet) exceed the 1:1 ratio, meaning that MDOT has paid more to maintain these vehicles than it did to originally purchase them. This is another indication that MDOT's fleet is aging and vehicles with relatively high maintenance costs should be evaluated for replacement based on a rational replacement schedule.

Replacement Strategy

7. Alabama Department of Transportation's (ADOT) Equipment Bureau has implemented a Comprehensive Equipment Management System (CEMS) designed to replace vehicles at optimal thresholds to maximize the salvage value of the vehicle. The system is designed to pay for itself in the sense that the resale value covers most of the purchase price of the replacement vehicles.

    a. The ADOT CEMS tracks data elements, such as fuel purchases, equipment mileage, monthly equipment usage, and maintenance histories. The historical data allows ADOT to:

        - Establish estimated utilization rates for equipment
        - Identify when maintenance and operating costs begin to peak compared to the salvage value, and
        - Select the optimal replacement schedule.

    b. ADOT uses a standard unit of usage depreciation rate adjusted annually to determine salvage values and can identify underutilized equipment and schedule fleet units for replacement at usage levels that maximize resale values.

ADOT's optimal replacement schedule for a ½ ton pickup is 55k miles or 5 years, yielding a return of 85%, much higher than the 19% return for pickup trucks in the MDOT fleet.

8. As noted above, MDOT's fleet is relatively old. Almost 50 percent of the MDOT fleet consists of pickup trucks with an average age of 11.2 years. An analysis of a small sample of MDOT's pickup fleet was undertaken to determine the potential savings that could be realized if MDOT's vehicles were replaced at a more optimal 5-year replacement schedule (similar to ADOT) as compared to a 10-year

replacement cycle that is closer to the average age of the pickups in MDOT's current fleet.

a. If MDOT were to replace its vehicles on a 5-year schedule (similar to ADOT), the expected mileage on such vehicles would be approximately 75,000 at the time of replacement (assuming 15,000 miles are driven each year).

b. In contrast, the expected mileage on a fleet of 10-year old pickups, assuming the same annual usage of 15,000 miles, would be 150,000 miles.

c. Looking at a small sample of pickup trucks within MDOT's current fleet, the assumed 5-year (75,000) and 10-year (150,000) expected mileage targets can be used to identify and compare the average lifetime repair, preventative maintenance, and acquisition costs associated with these two different replacement policies (i.e., replacement after 5 years vs. replacement after 10).

d. As shown in Table 6.4-3, the average lifetime repair cost of vehicles falling into the 5-year replacement category is $2,653 versus $9,250 in the 10-year category. Similarly, preventative maintenance costs for the 5-year and 10-year categories are $1,377 and $4,871, respectively.

Table 6.4-3: Comparison of Lifetime Repair and Maintenance Costs for a 5-Year vs. a 10-Year Replacement Schedule
(Sample of 16 MDOT Light Duty Pickups in MDOT Fleet as of November 2019)

Property ID	Odometer Reading	Acquisition Cost	Repair Cost	Preventive Maintenance Cost
Vehicles included in the assumed 5-Year Replacement Schedule				
9000860	73,607	$ 16,983	$ 1,172	$ 1,543
9000808	74,290	$ 16,589	$ 2,449	$ 907
9000510	76,482	$ 14,787	$ 3,680	$ 2,041
9000622	77,186	$ 15,078	$ 3,407	$ 1,155
9000715	77,879	$ 16,064	$ 2,559	$ 1,238
Average	**75,889**	**$ 15,900**	**$ 2,653**	**$ 1,377**

Property ID	Odometer Reading	Acquisition Cost	Repair Cost	Preventive Maintenance Cost
Vehicles included in the assumed 10-Year Replacement Schedule				
9000944	147,888	$ 20,332	$ 2,549	$ 2,001
9000126	148,727	$ 14,464	$ 10,066	$ 2,499
9000196	148,736	$ 16,715	$ 4,064	$ 1,856
9000080	148,843	$ 20,281	$ 4,911	$ 2,319
9000262	148,869	$ 13,638	$ 4,719	$ 4,593
9000478	149,220	$ 17,687	$ 2,752	$ 2,898
9000446	149,860	$ 16,353	$ 13,144	$ 9,802
9000047	150,671	$ 14,215	$ 6,460	$ 5,218
9000144	150,915	$ 14,667	$ 26,063	$ 12,021
9000039	152,832	$ 13,924	$ 23,330	$ 5,867
9000179	152,945	$ 16,756	$ 3,694	$ 4,511
Average	**149,955**	**$ 16,276**	**$ 9,250**	**$ 4,871**

Key Takeaway: Not replacing vehicles on an optimal schedule leads to higher lifetime repair and preventative maintenance costs per vehicle.

e. As further summarized in Table 6.4-4, replacing vehicles sooner (i.e., on a 5-year schedule rather than 10) would result in savings in repair and preventative maintenance costs of roughly $10,000 per vehicle.

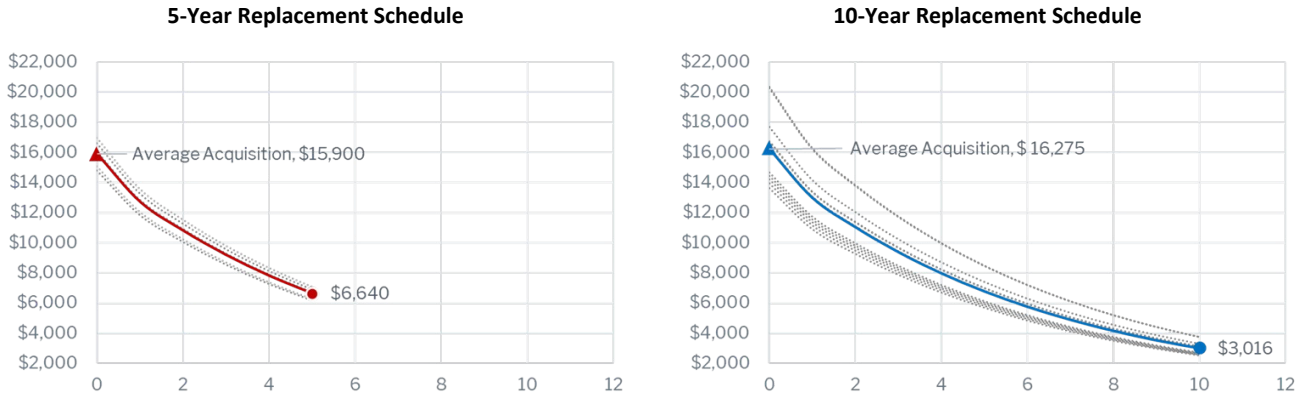
Table 6.4-4: Relative Savings per Vehicle by Replacing Vehicles at Five Years
(Sample of 16 MDOT Light Duty Pickups in MDOT Fleet as of November 2019)

Vehicles in MDOT's fleet would accrue lower repair and maintenance costs if replaced on a 5-year schedule, generating potential savings of $10,000 per vehicle.

Cost Category	5-Year Replacement Schedule	10-Year Replacement Schedule	Savings
Average Repair Cost	$2,653.28	$9,250.21	$6,596.93
Average Preventive Maintenance Cost	$1,376.76	$4,871.51	$3,494.75
Total Savings			**$10,091.68**

f. A more optimal replacement schedule should also allow MDOT to avoid excessive depreciation in asset value and thus achieve a higher return on investment upon disposal or resale. As illustrated in Figure 6.4-3, which projects a depreciation loss of 20 percent of the initial acquisition cost in the first year and 15 percent each year thereafter, the expected asset value at the time of replacement for the five-year sample is $6,640 vs. $3,016 for the 10-year sample. This suggests that MDOT could avoid $3,624 in additional asset depreciation per vehicle if a more rational replacement policy were implemented.

Figure 6.4-3: Comparison of Depreciation for 5-Year and 10-Year Replacement Schedules
(Sample of 16 MDOT Light Duty Pickups in MDOT Fleet as of November 2019)



Key Takeaway: Assuming a depreciation loss of 20 percent of the initial acquisition cost in the first year and 15 percent each year thereafter, the expected asset value at the time of replacement for the five-year sample is $6,640 vs. $3,016 for the 10-year sample. This suggests that implementation of a more rational replacement policy would allow MDOT to avoid $3,624 in additional asset depreciation per vehicle.

g. Considering the savings in repair and maintenance costs identified in Table 6.4-4 of $10,091, coupled with avoiding the additional reductions in asset value of $3,624, as illustrated in Figure 6.4-3, the total potential savings that would have resulted by replacing the 11 vehicles in the 10-year sample at the 5-year mark would have been $13,715 per vehicle.

9. The analysis above considers just a small sample of the pickups included in MDOT's current fleet.

   a. The total number of pickups in MDOT's current inventory that exceed the 10-year (150,000 miles) target is 307.

b. Applying the potential savings of $13,715 per vehicle (as calculated above) to this portion of the pick-up fleet, results in total savings of $4,210,505 (307 x $13,715 = $4,210,505).

c. If this $4.2 million were applied to acquire new pickups, approximately 280 new vehicles could be acquired based on the average MDOT acquisition cost for pickups between FY 2015-FY2019 of $14,959.

10. Based on this analysis, HKA recommends that MDOT use an asset management approach to evaluate the entire fleet, with a goal of reducing the overall age of the fleet, particularly for vehicles classes with large inventories. The program could be phased in incrementally over a 3 to 4-year period by investing in new vehicles combined with reducing older underutilized vehicles. Benefits of pursuing such an approach would include a better return on fleet investment, improved reliability, and reduced maintenance and operating costs.

To implement a more rational asset management approach to its fleet, MDOT would likely have to obtain an exemption from DFA's 7-year and 150,000-mile replacement policy. Benefits of pursuing such an approach would include:

- Better return on fleet investment,
- Improved reliability,
- Reduced maintenance and operating costs.

6.5 Analysis of Fleet Maintenance Staffing

1. Eliminating extremely underutilized vehicles and reducing the age of the fleet, as recommended in Sections 6.3 and 6.4 above, should reduce operating expenses (considering fuel, preventative maintenance, and repairs costs).

2. Reducing the fleet should also result in a corresponding decrease in the labor (number of mechanics) necessary to maintain the fleet.

3. MDOT's current in-house fleet maintenance staff includes 80 employees (with the title "Equipment Repairer") across six Districts covering approximately 2,278 vehicles, 633 pieces of heavy equipment, and 630 tractors. This equates to a mechanic-to-vehicle ratio of roughly 1:44 (3,541 ÷ 80 = 44.3), meaning that one mechanic is available to service and maintain every 44 vehicles/equipment.

4. As a general guideline for fleet maintenance staffing, the National Fleet Management Association (NFMA) recommends a ratio of between 1:60 and 1:100 mechanics per unit.

5. MDOT's 80 mechanics likely assume secondary responsibilities unrelated to fleet maintenance. However, comparison of MDOT's mechanic-to-vehicle ratio (1:44) to that recommended by NFMA (1:60 to 1:100) suggests that MDOT may have more mechanics than needed.

   a. It is important to note, however, that the NFMA benchmark must be considered in the context of the condition, age, and diversity of the fleet (i.e. varying types and classes of equipment).

   b. It is reasonable to assume that more effort would be needed to maintain a diverse and older fleet spread across multiple locations, such as that managed by MDOT, than a standard passenger vehicle fleet maintained in a centralized location.

   c. Furthermore, as the fleet transitions to newer computerized high-tech vehicles, further investment in staff may be needed to keep mechanics current with the advances in technology.

A reduction in the number of vehicles in the fleet should lead to a corresponding reduction in the labor needed to maintain the fleet.

Reducing the number of mechanics by 20% would lead to projected savings of over $600,000 annually.

6. Assuming MDOT's current 1:44 mechanic-to-vehicle ratio is therefore in line with the needs of its aging fleet, reductions in the number of vehicles in the fleet should lead to corresponding reductions in fleet maintenance staff.

    a. For example, a 20 percent reduction in vehicles could potentially call for up to a 20 percent reduction in fleet mechanics (or up to 16 fewer staff members). (A more detailed study is needed to account for time spent by mechanics on secondary responsibilities unrelated to the fleet.)

    b. Based on salary data provided by MDOT, the average annual cost for a fleet mechanic is $42,900 (average salary of $33,000 plus benefits). The potential projected savings would thus be $686,400 annually (16 mechanics x $42,900).

7. A more accurate method to assess staffing levels would be to convert the workload in each maintenance shop into maintenance repair units based on the specific vehicle types or classes, as measured against a baseline vehicle such as a passenger car. For example, a paving machine may require 3 times the level of effort to maintain than a typical sedan. Such an analysis would allow for more informed and transparent decision-making regarding how the composition and age of the fleet impacts staffing needs.

8. Leasing options present another future consideration in the analysis of the appropriate number of fleet maintenance staff.

    a. MDOT has piloted leasing options for certain types of standard equipment and operations (e.g., tractors used for mowing).

    b. If MDOT chooses to implement a longer-term leasing strategy, it should also consider transitioning to third-party fleet management services that cover leasing, fuel, maintenance, and accident and collision coverage for specific equipment and maintenance activities.

    c. MDOT could use this strategy to potentially make further reductions to in-house maintenance staff and to avoid the additional costs for technical training of in-house staff.

6.6 Other Optimization and Cost Reduction Strategies

Leasing or Renting

1. Other agencies have implemented different leasing strategies, including leasing compact sedans compared to larger passenger vehicles and entering into a favorable master lease agreement or lease purchase agreement using tax exempt financing where the cost of leasing was favorable compared to financed equipment purchases or mileage reimbursements.

2. To explore such options, MDOT engaged a consulting firm, Dye Management, to evaluate and make recommendations regarding vehicle and equipment rental and leasing as an option to reduce fleet size, save on purchasing and ownership costs, and operate as a reserve resource.

3. Based on the recommendations in the resulting 2013 Dye Management report, MDOT implemented trial equipment rental contracts for tractors during the mowing season in specific Districts. However, according to MDOT District staff, given the limited capacity of the rental industry in Mississippi, it may not be feasible to expand this trial program to other Districts.

4. MDOT has also used rental contracts for specialty equipment (e.g., heavy road working equipment, bucket trucks, mini-excavators), and increased the equipment rental vendor list.

5. Moving forward, when analyzing the need for future purchases, MDOT should consider rental or lease options to supplement the fleet when needed, particularly for specialty equipment (which tend to have high purchase prices) or periods of unusually high workloads.

6. If MDOT were to increase the percentage of vehicle rentals, it should first determine the minimum number of vehicles and equipment classes to cover both normal and emergency operations.

Use of GPS

7. Within the last decade, implementation of GPS (Global Positioning System) tracking has made fleet management much more efficient. With the use of telematics, agencies can get accurate data on driver behavior, overall vehicle performance, historical route data, idling and fuel usage, equipment diagnostics, and emergency response. It is a powerful tool that promotes transparency and accountability, and can potentially lead to reduced mileage, lower repair costs, decreased fuel consumption, and other benefits.

8. In Spring 2017, MDOT began installing GPS devices on all fleet vehicles.

    a. MDOT is now able to track among other things, idle time, speed alerts, harsh cornering, harsh braking, rapid acceleration, and similar information, and track if the issue occurred during working hours or not.

    b. Additionally, the system gives the Department a near real time view of all the asset locations, which vastly increases response times during an emergency by being able to quickly assign the nearest unit.

9. Three years into this initiative, MDOT seems to be very satisfied with the use of the GPS system.

    a. MDOT is now able to quickly address any public complaints regarding speeding and dangerous driving, and on some occasions, has disciplined or terminated employees based on information provided by the system.

    b. MDOT did not internally track metrics around fuel usage and miles driven before and after implementation; however, District staff believe that fuel usage and miles driven appear to have fallen since implementation. Although MDOT could provide only anecdotal evidence in support of this conclusion, it is consistent with national statistics, which have shown that implementation of GPS systems for average vehicles can realize a fuel savings of between 10% and 30% per year. Considering MDOT's typical annual fuel expenditures of $4.5 million, and conservatively assuming 10 percent fuel savings due to GPS implementation, MDOT is likely saving upwards of $450,000 annually.

10. Implementation of GPS provides MDOT with opportunities to introduce additional efficiencies into its operations.

Alabama DOT determined that deployment of GPS reduced fuel costs and mileage, saving the Department approximately $1.4 million per year.

Iowa DOT analysis of GPS Implementation calculated a benefit – cost ratio of 6.4 to 1.

---

a. Currently, the Central Office maintains a largely hands-off approach, and the use of the system is dependent on individual Districts.

b. The Central Office should establish metrics and controls to be used across all Districts, and leverage the resulting information provided by the system to track underutilized vehicles and vehicle usage patterns across Districts.

c. By using GPS data more fully and systematically, MDOT can realize additional savings related to fewer miles traveled, more efficient route planning, better driving behavior, fewer accidents, and lower insurance premiums.

Fleet Standardization

Standardization can bring savings in life-cycle maintenance, parts, and training. When purchasing new vehicles, it is important to consider these total life-cycle costs savings when comparing the price of a standard model with any new model.

11. DOT fleets must deal with a wide variety of vehicle classes and equipment types, between passenger cars and medium-duty trucks, heavy-duty trucks, and off-road equipment.

    a. With different makes and models for each type of asset, maintaining the assets and their parts is a significant challenge.

    b. Fleet managers are combatting this problem through standardization. By narrowing fleet operations to a few standard vehicle types or critical components, fleets can increase efficiency and save money on inventory, training, and repairs.

    c. Adherence to purchasing policies presents a common barrier to the standardization of DOT fleets. In some cases, fleets can find the lowest price for their standard models through state or cooperative contracts, but for others competition requirements based on the lowest initial purchase price control the purchasing decision. Also, some specialty vehicles and equipment are difficult to standardize.

12. To evaluate the level of standardization within MDOT's fleet, Table 6.6-1 presents the current distribution of vehicle makes and types.

Table 6.6-1: Fleet Distribution by Manufacturer and Vehicle Type
(MDOT Vehicle Data as of November 2019)

Manufacturer	Pickup Truck	Specialty Truck	Dump Truck	SUV	Sedan	Van	Grand Total
Ford	672	179	64	57	14	15	**1001**
International		141	302				**443**
Dodge	262	58	13	2	3	23	**361**
Chevrolet	75	33	49	32	49	20	**258**
GMC	108	12	1				**121**
Western Star Trucks		9	31				**40**
Freightliner		29	4				**33**
Nissan	3			5			**8**
Other Specialty*		10*		3			**13**
Grand Total	1120	471	464	99	66	58	**2278**
Vehicle Makes:	5	14	7	5	3	3	

*Note: 7 different manufacturers

Key Takeaway: MDOT uses 15 different manufacturers to cover their fleet needs, with at least three different manufacturers used in every vehicle category.

13. As shown, MDOT uses 15 different manufacturers to cover their fleet needs. Specialty trucks have the largest number of manufacturers with 14, due to the unique purpose of each vehicle (e.g. tractors, cranes, etc.). Pickup trucks, which comprise about half of MDOT's fleet, were purchased from five different manufacturers, with Ford making up more than half of the 1,120 pickups. At least three different manufacturers are used in every vehicle category.

14. Moving towards standardization of the categories with the largest inventory in MDOT's fleet (i.e. pickups, specialty trucks, and dump trucks) would help save on parts, preventative maintenance and repairs, and streamline mechanic training. Standardization could also reduce the number of diagnostic and specialty tools needed, reduce the Original Equipment Manufacturer (OEM) parts inventory, reduce down time, and simplify purchasing. Standardization could be phased in over time by focusing on one vehicle category at a time, establishing multi-year procurement and maintenance agreements, or developing bid specifications based on specific performance criteria.

6.7 Summary

HKA's analysis of the MDOT fleet has identified opportunities for significant cost savings or areas for potential improvements in fleet management consistent with national practices and initiatives implemented by other DOTs.

The recommendations below are based on a representative sample of MDOT's fleet data. **MDOT would need to conduct a more complete and in-depth asset management**

analysis of the fleet to test the recommendations and assess the extent of potential cost savings.

Recommendations	Potential Benefit
1. Take incremental steps to eliminate vehicles from the fleet that are consistently less than 50% of the average utilization for major vehicle categories (excluding vehicles used for emergency response or repairs).	$13.8M in projected savings
2. Eliminate underutilized commuting vehicles (< 15,000 miles/year) and repurpose to non-commute assignments.	$895K in projected savings
3. Implement an optimal replacement strategy for major categories of vehicles and equipment in the fleet (both on-road and off-road) with goal of reducing the overall age of the fleet and maximizing the salvage value that can be applied to future purchases. (Note that implementing this recommendation would require an exemption from State policy.)	$4.2M in projected savings (Pick-up fleet >150kmiles)
4. Right-size in-house vehicle maintenance staffing in proportion to a reduction in fleet inventory, increased use of leasing agreements with outsourced maintenance, or increased standardization.	Projected savings of up to $686K per year
5. Continue to use trial equipment rental contracts for mowing or leasing for specialty vehicles or equipment where financing terms are favorable, and costs are lower compared to equipment or vehicle purchases or mileage reimbursements.	Lowering operating costs
6. Develop a consistent set of metrics around GPS (e.g., location, idle time, speeding, harsh braking/accelerating, mpg, etc.) and standard policies governing GPS across all Districts to maximize the benefits and leverage the data to track vehicle usage patterns or identify underutilized vehicles.	Better governance and maximization of GPS benefits
7. Incrementally move towards standardizing the vehicle and equipment fleet to realize savings on parts, maintenance and repairs, training and necessary skills, and minimize down time. (Note that implementing this recommendation would require an exemption from State policy.)	Lower operating costs

7. MDOT's Local Public Agency Program

7.1 Introduction

Local Public Agencies (LPA) in Mississippi have raised concerns regarding MDOT's oversight of their Federal-aid projects, perceiving MDOT's involvement as contributing to cost increases and schedule delays. Among the questions that were raised:

- Are the perceived additional costs and schedule impacts attributable to preferential policies on the part of MDOT, or is MDOT merely implementing Federal requirements?
- To the extent that FHWA allows for flexibility in a DOT's oversight of LPA projects, do opportunities exist for MDOT to streamline its processes?

To answer these and other questions the audit team interviewed the MDOT coordinator for the LPA program, as well as representatives from:

- Various LPAs in Mississippi
- US DOT, Federal Highway Administration (FHWA) Headquarters Office
- FHWA Mississippi Division Office
- Roadway contractors who have performed both DOT and LPA work

Section 7.2 summarizes the issues raised by local agencies and industry regarding MDOT's administration of LPA projects and comparative costs of Federally and locally funded LPA projects. Section 7.3 then addresses MDOT's policies regarding the program and FHWA perspectives on MDOT's LPA oversight and management. The chapter concludes with a summary of potential recommendations and strategies to save costs and resources related to the administration of LPA projects.

Overview

This chapter assesses MDOT's LPA Program to identify any potential enhancements or savings through:

- Streamlining LPA project development
- LPA discretion on use of federal funds
- LPA Self-certification
- Risk-based approach to oversight and acceptance of work

Chapter Highlights

Area of Inquiry	How is MDOT performing?	Key Observations	Recommendations
DOT Oversight of LPA Projects	■	• MDOT strictly follows FHWA guidelines for state stewardship and oversight of LPA projects, and has well-developed manuals and guidance governing the oversight of federally funded LPA projects. • Despite MDOT's adherence to FHWA requirements, LPAs expressed frustration with MDOT's policies and oversight, perceiving that they cause delays in project execution and lead to higher costs.	• MDOT should assess whether it needs to increase its internal LPA project development resources to meet the demand for timely project development and concurrence reviews. Alternatively, such reviews could be outsourced to others within MDOT or to consultants. • MDOT should consider implementing more robust certification programs that would reduce MDOT oversight and allow certified LPAs to: – Use approved local standards and specifications – Practice greater discretion regarding the use of federal funds

▲ MDOT meets or exceeds industry leading practices
● Potential for improvement
■ Policy or market condition largely out of MDOT's control

7.2 Local Public Agency and Industry Perspectives

1. LPA projects using federal aid funding are subject to stewardship and contract administration by MDOT.

2. Local agencies in Mississippi have raised several issues related to MDOT's administration of LPA projects that use federal-aid funding.

    a. These agencies perceive that the level of oversight and review by MDOT as FHWA's steward of federal funds results in:

        - Excessive paperwork
        - Additional engineering fees
        - Duplication of effort
        - Delays and added costs to deliver the project in comparison to locally funded projects.

    b. LPAs claim that in some cases MDOT administered projects are 30 to 40 percent higher in cost and take four times longer than locally funded projects, which affects available taxpayer funding for future projects.

3. By way of example, the City of Ridgeland provided several comparisons demonstrating the cost and delivery time differences between locally and federally funded projects. The audit team did not independently verify such information but provides a sampling below to convey the type of concerns raised by LPAs.

    a. The City of Ridgeland provided an example of a 100% city-funded street rehabilitation project that despite starting out as a federal aid LPA funded project was ultimately completed as a city-funded project.

LPA FUNDED STREET REHABILITATION

EXAMPLE = HIGHLAND COLONY PARKWAY REHABILITATION PROJECT

- MDOT Managed Procurement
- 2014 – 2019
- Project consists of re-surfacing 2,000-feet of asphalt pavement.
- $45,000.00 spent on in-house Engineering
- 3 separate MDOT-managed bid openings were held with low bids amounts of $946,186.20, $810,760.00, & $589,728.00.
- On January 4, 2019, the City of Ridgeland returned $215,000 in Federal STBG funding after rejecting bids received from the project's 3rd bid opening. The Bids exceeded the budgeted funds and the bid prices were higher than reasonable. The City of Ridgeland decided it was in our best interest to complete this work using our City forces and term bid contractors without the use of Federal funds.
- Construction began on June 17, 2019 and the paving was substantially complete in 1-week at a total project cost of $365,000.00.
- The project was completed at a cost $580,000.00 less than the low bid received under the MDOT managed bid package.

    b. The City indicated that the 2000-foot project was completed in a week and saved the taxpayers $366,000 after the City spent five years in the

MDOT LPA project development process. The City further stated that under its Purchase Order procurements, it spent approximately an average of $238,000 per mile on city-funded street rehabilitations from 2014 to 2019.

c. The City provided further comparisons of LPA projects administered by MDOT versus City funded projects. The Highland Colony Parkway project ($1,006,331 for .38 miles of pavement resurfacing) was compared to a city funded project – East County Line Road Rehabilitation of similar size ($1,153,063 for .51 miles of resurfacing).

d. This comparison indicated that pre-construction and engineering for the MDOT administered federally funded Highland Colony Parkway LPA project took more than eight times longer to complete preconstruction than the City funded East County Line project for a similar scope (i.e., 1262 days/150 days = 8.4). The procurement process was two times longer, and closeout was six times longer.

e. According to the City records, a significant part of the excessive time for preconstruction on the federally funded LPA project was for MDOT review/approval of the plans, issuance of a Memorandum of Understanding (MOU), approval for advertisement by the LPA, and review/concurrence of the construction engineering and inspection (CE&I) contract.

4. Such criticisms of the LPA program are not unique to Mississippi. Input from LPAs outside of Mississippi confirm that the use of federal-aid funding for LPA projects creates an additional layer of oversight, costs, and extended delivery time that in some cases is significant enough to dissuade some local agencies from using federal-aid on LPA projects except when there is no other practical alternative to deliver a project.

5. Input from both in-state and out-of-state contractors revealed that an increased level of risk may contribute to higher bids and costs for federal-aid contracts. From the contractors' perspective, the level of risk (and associated bid pricing) is lower for LPA jobs for the following reasons:

   a. City and county projects typically use less rigorous standards and specifications related to design documents, procurement, contract administration, and documentation.

   b. Decision-making is faster due to fewer levels of oversight and more ready access to decision makers.

   c. The use of more economic and readily available materials, or recycled materials, results in the optimization of local funds for the purchase of materials, provided they do not compromise the quality and performance of the work.

   d. Product certifications and material testing requirements for local projects are not as rigorous as those for federal-aid project allowing for the use of more local producers.

   e. LPA projects may be exempt from federal aid requirements related to federal or state design standards (e.g., lane widths, materials testing

requirements), prevailing wages and disadvantaged business requirements, environmental compliance, CE&I, traffic control, documentation for quality and payment, and other reporting requirements that increase costs.

7.3 MDOT LPA Program and FHWA Perspectives

The MDOT LPA program is in strict conformance with FHWA guidelines for stewardship and oversight of federally funded LPA projects.

1. MDOT's LPA program coordinator indicated that MDOT administers the program in strict accordance with FHWA guidelines for stewardship and oversight of federal aid projects administered by LPAs.[7]

    a. The MDOT LPA coordinator noted that FHWA guidelines require that MDOT provide a higher level of oversight than just monitoring federal funding. MDOT's LPA Project Development Manual (PDM) includes detailed requirements related to MDOT responsibilities for oversight and approvals related to project activation, environmental assessments, Right-of-Way procedures, preparation of the plans, specifications, and estimate (PS&E) package , and MDOT authorization and LPA selection of contractor.

    b. During construction, MDOT LPA Engineers conduct periodic site visits, inspect the work, review invoices, and review project documentation. MDOT contract administration oversight also includes selection and management of the CE&I consultant, sign off on monthly progress payment estimates, review and approvals of Supplemental Agreements, oversight of material testing and acceptance of the work, monitoring compliance with federal requirements, and approvals for final acceptance and releases.

    c. MDOT indicated that it certifies LPAs consistent with industry practice, with required one-day training to renew the certification every two years.

    d. MDOT is conducting an internal study addressing risk-based inspection and testing requirements for LPA projects, suggesting that it is interested in implementing strategies to optimize CE&I and testing on LPA projects.

FHWA requirements for State DOT stewardship and oversight of federally funded LPA projects entail:

- Establishing formal State policy and procedures
- Approving or certifying LPAs for participation in the federal aid program
- Providing oversight of LPA projects
- Reimbursing LPAs of approved expenditures

2. The FHWA Mississippi Division Administrator indicated that the LPA program was revamped to address all the federal requirements related to the effective oversight of federally funded LPA projects and FHWA is very supportive of MDOT's current LPA program.

3. A representative from FHWA Headquarters provided additional observations, policy interpretation, and recommendations regarding LPA programs as follows:

    a. Federal-aid funds generally have more strings attached, which can drive up planning, development, and administrative costs (i.e. paperwork, oversight, federal regulations, etc.).

    b. LPAs can exercise discretion on the use of federal funding for specific project costs. This could extend to use of federal funds for planning activities, design, or other purposes outside of construction.

[7] https://www.fhwa.dot.gov/federalaid/lpa/

c. LPAs can seek exemptions from certain federal requirements based on the project type and justification.

d. LPAs can work with DOTs in a fund swap program –allowing DOTs to swap state funds for federal funds on LPA projects. However, state funds are discounted by 20% (presumed to be equivalent to the cost of using federal funds), which can be a significant cost impact in some cases.

7.4 Summary

Based on the analysis above, HKA has identified the following opportunities for cost savings and/or areas for potential improvement in the administration of the LPA program. MDOT would need to conduct a more complete and in-depth assessment of strategies to streamline requirements to assess the extent of potential cost and time savings.

Recommendations	Potential Benefit
1. Assess if MDOT's internal LPA project development resources should be increased to meet the demand for timely project development and concurrence reviews.	• Expedite project development and concurrence reviews
2. Develop robust self-certification procedures for LPAs with licensed engineers to minimize the MDOT LPA oversight and concurrence steps for contracts, construction plans, Right-of-Way acquisition, utility relocation, and final project acceptance.	• Streamlined project development process • Minimize project delays
3. Work with certified LPAs to transfer management, control, and responsibility for contract administration of their own projects with or without consultants and with less oversight from MDOT.	• Streamlined project execution process • Potential for cost savings
4. Give LPAs discretion on the distribution and use of federal funds. Allow LPA to draw on federal funds as needed until LPA local funds are available.	• Increase the flexibility for LPAs to use funding where they need it most • Allow projects to move forward earlier than they would otherwise
5. Allow certified LPAs to use approved local agency specifications and standards for their LPA projects (e.g., a city street rehabilitation with a narrower roadway width than the current state standard) and allow for LPAs to develop administration, and Quality Assurance Plans (QAP) and acceptance procedures tailored to the type, size, and criticality of work.	• Potential for cost and time savings stemming from less stringent design and QA requirements
6. Develop a tiered risk-based system for LPA projects that adjusts administration and oversight based on a project's cost threshold or the criticality of the work. The tiering would define the required level of MDOT oversight, delegation of responsibilities to the LPA, and documentation requirements for the project	• Potential for cost and time savings stemming from less stringent QA requirements

This page is intentionally left blank

Melinda L. McGrath
Executive Director

P. O. Box 1850
Jackson, MS 39215-1850
Telephone (601) 359-7249
FAX (601) 359-7050
GoMDOT.com

MDOT
MISSISSIPPI DEPARTMENT OF TRANSPORTATION

Brian D. Ratliff
Deputy Executive Director/Chief Engineer
Lisa M. Hancock
Deputy Executive Director/Administration
Willie Huff
Director, Office of Enforcement
Charles R. Carr
Director, Office of Intermodal Planning

January 30, 2020

Honorable Shad White, State Auditor
Office of the State Auditor
State of Mississippi
P. O. Box 956
Jackson, MS 39205-0956

Re: Agency Response to MDOT Performance Audit Report dated January 2020

Dear Mr. White:

Thank you for the opportunity to review and comment on the MDOT Performance Audit Report. I would like to express my appreciation for the way your team conducted the field review and interacted with my staff during the performance audit.

The Department continually looks for ways to increase its efficiencies and recognizes there is always room for improvement. We plan to use this report as a guiding document to analyze recommendations and develop an action plan to prioritize and implement improvements. Our next steps will be to fully vet these recommendations with the Mississippi Transportation Commission, internal staff, Federal Highway Administration, and other stakeholders to continue our pursuit of best practices.

I also want to express my gratitude for the recognition this report gives to the many functions that MDOT performs well. I feel very fortunate to work alongside some of the most capable and passionate Mississippians, who work diligently to achieve the highest possible standards.

Once again, I would like to thank you and your staff for working with HKA Global Inc. to encourage further analysis on areas of potential improvement. I remain committed to increasing the Department's efficiency and best utilizing the taxpayers' money.

Sincerely,

Melinda L. McGrath, P.E.
Executive Director
Mississippi Department of Transportation

cc: Commissioner Tom King
Commissioner John Caldwell
Commissioner Willie Simmons