Maintenance Performance Audit

January 2, 2003
# Executive Summary

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Executive Summary

This summary presents the results of a performance audit of the Utah Department of Transportation (UDOT) Maintenance function. The audit reviews the Division’s operations, functions, and processes, and provides recommendations as to how these can be improved to achieve greater economy, efficiency, and program effectiveness. Specifically, the audit evaluates the following areas:

- The Central Maintenance Unit’s efficiency and effectiveness in its support activities, including planning, budgeting, performance management, and process improvement.
- The current maintenance management system and its accuracy, reporting, budget support, and proposed improvements.
- The Region/District Maintenance Units’ efficiency and effectiveness, including staffing, processes, and resource allocation.

To meet the objectives of this audit, Dye Management Group, Inc. conducted interviews and focus groups, administered an e-mail survey, performed a best practices and benchmarking review, and analyzed Department documents. The audit was overseen by a steering committee of UDOT officials from both headquarters and the regions/districts.

The following describes some of the most critical findings and recommendations of the audit.

I. Organization and Communication

Responsibility for maintenance in UDOT is shared between two levels: the Central Maintenance Unit (“Central”) located in the Salt Lake City headquarters complex and six geographically located region/district field operations around the State. The Engineer for Maintenance reports to the Director of the Operations Group, who in turn reports to the Deputy Director. Central provides leadership and support to the regions/districts in a variety of technical areas, such as budgeting, methods, and asset preservation. The region/district operations offices are highly decentralized due to the geographic distribution of the work, and day-to-day decisions for field operations are made by the region/district maintenance managers. UDOT’s strategic plan identifies values, goals, and strategies for the Department as a whole, including maintenance.

Strengths of the maintenance process include the fact that UDOT has developed a strategic direction that includes maintenance. Strategic elements are also included in manager performance plans. Process weaknesses include the fact that region/district maintenance personnel do not clearly understand UDOT strategic goals. The strategic direction has not yet been operationalized for maintenance by including elements in the budget, MMQA, and other processes. Communication between the region/districts and
some staff in Central is strong. However, communication between the regions/districts and other staff in Central is poor.

Recommendations include:

**Recommendation 1.** Develop a strategic approach to maintenance.

**Recommendation 3.** Involve managers at all levels in the planning and implementation process.

**Recommendation 4.** Strengthen the decision-making and issue resolution structure for maintenance.

**Recommendation 6.** Increase the expertise of Central.

### II. Asset Management

Asset management is a comprehensive approach involving asset inventory, condition, and future investment scenarios. The agency’s current strategic business plan identifies several priority areas relevant to asset management. Specifically, UDOT’s maintenance management system philosophy enables this system to track program expenditures, resource usage, and accomplishments much more closely than other state DOTs. However, leadership is needed to define asset management, communicate it internally and externally to key stakeholders, coordinate the efforts of the several organizational units involved, and demonstrate long-term commitment by example.

Regions/districts reported receiving good customer service from Central for pavement preservation. However, they were concerned about the unpredictable funding for the program because such unpredictable funding undermines preventive pavement maintenance.

While region/district personnel reported good customer service from Central’s Lands and Buildings function, the Department has not articulated goals or strategies for the function, nor used consistent standards for maintenance facilities.

Recommendations include:

**Recommendation 7.** Develop an asset management plan for Maintenance consistent with the broader statewide framework now being considered by UDOT.

**Recommendation 8.** Strengthen the policy framework for maintenance management as a performance-based process.

**Recommendation 11.** Engage the Legislature and the Transportation Commission in the concept of a policy-driven, performance-based budgeting approach, and discuss with them their roles in this process and their willingness to apply it.
**Recommendation 17.** Adopt a funding approach that stabilizes annual Orange Book funding commitments as much as possible to ensure continuity in meeting preservation objectives.

**Recommendation 21.** Establish a master plan for Lands and Buildings.

### III. Budgeting

Maintenance Management Quality Assurance (MMQA) was designed to provide a clear link between maintenance objectives, maintenance activities, maintenance levels of service, the budget, and actual performance. UDOT has begun implementation of elements of a performance-based maintenance program, including target levels of service, condition surveys, analytic tools, and documentation. However, problems with the program include lack of identified need and rationale for it and a failure to engage internal and external stakeholders. Regions/districts have yet to buy into MMQA and do not rely upon it for decision making. UDOT also has not incorporated customer perceptions in the formation of MMQA targets.

The budgeting process is flexible enough to shift funds among different groups at the region/district level. The process encourages accountability for and adherence to the budget. The biggest issue with the budgeting process is that UDOT primarily employs a mixed feature-based and historical-based budgeting approach. MMQA does not yet drive the budget process.

Recommendations include:

**Recommendation 25.** Appoint an action team to guide MMQA revision and implementation.

**Recommendation 32.** Conduct ongoing customer surveys and focus groups and incorporate the results into the MMQA process.

**Recommendation 34.** Apply a single, performance-based budgeting approach.

**Recommendation 38.** Base the budget upon customer expectations.

### IV. Maintenance Support

The current Maintenance Management System (MMS) has several strengths. It provides for single entry of labor, materials, and equipment usage. It collects data near the source and computes costs for resources as they are utilized rather than waiting for payroll and financial system cycles to provide the cost for an activity. However, the system is difficult to use, support, and modify. Users experience poor performance and cannot rely on the data. Further, there are reconciliation issues between the MMS and other statewide systems and there is little integration between MMS and other UDOT systems.
Central’s training program was lauded by the majority of interviewees in the regions/districts. The program has specific objectives for learning, accessible trainers, and reasonable student-to-teacher ratios. The Training Committee has also responded to suggestions from the trainees, resulting in great program flexibility. However, UDOT has not compiled or analyzed test scores or student evaluations in order to assess the success of the program.

Recommendations include:

**Recommendation 39.** Implement a commercial MMS package.

**Recommendation 44.** Conduct rigorous evaluations of training.

V. Region/District Operations

UDOT has a decentralized organizational structure that encourages regions/districts to be innovative and creative in finding solutions to common problems. Some form of performance management is used in each of the regions/districts. However, there are a number of organizational issues. Although UDOT has recognized that attrition will affect the Department’s future performance, UDOT has not developed a formal succession plan. MMQA targets and the Department’s Strategic Direction have not been tied to some region/district performance management plans. No region/district reported having a systematic approach for evaluating whether maintenance activities should remain in-house or should be contracted out.

UDOT’s Transportation Technician Program seeks to cross-train construction and maintenance personnel to enable maintenance staff to serve as construction inspectors and construction staff to assist maintenance in winter activities. The Program allows Transportation Technicians to become more well-rounded employees, as Technicians from construction understand better the implications of construction quality for road performance and Technicians from maintenance understand better how quality is managed in the construction process. However, the program results in loss of maintenance manpower at a time when peak work demands occur through the summer. While internal analyses of the benefits to construction have been completed, the impacts to maintenance have not been studied.

The work program allocation is developed initially in Central, using both the approved legislative budget and the MMQA breakdown of budget by labor, equipment usage, and materials for each activity. Maintenance expenditures are strongly correlated with both labor force FTEs and inventory lane-miles and are equitable. One issue is that the current MMQA approach is not able to roll-up budget estimates to a statewide level. Also, MMQA lacks buy-in and credibility among UDOT managers, which inhibits its acceptance and greater use in resource allocation.

UDOT has a 25-year plan for replacing and rehabilitating all maintenance stations. However, UDOT relies on the region/district to propose particular sites for replacement.
stations. Central may encourage the region/district to consider factors in the site selection, but the final decision is made by the region/district.

Recommendations include:

**Recommendation 55.** Develop a departmental succession plan.

**Recommendation 56.** Provide leadership to the regions/districts in developing effective performance management plans.

**Recommendation 58.** Develop guidance for the regions/districts for evaluating whether or not maintenance activities should be contracted out.

**Recommendation 59.** Ensure that ongoing analyses of the impacts of the Transportation Technician Program reflect the full range of its benefits and costs in both maintenance and construction.

**Recommendation 62.** Move to MMQA as the basis of resource allocation.

**Recommendation 65.** Require maintenance stations to periodically review service areas as part of a master planning process.

### VI. Maintenance Work Methods

UDOT organizes region/district work methods by the following 10 groups:

- **Snow and Ice Control**  
- **Hard Surface Maintenance**  
- **Non-Hard Surface Maintenance**  
- **Roadside Maintenance**  
- **Vegetation Control**  
- **Major Structure Maintenance**  
- **Drainage and Slope Repair**  
- **Traffic Services**  
- **Supervision, Training, and Support Maintenance**  
- **Rest Area Maintenance**

The audit evaluated each of these areas. Following are observations on some of these areas:

UDOT has established MMQA standards for snow and ice, depending on the road classification and traffic volume. In practice, the MMQA standards are loosely implemented. The Department has implemented a comprehensive equipment operator training and certification program, and frequent maintenance seminars and meetings provide an excellent forum for internal and external knowledge transfer on snow and ice control techniques. However, variations in field implementation of snow and ice policy results in considerable variation of service levels between regions/districts and maintenance stations. Route planning and preparation, while an important management function, is practiced very loosely in the field.

Pavement maintenance project selection is conducted at both the region/district and Central level. At the present time, UDOT does not have a method of tracking all of its
maintenance applications in a manner that is consistent with the pavement management system. Also, the goal for the preventive maintenance program is not well known among maintenance personnel.

Non-Hard Surface Maintenance, or maintenance of unpaved roads and unpaved shoulders, is scheduled on an as-needed basis. While UDOT’s work methods appear to be in line with industry norms, the Department lacks a defined cycle of shoulder maintenance.

UDOT is in the process of implementing an Integrated Roadside Vegetation Management (IRVM) approach to roadside maintenance. While some regions/districts have implemented this approach, others have not. Region/district personnel are sometimes assigned vegetation control duties that they are not adequately trained to accomplish.

UDOT maintenance stations perform several of the routine treatments to extend the life spans of major structures. However, UDOT lacks a defined preventive maintenance approach for bridges.

Drainage maintenance and slope repair have important safety implications and prevent damage to the highway, associated structures, and adjacent property. UDOT’s work methods for drainage and slope repair crews generally conform to best practices. However, maintenance of drainage facilities is usually accomplished on an as-needed basis, rather than as preventive maintenance.

The Department’s traffic service maintenance practices are generally in line with industry best practices. However, the Department is not achieving a desirable service level for pavement striping. Many DOTs have moved to contract for pavement striping. These contracts contain warranties where the contractor guarantees that the striping will function at specified performance levels for a designated period, often as long as five years.

Recommendations include:

**Recommendation 69.** Provide more training to section managers on the benefits and cost-effectiveness of route planning.

**Recommendation 70.** Develop and conduct annual refresher training.

**Recommendation 72.** Formalize the State’s preventive maintenance program.

**Recommendation 73.** Provide training on treatment applications.

**Recommendation 76.** Develop a regular cycle of shoulder maintenance.

**Recommendation 81.** Increase specialized training for all personnel involved in vegetation control activities.
**Recommendation 82.** Target regions/districts that have not fully implemented IRVM for additional education and training.

**Recommendation 84.** Establish a preventive maintenance program for bridges.

**Recommendation 85.** Develop a preventive maintenance program for drainage structures.

**Recommendation 90.** Pilot test contracts for pavement striping.
I. Introduction

This document presents the results of a performance audit of the Utah Department of Transportation (UDOT) maintenance function.

A. Study Purpose

UDOT has contracted with Dye Management Group, Inc. to conduct an audit of the Maintenance Division. The audit will review the Division’s operations, functions, and processes, and provide recommendations as to how these can be improved to achieve greater economy, efficiency, and program effectiveness. Specifically, the audit evaluates the following areas:

• The effectiveness and efficiency of the Central Maintenance Unit (Central) in its support activities, including:
  – Planning for statewide maintenance needs.
  – Preparing budgets and distributing statewide maintenance funds.
  – Monitoring statewide maintenance expenditures and providing timely reports through the maintenance management system (MMS).
  – Managing the statewide Feature Inventory.
  – Providing effective performance measures.
  – Developing and improving processes, procedures, and materials.
  – Interfacing with the Procurement Division to assure timely delivery and warehousing of maintenance materials.
  – Training maintenance workers, including the training of Highway Operations Specialists in appropriate maintenance, traffic control, and safety procedures.

• The current Maintenance Management System (MMS) and its:
  – Data accuracy.
  – Usage of reports produced for end users.
  – Effectiveness in providing information for allocation of budgets and monitoring expenses against the budget at Central, region/district, and maintenance station locations.
− Modifications or enhancements needed to meet maintenance business objectives and to make the system more effective and responsive to user needs and to bring the system to the state of the art.

• The structure, staffing, processes, and procedures used by the Region/District Maintenance Units.
• The efficiency and effectiveness of Region/District Maintenance Units in performing required maintenance activities in support of overall departmental objectives.
• The allocation of resources among regions/district and the allocation of resources among maintenance stations within regions/districts.
• Department standards and practices for placement of maintenance stations.

B. Key Issues

The following key issues to be addressed in the performance audit were identified in the initial stages of the audit.

• Central’s role needs to be better defined and documented. UDOT staff particularly in the regions/districts do not understand the purpose and function of Central.
• Central has been hurt by turnover and lack of experience. Regions/districts often do not respect Central; they believe Central does not understand their problems and issues. In the past, this had been worsened by the lack of visits to the regions/districts from Central.
• Maintenance Management Quality Assurance (MMQA) is a good system, but it has problems. Measurement is not consistent among different regions/districts, and the measurements are flawed for some activities. Some managers lack confidence in the validity of performance data; not all regions/districts fully endorse MMQA.
• Maintenance Management System (MMS) is not flexible enough. It does not produce useful reports, and does not allow data to be downloaded for manipulation. Many regions/districts use spreadsheets for their management and only use MMS for compliance.
• Now is the time to review the maintenance function. The Division has new leadership and retirements are expected within months. A restructuring of the Division may be appropriate. The more time that passes without new management making changes, the more entrenched the system becomes.
• Decision-making points in the budget process and issues such as fair distribution of funds do not take into account the unique needs of the regions/districts.

C. Methodology and Approach

To meet the objectives of this audit, Dye Management Group, Inc. conducted interviews and focus groups, administered an e-mail survey, performed a best practices and
benchmarking review, and analyzed Department documents. The audit was overseen by a steering committee of UDOT officials from both Central and the regions/districts.

1. **Interviews and Focus Groups**

Issue identification interviews were held with each of the members of the steering committee in order to validate and expand upon the direction of the audit. Interviews were also conducted with individuals from Central. The following exhibit shows the individuals interviewed and the topics discussed in the interviews.

<table>
<thead>
<tr>
<th>Interviewee</th>
<th>Topics Discussed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineer for Maintenance</td>
<td>Management of Central</td>
</tr>
<tr>
<td>Manager of UDOT Maintenance Systems and Planning</td>
<td>Maintenance Management System (MMS)</td>
</tr>
<tr>
<td>Budget and Accounting Officer</td>
<td>Budgeting and Program Development</td>
</tr>
<tr>
<td>Feature Inventory Analyst</td>
<td>Feature Inventory</td>
</tr>
<tr>
<td>Facilities Maintenance Manager</td>
<td>Lands and Buildings</td>
</tr>
<tr>
<td>Training Specialist</td>
<td>Maintenance Training</td>
</tr>
<tr>
<td>Methods Engineers</td>
<td>Methods Engineering, MMQA</td>
</tr>
<tr>
<td>Maintenance Operations Engineer</td>
<td>Asset Management</td>
</tr>
<tr>
<td>Contracts Specialist</td>
<td>Pavement Preservation Contracts</td>
</tr>
<tr>
<td>Roadside Vegetation Manager</td>
<td>Vegetation Program</td>
</tr>
</tbody>
</table>

In order to assess the performance of Central from the perspectives of regions/districts, interviews of officials from each region/district were conducted. Individuals interviewed in the regions/districts included region directors, operations/district engineers, maintenance engineers, maintenance analysts, and training specialists. Focus groups were also held with area supervisors and station supervisors in each region/district.

2. **E-mail Survey**

To collect quantitative evaluations of Central’s functions from the regions/districts, an Internet-based survey was administered. Survey participants included all region directors, operations/district engineers, maintenance engineers, region/district maintenance analysts and trainers, area supervisors, and station supervisors. Participants were e-mailed a hyperlink to a Web form that requested input on Central’s performance. The survey received a 70 percent response rate. Appendix A contains a copy of the e-mail survey.
3. **Best Practice/Benchmarking**

A review of available professional literature and previous maintenance audits provided best practices in each of the areas analyzed. In addition, the following state departments of transportation were contacted to provide benchmarks:

- Arizona
- Colorado
- Florida
- Kansas
- Minnesota
- Virginia
- Washington

Using best practices and benchmarks, the current processes used by the UDOT Maintenance Division were evaluated for strengths and issues.

4. **Record Analysis**

Documents provided by UDOT, including policies and procedures, legal requirements relating to maintenance, organizational charts, and position descriptions, were analyzed.

5. **Steering Committee**

Study oversight was provided by a steering committee of UDOT officials from both inside and outside the Maintenance Division and from both Central and a region unit. The following officials were involved in the study oversight:

- Neal Christenson, Administrative Services Group Leader
- Sterling Davis, Engineer for Maintenance
- Ahmad Jaber, Region 1 Director
- Jim McMinimee, Director of Project Development
- Dave Miles, UDOT Operations Engineer
- Richard Miller, Maintenance Operations Engineer

**D. Report Structure**

This report is organized into the following sections:

I. Introduction
II. Organization and Communication
III. Asset Management
IV. Budgeting
V. Maintenance Support
VI. Region/District Operations
VII. Maintenance Work Methods

Each section of the report describes:

- The existing approach.
- Strengths and issues.
- Best practice.
- Recommendations for improvement.

Appendix A: Online Survey
Appendix B: Survey of State Agency Highway Maintenance Best Practices
Appendix C: Asset Management Best Practices
Appendix D: Technical Appendix to MMQA
Appendix E: Utah Laws on Maintenance
Appendix F: Acronyms
Appendix G: Region/District Organization Charts
Appendix H: Condensed Report
II. Organization and Communication

A. Organization

This section describes the context within which the UDOT Maintenance Division operates, the scope of maintenance, the organizational structure, and the Division’s strategic direction.

1. Existing Approach

Maintenance of the UDOT highway system includes activities that protect the highway infrastructure and public safety, as well as those activities necessary for the daily operation of over 5,900 miles of roads. Maintenance includes work to care for the highway and associated features so that they substantially retain their intended use. Maintenance may also include those activities necessary to operate the highway and associated facilities. Many of the operational activities provide a direct service to highway customers, such as rest area operations and emergency operations to keep highways open during natural disasters.

Activities performed to care for the infrastructure can be classified under three categories: preventive maintenance, routine maintenance, and reactive (corrective) maintenance.

*Preventive Maintenance* comprises early measures performed on infrastructure in order to reduce the chances of defects developing prematurely. An effective pavement preservation program encompasses a full range of preventive maintenance techniques and strategies, such as fog seals, slurry seals, chip seals, micro-surfacing, thin lift overlays, crack sealing, portland cement concrete (PCC) joint sealing, dowel-bar retrofit, full- and partial-depth concrete pavement repair, and milling and grinding. Adopting effective preventive maintenance strategies that extend the anticipated life of infrastructure features can help highway agencies make the most of their maintenance budgets, improve reliability, and provide safer roads for travelers. Many of the UDOT preventive maintenance activities are covered by the preservation or “Orange Book” contracts.

*Routine Maintenance* is the day-to-day maintenance activities that are scheduled or whose timing is within the control of maintenance personnel. This type of activity is generally scheduled on a calendar basis and done periodically to care for the infrastructure. Examples of routine maintenance activities include mowing and cleaning roadsides, cleaning ditches, sealing cracks in the pavement, painting pavement markings, and pruning trees. UDOT does all of these activities.
Reactive Maintenance comprises activities that must be done in response to events beyond the control of the highway agency, such as repairing features when they are broken. Examples of reactive maintenance include patching potholes, removing and patching pavement blowups, unplugging drainage facilities, replacing a regulatory sign knocked down by traffic, removing tree limbs and branches fallen on the pavement, and responding to a road closing because of flooding. Another important reactive maintenance activity is responding to complaints from the public. Some events require an immediate response to avoid serious consequences because a present or imminent danger exists. Reactive maintenance activities cannot be scheduled because they occur without warning and often must be immediately addressed. Reactive maintenance activities may be performed at any time of the day or night and on an overtime basis. UDOT also performs each of these activities.

a. Organization

Responsibility for maintenance in UDOT is shared between two levels: the Central Maintenance Unit located in the Salt Lake City headquarters complex and six geographically located region/district field operations around the State. The Central Maintenance Unit is part of the Operations Group. The Director of the Operations Group reports to the UDOT Deputy Director. The Region Operations offices are highly decentralized due to the geographic distribution of the work, and day-to-day decisions for field operations are made at the field level by the region/district maintenance managers. Region/District Maintenance Units report to the Region Director, who in turn reports to the UDOT Deputy Director. The relationships are highlighted in Exhibit II-1
Exhibit II-1: Organization of the UDOT Maintenance Function

(1) The Central Maintenance Unit

Central is primarily responsible for providing support to region/district field operations. Central provides a number of functions, as depicted below:
• **Vegetation Management**
  Vegetation management is very important within the rights-of-way. In addition to preserving aesthetics, vegetation management stabilizes soil from erosion and provides dust control. It acts as a safety barrier and as a snow fence in high-drift areas. Unfortunately, weeds creep into the planting areas and, if not controlled, can destroy those important functions. UDOT is also mandated by law\(^1\) to have a “landscape control program,” which requires trimming and removing vegetation along state roadways.

• **Lands and Buildings**
  Over time, existing maintenance stations require repairs and modifications. As operations expand or stations become functionally obsolete, the need for new stations arises. Central is responsible for prioritizing and administering funds for these needs.

• **Preservation Contracts (Orange Book)**
  These are maintenance contracts that help preserve pavements in good condition in order to increase service life. This reduces the need for expensive rehabilitation or reconstruction at a later time. The contracts are normally less than $2 million and are restricted to pavements and bridges.

• **Methods Engineering**
  This is a form of applied research and technology transfer custom-made for problems experienced in the field that are beyond normal operation. A problem is identified, investigations are carried out, and solutions are tested and evaluated. If successful, the solution is widely applied to similar situations.

• **Maintenance Management Quality Assurance (MMQA)**
  This approach was introduced to demonstrate the linkage between desired levels-of-service and the required effort. By generating options for the decision-maker, the intent is to achieve more enlightened decisions.

• **Maintenance Management System (MMS)**
  This system assists in the planning and scheduling of required maintenance. The system tracks real quantities and money spent in delivering the required maintenance. This system is widely used in the daily management of maintenance activities.

\(^1\) 72-7-514.
• **Feature Inventory**
  This is a record of the various features and their locations.

• **Training**
  UDOT requires practical training for all maintenance workers. As a result, UDOT has assumed the responsibility for managing the Training Academy, which is the program for training entry-level as well as career-oriented maintenance staff.

• **Budget Preparation**
  This is the apportioning of the budget allocated by the Legislature among the various regions/districts. The allocation is based on a number of features and the history of funding. Currently, support is being generated towards developing a needs-based system.

(2) **Region/District Maintenance Units**

Region/District Maintenance Units are responsible for delivering the day-to-day care and operation of the state highway system. The work includes monitoring and evaluating field conditions, selecting appropriate maintenance strategies, assigning work crews, accomplishing appropriate maintenance tasks, and accounting for deployment of resources and expenditures.

Although Central provides support for region/district maintenance, they do not have any direct authority over Region Operations. All region/district maintenance managers report directly to a regional director. Exhibit II-1 shows the lack of a reporting relationship among the various units responsible for maintenance.

b. **Strategic Direction**

UDOT has developed a Strategic Plan that identifies values, goals, and strategies for the Department as a whole, including maintenance. It is posted on the website as the “Strategic Direction.” It was established by the Quality Improvement Council (QIC). Following are some highlights of the strategic plan.

(1) **Values**

The Department aspires to be:

• Employee centered.
• Customer focused.
• A quality service provider.
• A great performer.

(2) Goals and strategies

Several UDOT goal statements and strategies from the Strategic Plan are relevant to maintenance.

• Together with our external and internal customers, establish and share the vision of Utah’s transportation future, and pro-actively seek public acceptance of that vision.
• Provide a quality transportation system that is safe, well maintained, smooth, pleasing, has up-to-date signs, and is an asset to the community.
• Effectively involve customers, and communicate on current and future transportation issues.
• Be responsive to customer complaints and inputs.
• Improve and maintain efficient communication channels which are based on how the targeted audiences prefer to receive their information.
• Assure customers and employees timely and responsive access to information they request.

(a) Customer involvement

Optimize stakeholder and customer involvement in department strategic direction preparation and throughout project planning, design, construction, and maintenance.

(b) Preserve and improve infrastructure

Preserve and improve the transportation infrastructure, focusing on transportation needs, being an asset to the community, being compatible with the natural and built environment, security, safety, and effective systems management.

(c) Operational performance

Conduct all functions of the department to respond to needs of the economy, provide quality products and services, and demonstrate use of leading edge technology.
(d) Continuous internal improvement

Optimize performance through continuous process improvement, effective performance management and measuring, use of best practices, efficient use of resources, and rapid response to change.

(e) Employee centered

Provide effective leadership and coaching to employees, and empower them to take ownership and be accountable to achieve great performance.

In addition to the above goal items, the strategic direction identifies “Priority Strategies” from Fiscal Year 2002, including:

- Implement a priority initiative to enhance leadership training and skills in all organizations within the Department.
- Design and carry out an initiative to achieve a more effective and efficient allocation of funding, staffing, and other resources throughout the Department.
- Develop and implement a plan to improve legislative relationships, understanding and support of UDOT operations, performance, and priority needs.
- Approve and begin implementation of the Department’s asset management business and general design plan.
- Prepare and implement a strategy to provide funding and other resources to develop and maintain new and expanding transportation infrastructure.

(3) Maintenance vision and strategies

In addition to the UDOT Strategic Direction, the Maintenance Division also has developed a vision.

(a) Vision

The Maintenance Division vision statement is to provide “effective/efficient roadway maintenance through quality leadership and interaction with our partners/customers and team members.”

(b) Strategies

“Leadership within the Department is directed toward becoming the best state roadway maintenance organization in the nation. UDOT will
achieve this through pursuing innovative and cost-effective approaches to serving customers needs.”

To achieve this vision UDOT will:

- Continually compare performance against consultants/contractors and other state agencies.
- Contract out activities outside the scope of available expertise or resources.
- Provide training for employees.
- Expect open and honest dialog with partners/customers and team members.

By working together, UDOT will transform the vision into reality. In the process, UDOT will strengthen its credibility, take advantage of leading technology, provide an inviting work environment, and maintain the ability to adapt to customers needs.

c. **Context Sensitive Solutions**

UDOT has drafted revisions to its policies and Station Supervisors Handbook to incorporate Context Sensitive Solutions (CSS). According to the Station Supervisors Handbook, the principals of CSS are:

- Address the transportation need.
- Be an asset to the community.
- Be compatible with the natural and built environment.

If these principles are followed, UDOT believes it can provide a transportation system that “is safe for users, minimizes environmental intrusion, is aesthetically pleasing, is compatible with the community’s social and likeability values, honors stakeholder commitments, and receives public acceptance.

2. **Best Practices**

Following are best practices as reflected in other states such as Washington, Minnesota, and Colorado.

- Including elements in the strategic plan that address customers, goals, strategies, and actions for preservation, and dealing with organizational and employee performance.
- Linking the strategic plan to implementation through budgets, operational plans, individual management performance plans, and evaluations.
- Establishing measurable targets and strategies through MMQA and, more recently, through asset management.
- Involving managers at different levels of the organization in planning.
• Ensuring understanding of the goals and strategies throughout the Department by staff meetings, newsletters, websites, and other means.

3. **Strengths**

• UDOT has developed a strategic direction that includes maintenance elements and covers important areas such as customer approval, infrastructure preservation, performance evaluation, and employee satisfaction.

• Strategic elements are included in manager performance plans.

• The strategic direction is posted on the UDOT website.

• UDOT has attempted to implement MMQA and is developing an asset management process.

• UDOT’s proposed CSS policies would implement key areas of the Department’s strategic plan related to customer involvement.

4. **Issues**

• Maintenance personnel do not understand UDOT strategic goals. In our recent survey of maintenance managers, only 46 percent of respondents indicated a good or complete knowledge of statewide maintenance goals. This contrasts to 70 percent who have a good or complete understanding of region-wide goals.

• The strategic direction is not yet linked to an implementation plan. It is critical that there be measurable targets to guide implementation, yet the principal vehicle for MMQA is really followed only in one region. This is described later in the report.

• Central support of regions was only ranked as moderately effective (an average of 3 on a scale of 5 to 1, with 1 being very effective). Region maintenance management was rated more effective, with an average ranking of 2.27.

• The strategic direction has not yet been operationalized for maintenance. Only in April 2002 were Maintenance Division staff notified of the strategic direction. There is no evidence of strategic direction in the maintenance budget (building blocks). The UDOT asset management process is still under development.

• Managers at lower levels in UDOT have not been involved in plan development. This affects their understanding of, and buy-in to, the plan.

5. **Recommendations**

**Recommendation 1. Develop a strategic approach to maintenance.**

Maintenance needs to continue what the Department has begun with regard to strategic direction. In particular, maintenance should bring together information from
MMQA, asset management, best practices research, methods research, customer input, and other areas to formulate more specific goals and strategies.

**Recommendation 2. Operationalize the strategic approach.**

Tactics should be developed to implement goals and strategies. Strategic MMQA target levels of service (outcomes) and priorities should be developed. The maintenance budget and programs should reflect the direction and individual performance plans and evaluations revised to reflect strategic elements. The asset management process also should support and be consistent with the maintenance strategy.

**Recommendation 3. Involve managers at all levels in the planning and implementation process.**

An action team comprised of a cross-section of managers from the Maintenance Division and regions should assist in developing tactics and elements to include in budgets, programs, and other implementing documents. Managers should review progress of implementation actions throughout the year. There should be statewide and region/district strategies to communicate the strategic direction and implementing actions, including discussion in staff meetings, newsletters, memos, and other documents that reach target staff.

**B. Communication**

This section reviews communication within the maintenance function. For organizations – whether centralized, decentralized, or mixed – good communication is a key element for success. UDOT has a decentralized organizational structure. A decentralized structure may be advantageous for a state with a large, varied geographic area and variable weather conditions, or a state that experiences great variations in public expectations and values. However, this structure creates additional problems of coordination among different regional areas. This coordination requires good communication.

1. **Existing Approach**

Existing communication between Central and the regions occurs in a number of ways.

- Direct in-person, telephone, e-mail, and other contacts between Central management and regional management.
- Regular meetings of existing groups, such as the Quality Panel and the monthly Operations Engineers meetings, are held to discuss matters of interest.
- Within the context of mandatory processes such as budgeting, programming, and awarding preservation contracts, district staff may request assistance from Central in interpreting rules, clarifying deadlines, or packaging the contracts.
- Officials from Central visit the regions, as in the case of semi-annual assessments.
• District staff will call Central staff, either for technical help or financial support, if there are problems beyond the normal routine in the districts, such as weed control or shed repairs.

• If district staff have a problem with existing systems, such as the Feature Inventory, MMS, or MMQA, they call upon Central.

2. Best Practices

Following are some communications best practices for different types of communication.

• **Individual.** Good individual communication refers to the ability of individuals to express their views, wants, and opinions clearly and without offense to others. These skills are groomed through individual training programs since there are great variations in abilities and skills among the various staff members.

• **Unit.** Good unit communication means the ability of each unit to share knowledge and information among staff to maximize the performance of the unit. Many organizations require a large number of knowledgeable workers to help organize and develop content. This may present a problem for organizations with limited resources and competing priorities. These organizations need to take advantage of the intellectual capital that is developed as a natural part of the work process itself. This is achieved by knowledge of management systems, staff meetings, a project teaming approach, central filing systems, local area networks, and encouragement of good relations among the staff.

• **Vertical.** Vertical communication is the ability of a group of units (a group, branch, or division) that normally reports to one supervisor to communicate among themselves effectively, thus allowing the supervisor to fulfill his/her assigned roles and responsibilities effectively and efficiently. This is normally achieved through the regular weekly unit head meetings, specific issue meetings, established formal reporting procedures, monthly reports of progress, and good team spirit among the unit managers and staff. Local area networking is also important. This vertical communication is known as “silo communication” in management jargon.

• **Lateral.** Lateral communication is the ability of branches, divisions, or units to communicate across the enterprise, outside of the normal boundaries, with other branches and divisions, in order to maximize the effectiveness and efficiency of the organization. This is normally accomplished via strict protocols and formal forums for sharing information and making collective decisions, but informal lateral communication can also enhance the efficiency of the operation as well.

• **Public relations.** Good public relations is the ability of the agency (or its constituent units) to communicate with elected officials, the governor’s office, and the public at large.
Communication with the legislature and governor’s office is normally accomplished through processes such as the budget and policy approval; the adherence to requirements that must occur before the communication takes place; and through special reports and briefings that focus on the issues.

Communication with the public takes the forms of answering phone calls and letters; establishing a specialized communication unit/branch to edit letters, publish reports, attend community meetings and publish newsletters for public consumption; and/or hiring specialists to develop media applications for special issues or objectives. It also can include use of statewide surveys and citizen focus groups to understand citizen viewpoints.

Organizations normally use a mix of formal and informal communication. The following are some means to enhance communication in decentralized organizations.

a. **Formal Methods**

   - Providing good organizational structure (matrix management).
   - Establishing reporting procedures.
   - Establishing advisory and executive committees.
   - Communicating through teleconferencing.
   - Centralizing the filing, making it accessible to all staff.
   - Making checklists of consultations required.
   - Consolidating the information base (knowledge management).
   - Requiring monthly, bimonthly, and quarterly progress reports.
   - Holding staff meetings.
   - Assigning multi-disciplinary project teams.
   - Establishing a wide e-mailing distribution list.
   - Providing a common set of software tools for business communication.

b. **Informal Methods**

   - Staff networking
   - Social gatherings/occasions
   - Reward/recognition systems to encourage combined work efforts
   - Other activities that build camaraderie and trust among staff
Successful organizations maintain a balance in communication between individual action (informal and formal); between vertical (within division), horizontal (across enterprise) and public relations; and between individuals and units. Such a balance reflects a more realistic picture of the communication behavior required for success in organizations. This necessitates the deployment of appropriate technologies for facilitating communication. Improving communication often requires allocation of resources.

3. **Strengths and Issues**

The following discussion of the strengths and weaknesses of communication at UDOT is from the best practices perspective.

**a. Strengths**

Our interviews show that communications with some Central staff and the regions/districts is considered excellent. Comments consistent across regions/districts for these staff include: “work with regions/districts; share their ideas; are honest and up front; and, seek win/win strategies.”

The Operations Engineers’ meetings provide the opportunity to identify issues and resolve problems on a statewide basis.

The Annual Maintenance Conference provides an opportunity to discuss issues and statewide initiatives and share solutions.

**b. Issues**

Some key issues, such as the recent concern about inadequate water-based paint, indicate difficulty in resolving issues. There are different expectations of top management, Central, and regions/districts that have not been addressed.

Regions consider communications between some Central staff and region/district staff as poor. Comments regarding other staff included: “lack of expertise” and “not involved.” One central staff member was referred to in some regions as “Old Two Weeks.” This person would indicate that a response to a region’s questions would be provided in two weeks, but the region would never hear back.

There are staff meetings at Central to discuss what is happening in maintenance and other issues. At one meeting our team attended there was little structure (e.g., no agenda) and the discussion did not include a review of any reports on maintenance financial performance, organizational performance, or activity outcomes.

There is a perception that Central does not provide leadership on issues like MMQA and methods engineering. This has been worsened by staff turnover, which has resulted in lack of expertise.
Region/district staff often does not know where to go to get answers. They cite a lack of documentation on Central staff authority and responsibility.

Even though there are meetings like that of the Operations Engineers, there is perceived to be a lack of a clear process for decision making.

4. Recommendations

Recommendation 4. Strengthen the decision-making and issue resolution structure for maintenance.

The current decision-making structure is not working well. The fact that there is a gap in communication and so many staff concerns indicates that the issues are not being resolved satisfactorily. The current Operations Engineers’ meetings and the Annual Maintenance Conference have not been sufficient.

To address this there should be a new decision-making structure. There should be a Policy Committee with top level managers, including the Deputy Director, Director of Operations, and region/district administrators. There should be an Operational Committee, which includes the Maintenance Engineer, other Central managers, and region Operations Engineers. Below the Operational Committee could be action teams that work through details of various issues such as MMQA, methods, and so forth.

The Policy Committee should approve or revise maintenance planning directions, resolve policy issues passed onto it by the Operational Committee, monitor overall maintenance performance, and direct the implementation of actions to address problems and improve performance in Central and in the regions/districts.

The Operational Committee should participate in planning, review of operational and financial performance, and help resolve issues. The Operational Committee would forward recommendations, as necessary, to the Policy Committee.

This decision-making structure, or something like it, is necessary to be successful in a decentralized, matrixed environment. It brings together leadership, expertise, and perspectives necessary from throughout the maintenance organization to achieve maintenance goals. It is not necessary to create new committees if the charters of existing ones could be revised. However, it is essential that these committees adopt the new roles and ensure that issues are resolved.

Recommendation 5. Develop a Central customer relationship management (CRM) process.

Central needs a formalized approach to quality support for the regions. This should include establishing goals, strategies, tactics, and performance measures for internal customer support. These elements should address different ways to communicate with
regions remotely, as well as site visits in each region by all key Central staff. The CRM process should include:

- Providing employee training in communication and customer service.
- Including in the CRM process customer service goals and strategies in maintenance strategic and tactical plans, as well as individual employee performance plans.
- Recruiting Central staff who have good communications skills and who are customer oriented.
- Developing simple methods to track requests for assistance from regions, age them, and report when service is provided.
- Evaluating service levels at monthly staff meetings, periodic planning reviews, and during employee performance evaluations.

**Recommendation 6. Increase the expertise of Central.**

In order to have credibility with region staff, Central staff not only need to communicate well but know the subject matter they are communicating. With new staff, there is the need to provide additional expertise and knowledge. This can be addressed in the following ways:

- Provide specialized training for Central staff where it is available.
- Supplement Central staff with experts in particular areas including experts from the regions/districts, from consulting firms, from the research unit, from universities, or from other states.
III. Asset Management

A. Asset Management

1. Existing Approach

   a. I-15 Asset Management Systems Evaluation

      (1) Systems study overview

      UDOT has recently begun to consider asset management as a departmental approach to infrastructure management by evaluating a 17-mile length of the reconstructed I-15 Corridor in Salt Lake City. The I-15 project was a major transportation improvement undertaken for the 2002 Salt Lake City Winter Olympics. UDOT believed that this new facility could provide a laboratory for implementing asset management concepts and techniques that might later be extended to other parts of the transportation network. The initial phase of the asset management study was completed in March 2002. A report to UDOT provides an evaluation of UDOT business processes, staffing, those information systems listed in Exhibit III-1, and the data needed to support asset management on I-15. The report also presents a series of recommendations for next steps in the systems area.² A subsequent phase of this work is now ongoing, concurrent with preparation of the Dye Management Group, Inc.’s Performance Audit of UDOT Maintenance Activities.

      (2) I-15 Asset management recommendations relevant to this audit

      The I-15 Corridor Asset Management recommendations that are relevant to this audit of maintenance activities are listed below, with additional details in the I-15 Asset Management System Evaluation report:

      • Use existing UDOT systems as much as possible to store inventory and condition data for I-15, adding asset classes and more detailed data to the existing systems where appropriate. This recommendation focused on the existing systems dTIMS (migrating to the new version of dTIMS), Pontis, and MMQA to analyze asset preservation investment needs and future

conditions. Other UDOT systems should also be applied, however, to store asset information, including the Feature Inventory, the Sign Management System, and the Pipe Culvert Database.

**Exhibit III-1: Systems Included in the Asset Management Evaluation**

<table>
<thead>
<tr>
<th>System</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>dROAD/dTIMSTM™</td>
<td>Pavement management system licensed from Deighton Associates Limited</td>
</tr>
<tr>
<td>Pontis®</td>
<td>Bridge management system licensed from AASHTO</td>
</tr>
<tr>
<td>MMS</td>
<td>Maintenance Management System</td>
</tr>
<tr>
<td>Feature Inventory</td>
<td>Inventory of maintainable features</td>
</tr>
<tr>
<td>MMQA</td>
<td>Maintenance Management Quality Assurance</td>
</tr>
<tr>
<td>PDBS</td>
<td>Project Development Business System</td>
</tr>
<tr>
<td>FINET</td>
<td>Financial Information Network – accounting system for the State of Utah</td>
</tr>
<tr>
<td>Pipe Culvert Database</td>
<td>Inventory and condition data on pipe culverts</td>
</tr>
<tr>
<td>CARS</td>
<td>Central Accident Reporting System</td>
</tr>
<tr>
<td>GIS</td>
<td>Geographic Information System</td>
</tr>
<tr>
<td>Location Referencing</td>
<td>Approaches to linear referencing of assets used by UDOT</td>
</tr>
</tbody>
</table>

- While MMQA is not implemented as a production system, its analytical approach is valuable and should be used in implementing asset management for the I-15 Corridor. Steps to implement this recommendation include increasing the MMQA sample size and storing MMQA results in a format that is more accessible to regions, such as a relational database.

- Develop an additional database for the purposes of integrating and sharing asset data (including analysis results), assisting in the management of I-15, and storing any additional inventory data that cannot be stored in existing systems at an appropriate level of detail. This would be referred to as the I-15 Asset Manager (IAM). IAM should be used as a performance-based tool for day-to-day management of I-15 and as part of the budgeting process to establish performance targets, predict condition and performance, and recommend budgets for the I-15 Corridor. It should provide UDOT staff the capability to easily view and analyze asset data in an integrated fashion. Since this Parsons Brinckerhoff (PB) report was written, UDOT has determined that the Deighton product with its full CT software will meet all of these requirements and they will be implementing that system.
• Adjust business processes for managing I-15 to allow flexibility in budgeting across assets, monitor program delivery and assess condition and performance over time, and facilitate monitoring and review of how the asset management concepts have been implemented.

b. Central Interviews on Asset Management

(1) Overview

Interviews with senior managers in Central confirmed that the exploration of asset management concepts and how they may apply to UDOT functions is still at a very early stage. The I-15 Asset Management System Evaluation report was delivered to UDOT in March 2002, and Parsons Brinckerhoff (PB) continues to work with UDOT to identify opportunities for asset management applications and to refine the proposed approach of the IAM. The several recommendations cited above have not yet been acted upon in-depth for I-15, let alone for agency functions more broadly, including statewide highway maintenance. The leadership of asset management at Central has experienced turnover in recent months. While the department is committed to asset management, the Executive Director has not determined how quickly and how extensively it will be implemented.

In these interviews, asset management was often discussed in the context of improved systems, data, and information. This is perhaps not surprising for several reasons: information technology (IT) provides a practical, concrete basis for capturing asset management concepts; a key element of the initial phase of the I-15 study was a systems evaluation; and current UDOT efforts toward systems upgrading and integration (particularly the migration of data to an Oracle database) fits nicely into the asset management framework. The current status of UDOT thinking about asset management within this context is described in the following sections, based upon the interviews with Central managers.

(2) Maintenance perspective on asset management

The Maintenance Operations component of UDOT is in favor of asset management. Asset management would bring together information on the current stock of infrastructure assets, its condition, and the time of the last treatment to the asset (presumably as a guide to the next scheduled treatment). The agency considers its infrastructure asset base to include not only the highway network, but also ancillary buildings and structures. Regarding problems in current condition and maintenance practice for these assets, the following should be considered:

• Policy goals and objectives for asset management are not explicitly stated.
• Funding for highway maintenance in the past has been theoretically allocated on the basis of feature inventory (that is, prior to introduction of MMQA). However, the perception is that the existing feature inventory is under-funded according to current standards even before MMQA levels of service thresholds are considered, implying deferred maintenance.

• The Orange Book pavement preservation program was intended for preventive maintenance of pavements, but is actually being used for rehabilitation. The preventive concept must be restored, consistent with asset management principles of least lifecycle cost preservation strategies.

• Asset management at UDOT would include not only resource allocation in maintenance program development, but resource utilization as well in the program delivery stage. For example, there is currently not much outsourcing of maintenance services.

• Asset management practices on UDOT buildings have fluctuated. There are 70 to 80 maintenance stations, but only 10 have been surveyed for condition. No software currently exists to identify building needs.

(3) Information technology supporting asset management

UDOT managers who were interviewed believe that the value of asset management is in sharing information. While good information is critical to asset management, there are several issues with the current information base supporting UDOT Maintenance:

• There is an “overload” of information, some of it duplicated. For example, MMQA collects the same pavement information as Programming: e.g., falling weight deflectometer (FWD) assessments of pavement strength and information on surface rutting and cracking. There are also questions of how some of this information is actually used.

• Data quality is rated as a “C” by the UDOT Maintenance Operations Engineer. For example, while pavement data is collected on a 100 percent sample, regional data collection practices are inconsistent (Region 1 collects in autumn using Maintenance forces, while Region 4 collects in December or January using Construction staff). There are also delays in processing data for finished use.3

• Currently, each functional group has its own database (e.g., PMS, BMS, and MMS). Some of these existing databases do not have condition data, and would need this data for asset management. UDOT is now working through its Information System Support (ISS) group to integrate relevant

3 Pavement data is collected by the Pavement Management Group and shared with Maintenance to eliminate duplication of effort.
databases such as for pavements, bridges, maintenance, and accidents, with all databases migrating to Oracle.

(4) Organizational placement of asset management leadership

A consensus has not yet been reached on organizational responsibilities for leading and conducting the asset management effort. The UDOT Administration Branch now has the assignment to develop the IAM but, more broadly, there is no agreement that this unit should be the permanent home for the asset management function. Maintenance/Operations management feels that leadership of asset management could reside appropriately in Maintenance or in a separate distinct organizational unit.

2. Best Practice

Guidelines for transportation asset management are being developed in an ongoing National Cooperative Highway Research Program (NCHRP) study sponsored by AASHTO and the FHWA. The NCHRP study defines transportation asset management as a strategic approach to managing transportation infrastructure, built upon a number of best practices. A distillation of these best practices is presented in Appendix C, adapted for highway maintenance. These best practices are organized within four areas determined in the NCHRP study to be critical to asset management practice in U.S. transportation agencies:

- Formulation of policy goals and objectives that guide the management of transportation infrastructure.
- Planning and programming processes, which are at the core of resource allocation decisions in infrastructure management.
- The program delivery process, which deals with effective resource utilization in managing infrastructure.
- Information and analysis, which provide for system performance monitoring and IT support at all stages of asset management.

Individually, these best practices provide specific guidance on the state-of-the-art for particular agency functions and capabilities. Collectively, they embody a number of key principles of asset management that may be summarized as follows:

- Focus on results.
- Use an integrated management approach.
- Apply quality information throughout the process.

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• Consider asset management as a “way of doing business.”

The following sections expand upon these principles with respect to highway maintenance.

a. Focus On Results

• Asset management focuses on results or outcomes of management decisions. In maintenance, these outcomes can be expressed through levels of service defined for each maintenance activity or maintenance activity group.

• Asset management is a policy-driven, performance-based process. Resource allocation decisions are driven by policy objectives and measures of system performance.
  − Policy objectives in highway maintenance may be captured through target levels of service that respond to statewide policies established by the Legislature and the Transportation Commission as they relate to the maintenance program.
  − System performance may be captured through achieved levels of service as related to observed highway conditions or quality of services performed.

• Levels of service should reflect customer as well as agency considerations where feasible. For example, the quality of ride as affected by surface maintenance, or the time to bare pavement as affected by snow and ice control, should influence levels of service determinations together with agency considerations based, for example, on asset preservation and lifecycle cost.

• Performance results should be tracked and communicated to internal and external stakeholders.

b. Use an Integrated Management Approach

An integrated management approach considers options and alternatives to get the best result given the resources available. It establishes common approaches for assets being maintained, and brings all affected units and organizational levels into the decision-making process. Examples of an integrated approach involving highway maintenance include the following:

• Consideration and evaluation of new materials and processes in performing maintenance activities.

• Consideration of both corrective and preventive maintenance activities within lifecycle cost analyses for pavements, bridges, and other major asset preservation.
• Consideration of capital-maintenance tradeoffs, employing the results of the lifecycle analyses above.
• Use of levels of service and performance-based budgeting across all maintenance activity groups.
• Use of feedback mechanisms to review and update levels-of-service thresholds where needed.
• Involvement of all affected organizational units and levels in designing and implementing strategic management changes and initiatives.
• Training in asset management concepts and techniques as appropriate to each unit.

c. **Apply Quality Information throughout the Process**

Effective asset management as it applies to highway maintenance depends upon current, accurate, complete, and timely information and analyses in a number of areas, including the following:

• Asset inventory and condition.
• Maintenance management systems and tools for planning, budgeting, scheduling, work accomplishment, performance monitoring, and review and update of information and practices.
• Life-cycle cost analyses of preservation strategies for pavements, bridges, and other major asset classes.
• Performance monitoring (updates of condition and translation to current level of service).
• “What-if” analyses in performance budgeting and lifecycle cost analyses.
• Performance-based budgeting and relationship between level-of-service values and respective costs of maintenance.

With regard to the last item above, performance-based budgeting, it is important to note that performance-based budgeting links budgetary funding levels to measurable goals. Measures typically include outcomes (e.g., condition), results of activities (e.g., “pavement condition after pothole patches”), as well as efficiency (e.g., cost per pothole patch). In maintenance, MMQA that is used properly to establish budget levels constitutes a form of performance-based budgeting.

d. **Consider Asset Management as a Way of Doing Business**

Asset management is not a separate initiative distinct from, say, maintenance management, MMQA, MMQC, performance budgeting and monitoring, and so forth. Rather, it is a perspective on how to do business in each of these and other
management areas, based upon the principles illustrated above and described in more detail in Appendix C.

- It is an integral part of maintenance planning, budgeting, scheduling, work accomplishment, performance monitoring, and review and update of information and practices.
- It requires clear top-management support and direction. It also requires both top-down and bottom-up communication within maintenance units, as well as effective horizontal coordination and communication with other agency units where needed.
- It implies clearly defined roles and responsibilities, and accountability for results.

Stated another way, efforts such as MMQA and MMQC are examples of the opportunities and mechanisms by which UDOT can implement asset management principles within its maintenance function.

e. **Typical Elements of Good Asset Management**

A good asset management implementation is characterized by elements such as the following:

- Well-defined, clearly stated policies that drive decisions and performance measurement.
- Business processes and organizational roles clearly aligned with these policies.
- Quality information to guide decisions on resource allocation and utilization.
- Emphasis on customer service (outcomes) and accountability.

3. **Strengths and Issues**

This section reviews current UDOT asset management practices related to maintenance. Areas of current strength at UDOT are discussed first, followed by identification of specific issues in each area.

a. **Strengths**

- UDOT state statutes authorize a maintenance function and specify certain requirements for how maintenance is delivered.
- The agency’s strategic business plan identifies several priority areas relevant to asset management, including customer orientation in dealing with
transportation issues and providing services; minimizing congestion where possible; providing a safe, well maintained system with up-to-date signs and clean, functional rest areas; and embracing alternate solutions to problems.

- The QIC sets the strategic direction for the Maintenance Division. This strategic vision is very general, however, except for very large projects.

- The definition of maintenance levels of service (LOS)\(^5\) and LOS thresholds that are part of MMQA embody the basis for translating broad policy goals in to more specific objectives and performance targets.

- Central uses the MMQA to show the budget impacts of different levels of maintenance service.

This capability conforms to good asset management practice in that it illustrates outcomes of selecting particular budget options. The role of MMQA in asset management would be stronger, however, if the application were used directly for budgeting on a performance basis. Current impediments facing UDOT in taking this additional step are discussed as “issues” in Section 2.

- UDOT’s MMS philosophy enables this system to track program expenditures, resource usage, and accomplishments much more closely than in other state DOTs.

Two factors contribute to this capability:

- UDOT’s input data to MMS consists of information from the T-91 data input system, the same source used by Payroll, with unit costs updated annually.

- MMS and FiNet financial data are compared throughout the year and reconciled at year’s end. The result is that cost tracking by UDOT’s MMS is within five percent or less of the FiNet financial system totals. Comparable results in other states are about 15 percent.

- UDOT regional managers consider options in their resources available, particularly in labor where seasonal hires and prison labor supplement state forces. Equipment sharing is also practiced for specialized pieces. Outsourcing is used, though not to a great degree.

b. Issues

Issues facing UDOT in each of the areas of asset management discussed above are presented in the respective sections below.

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\(^5\) Central is considering using the term Levels of Maintenance (LOM) to distinguish it from the more commonly used traffic LOS. In this report, LOS refers consistently to maintenance levels of service.
UDOT is impeded in the full implementation and application of MMQA by several technical factors. Until these issues are resolved and MMQA is applied on a consistent and meaningful basis in both Central and the field, it will be difficult to employ the policy framework in MMQA that is needed for effective performance-based management and resource allocation. Bringing MMQA fully online as a policy framework for asset management will require the completion of several tasks detailed below.

State DOTs that use a quality assurance approach such as MMQA in their maintenance budget development (e.g., Colorado, Washington State, Arizona) actively engage in discussions with their legislatures and transportation commissions or boards regarding the appropriate levels of service to be assigned. Topics of discussion typically include the overall LOS values that can be targeted within available funding, degree of uniformity or variance among regions/districts within an activity group (including the need to address unique local issues), and degree of uniformity or variance among activity groups (e.g., LOS targets for hard-surface maintenance versus traffic services versus snow and ice control). These discussions are in the context of the current highway condition determined from the most recent condition survey, and the implied current LOS throughout the system.

- A review of LOS definitions and thresholds to address concerns of the regions and districts.
- Effective teaming, communication, and training internally within the department to engage Central and field staff in the refinement, understanding, and acceptance of MMQA as a useful approach.
- Communication with the Legislature, the Governor, and the Transportation Commission regarding the use of MMQA as a policy framework and performance budgeting tool.
- Issues regarding program delivery from an asset management perspective drawing on specific data and reporting capabilities.
- The Feature Inventory as a more fully-utilized resource. It is not employed by MMQA, even though LOS computations include total inventory quantities. It does not include information on the condition of highway assets.
- Existing UDOT capabilities to perform maintenance according to asset management “best practices” as a fully utilized resource and, therefore, not impeding potential new capabilities.

UDOT managers have pointed out some of the obvious causes, including turnover in critical leadership areas, lack of communication between Central and field, lack of comprehensive training, failure to establish buy-in among critical stakeholders, and the historical development of legacy systems that may lack features needed in today’s management environment.
In considering a program such as MMQA, for example, a perspective of how this application affects all levels of the Maintenance organization is absolutely critical to success:

- A rationale needs to be established for why MMQA and levels of service are needed.
- Policy objectives for the maintenance program need to be defined and communicated clearly to all organizational levels so that a tool like MMQA can analyze resource allocation options to meet these objectives.
- Teamwork is necessary to develop not only the details – e.g., the specific LOS units of measure and threshold values – but also the more fundamental capabilities needed – e.g., the procedures to develop, debate, and produce the recommended maintenance program budget.

• Leadership is needed to define the mission, communicate it internally and externally to key stakeholders, coordinate the efforts of the several organizational units that need to be involved, and demonstrate long-term commitment by example.

• Capabilities need to be brought into alignment with one another. Management systems need to support the recommended business processes. Data collection procedures need to reflect the intended accuracy and use of the information. Is the purpose of MMQA to develop a statewide program budget? Or to support local management at a regional, area, or station level? The answers to these questions make a big difference in the type of data collection effort needed.

• An ongoing process of review, update, and addition of new capabilities must be put in place to meet new demands on the program, reinvigorate existing capabilities, and reflect changes in policy and advances in technology.

Questions such as these should not be addressed individually, but rather as part of a comprehensive framework for improved maintenance management reflecting the principles of good asset management.

4. Recommendations

The following recommendations address issues associated with asset management as a strategic, comprehensive, performance-based approach to managing maintenance and the interactions between maintenance and other UDOT functions.
Recommendation 7. Develop an asset management plan for Maintenance consistent with the broader statewide framework now being considered by UDOT.

UDOT should consider the principles of good asset management illustrated in Appendix C as it develops its asset management framework. These include:

- A strengthened policy approach for maintenance management as a performance-based process.
- Use of MMQA as the basis for performance-based budgeting in maintenance.
- Development of a department-wide data collection approach that all regions subscribe to and conduct regularly and consistently.
- Review of current business practices and legacy system applications to update them where needed, bring them into alignment, and promote integration and data sharing where useful.
- Development of an ongoing program of training, communication, and review among Central Office and field managers to sustain and increase management capabilities and staff familiarity with this approach, identify problems and resolve them, and recommend updates and enhancements of the approach.
- Engagement of the Legislature and the Transportation Commission in the concept of a policy-driven, performance-based budgeting approach, and discussion of their roles in this process and their willingness to apply it.

UDOT should incorporate these in an action plan for maintenance. Each of these points is discussed in greater detail in the recommendations that follow.

Recommendation 8. Strengthen the policy framework for maintenance management as a performance-based process.

A strengthened policy framework provides guidance for resource allocation decisions in the maintenance program, and identifies critical priorities. With the use of feature-based budgeting to date, such policy guidance has not been a formal part of the process. With the use of levels of service in a performance-based approach, however, a policy framework is needed.

The policy framework should be based upon two formulations:

- Develop a set of policy statements maintenance activities with high public visibility. These statements should respond to the maintenance-related policy goals of the Legislature and programming goals of the Transportation Commission, as well as to accepted departmental policies and practices. Discussions with Legislative staff and Transportation Commission members should explain the use of these statements as part of an asset management approach to maintenance. Asset management should be used to enhance the information the Legislature and Transportation Commission use for policy
setting, with the Department retaining its role in management. The statements should express the desired quality of service or condition, using numerical measures if possible. It is also helpful to indicate relative priority of different maintenance situations if appropriate, or to stratify policy objectives by class of asset (e.g., functional class, AADT level, etc.), as is now done in the “matrix criteria” for snow and ice control, rest area maintenance, and vegetation control. An example policy objective is the following (for illustration only) “In snow and ice control, attempt to achieve bare pavement on [this] class of highway within four hours after the end of precipitation.”

- Structure the LOS units of measure, thresholds, and matrix criteria (if needed) to be able to translate policy objectives into specific LOS selections. If explicit policy statements have not been defined for an activity group, define LOS units of measure and threshold values to represent meaningful policy choices. The purpose here is not to specify particular policies, but rather to build the framework within which realistic and meaningful policy options can be explored later through MMQA. For example, if a policy objective regarding pavement surface maintenance focuses on rideability, then LOS units of measure should likewise relate to surface conditions associated with rideability. More will be said about LOS units of measure in the next recommendation.

**Recommendation 9. Renew the MMQA as the basis for performance-based resource allocation in maintenance.**

MMQA should be reviewed and renewed to reestablish its purpose, attain buy-in and credibility, and benefit from suggested changes to the current version. This recommendation does not mean that the MMQA must be redone. A renewed MMQA should, however, resolve issues and concerns of field staff with its design and implementation. It should encourage consensus on a consistent application of MMQA throughout the state, and UDOT should implement it on that basis. This recommendation will provide the needed framework for performance-based resource allocation in Maintenance.

Several aspects of MMQA deserving attention are listed below:

- MMQA needs to be understood and accepted at all levels of the Maintenance organization through communication, involvement, and training.
- LOS threshold values and units of measure need to be reviewed and revised where needed to have greater consistency and acceptance. The potential need to have multiple measures to reflect different functions in maintenance management should be recognized.
- A method of data collection and interpretation for each asset should be defined and used regularly and consistently by all regions and districts.
• The MMQA relationship between LOS and cost should be reviewed by a group of Central office and field managers to ensure that it is reasonable for budget projections.

• UDOT executives need to work with the Transportation Commission and the Legislature to explain how asset management encourages a policy-driven, performance-based approach and how these concepts are embodied in an updated MMQA and maintenance levels of service to gain support for a budgeting process that uses these concepts and techniques.

• An Academy training program should be developed for MMQA.

Recommendation 10. Develop a department-wide data collection approach that all regions/districts subscribe to and conduct regularly and consistently.

Regions/districts differ on data collection procedures and timing, as well as on the criteria for translating condition data to LOS. A revised data collection strategy should encompass the following elements:

• **Scope, purpose, and basic approach:** There needs to be agreement on what items will be collected, what purpose the data collection will serve, and what the basic methodology will be. Purpose and approach are closely linked and must be considered together. For example, if the purpose is to support a statewide budget with no analyses at a more detailed level, then a particular sampling strategy is justified. If the purpose is to support not only statewide analyses but also regional, district, and perhaps even area or station analyses, then much more detailed sampling or full coverage is needed.

• **Methodology:** Details of the methodology need to be developed and agreed to. The units of LOS measure need to be reviewed for practicality of data collection if this has not already been done and refined as needed. Specific instructions and examples should be developed, together with recommended frequency and timing of inspection. Quality control methods should be defined.

• **Training:** An Academy training program should be developed for data collection as a companion course to MMQA.

Recommendation 11. Engage the Legislature and the Transportation Commission in the concept of a policy-driven, performance-based budgeting approach, and discuss with them their roles in this process and their willingness to apply it.

It is critical that the Legislature and the Transportation Commission understand and accept a performance-based approach to resource allocation and program management in an asset management framework. This recommendation proposes briefing sessions by UDOT executives to the Legislature and the Transportation Commission on the purpose, operation, and illustration of MMQA, and the use of maintenance LOS values as expressions of maintenance policy. These sessions should be presented at
several points throughout MMQA review, revision, and implementation, with the objective of gaining buy-in by these bodies to this approach.

**Recommendation 12.** Develop a program of training, communication, and review for Central and field managers to increase management capabilities and staff familiarity with asset management, to identify problems and resolve them, and to recommend updates and enhancements of the asset management plan.

Maintenance staff needs to be continually informed and engaged in asset management.

Training courses should be developed at the Maintenance Academy on the purpose and use of MMQA and associated data collection procedures and the use of management systems and analysis tools appropriate to each level of the organization. These courses should be designed both for new employees and for existing employees to be updated on the latest techniques, new policies that affect MMQA resource allocation, solutions developed to identified problems, and so forth.

Regular internal communication on asset management subjects will keep employees informed, provide consistent guidance throughout the department, and reinforce employee perceptions of management interest. Information and “problem solver” sheets, examples of latest practices, helpful hints, and similar ideas can be incorporated on paper and in electronic newsletters. Organizational meetings also provide forums for discussions of these points, whether open-ended or organized around theme areas.

External communication is important in maintaining interest and acceptance of the Transportation Commission and the Legislature in the asset management approach. Summaries of LOS conditions throughout the state, proposed solutions to indicated problems, implications of current situations for future policy considerations, and demonstrations of management willingness to accept accountability for meeting LOS targets help reinforce the perception of UDOT’s commitment to making this approach work effectively.

A Maintenance group should be charged with meeting periodically to review procedures associated with asset management, particularly regarding MMQA and MMS, data collection, and training. The group should provide a forum for identifying problems and best practices, recommending revisions where needed, and ensuring implementation of recommended changes. It is important that this group represent all Maintenance organizational levels and regions.

**Recommendation 13.** Review current business processes and legacy system applications to update them, bring them into alignment, and promote integration and data sharing where useful.

The I-15 study described at the beginning of this section included recommendations for stronger use of existing management systems, including MMQA, and greater
sharing of data. Maintenance has already taken steps in this area through the use of pavement distress survey information in LOS computations for hard surface maintenance, and these types of integration efforts should continue as part of UDOT’s statewide asset management effort.

The proposed migration to an Oracle database should be pursued, but with the involvement of potential end-users in Central and the field to ensure that the product can be used effectively by them.

The value of MMS would be enhanced through better output reporting. UDOT should update MMS report capabilities to meet current business needs for greater reporting flexibility, for greater ability to archive electronic reports, and for the production of an end-of-month report for reconciliation with FiNet. UDOT should download MMS output data from both the mainframe and the PC systems to a database, spreadsheet, or information reporting application that can work with this “snapshot” of the data. Standard and customized reports should be generated and formatted, and information archived, directly from the application.

Other capabilities that UDOT should develop include building in an end-of-month and end-of-fiscal year trigger within MMS to obtain a similar snapshot for a monthly and annual report. This would provide the ability to compare planned versus actual costs and accomplishments. Electronic copies of year-end reports may be useful in the future for analyses in connection with MMQA resource allocation: e.g., to track costs and accomplishments over several years (in conjunction with LOS from MMQA, for example), and to update computations of a “standard winter” using, say, a five-year rolling average.

The Feature Inventory should interact with MMQA as well as with MMS. Regional maintenance-operations engineers should be notified of construction project close-outs so asset inventories can be updated.

B. Feature Inventory

UDOT maintains a Feature Inventory to keep track of its infrastructure. This inventory has grown in importance due to its use for budgeting, scheduling, and managing work at maintenance stations. Like other data systems, the Inventory remains useful to the extent that it is kept up-to-date and provides reliable, relevant information.

This section reviews the existing approach, best practice in the field, strengths and issues, and recommendations for improving the Feature Inventory.

1. Existing Approach

This section summarizes the current computer system, the update process, and the interaction between Central and the regions.
a. **The Feature Inventory**

The Feature Inventory is a database that keeps track of features under the jurisdiction of UDOT. It covers items such as:

- Right-of-way
- Pavements
- Parking lots
- Shrubbery
- Rest areas
- Station surface maintenance

Because the system allows for microcomputer access, users can generate standard reports from their offices. These reports allow the user access to different types of information such as:

- Point-to-point segments
- District responsibility segments
- Left or right lanes
- Ramps and interchanges

However, the Feature Inventory does not allow the user to generate custom reports. A user familiar with the COBOL computer language could create such reports, but this is not the case for the majority of users.

Features in the Inventory are identified using the Route Number, Delineated Reference Posts, and offsets. The record includes some dimensions (such as the length of the feature), but does not include any performance characteristics. For example, the Inventory would identify the length of a bridge deck or a ramp, but it would not provide information regarding the thickness of a slab or its condition.

Roadway type is identified by top layer only. The surface can be bituminous, concrete, open graded, or gravel. Composite pavements are therefore not recorded as such. The thickness, age, and condition of the pavement are not recorded. Although a field exists for recording condition, it has not been used.

Roadway signs in the Feature Inventory are documented by location. Arc View is used to display the information by translating the linear referencing to GIS; this is done once a year.
b. The Computer System

The computer system that operates the statewide Inventory comprises the following elements:

- A mainframe in Central where the data is stored.
- A local area network (LAN) that connects staff within units.
- An Internet link to give the staff access to the database.
- Monitors and local printers to extract the reports in either a visual or written format.

c. The Feature Inventory Update

Individual station supervisors are responsible for determining additions or deletions to the Inventory that result from new construction, change in maintenance standards, or corrections to earlier recording errors. The modifications to the Inventory are submitted to the local Maintenance Analyst for review and approval. Once approved, the Maintenance Analyst updates station inventory totals, with the following exceptions. Only the Feature Inventory Analyst in Central Maintenance can alter information related to elements 100, 110, 120, 140, 150 and 170. In this case, the Maintenance Analyst is limited to reporting the desired changes to Central Maintenance. The Feature Inventory Analyst in Central Maintenance reviews and saves the changes made by the Maintenance Analyst. If necessary, changes are made to the six restricted elements. The Maintenance Analyst returns an updated printout of stations inventory to the originating station supervisor. When the Feature Inventory Analyst in Central Maintenance discovers an error, he corrects the Inventory.

d. Reliability of the Inventory

Central staff believe that out of the six locations, the Feature Inventory is very reliable in two locations, fairly reliable in two locations, and unreliable in two locations. Concern about the accuracy of the Inventory is shared by region and district staff.

In particular, there are problems with the accuracy of location information in the database. Crews are finding differences between measured distances and the mile delineators on the highway. Since linear referencing is used to record location, an error in the coordinates of the milepost automatically translates into an error in the feature location. In addition, some passing and truck climbing lanes have not been added to the Feature Inventory, although construction has been completed. This casts some doubt on the timeliness of information. However, UDOT is undergoing a location referencing initiative to improve the accuracy of location information statewide.
When pressed for an opinion, most interviewees indicated that, despite the 5 to 10 percent error rate in the database, the information is still reliable for planning purposes. However, the system used for the Inventory is considered antiquated and inefficient.

e. **Satisfaction with the System**

Most users expressed frustration with the existing approach. Interviewees complained about the slow operation, antiquated computer hardware, and the obsolete (non-Windows based) information technology employed.

2. **Best Practices**

Highway inventories across North America have been established for different purposes. To a large extent, those purposes determined the information collected. The information to include in the Inventory has to satisfy the business process it is supposed to serve. Some inventories are established to keep track of existing features and include a section identifier, location, and physical description. Other jurisdictions establish inventories to estimate the condition of their network and the extent of existing problems; these inventories include information on condition and recommended field solutions. Still others use an inventory for capital planning; they collect data including condition, usage, short-term traffic forecasts, and maintenance history. In recent years, state and local finance departments have shown an interest in an accurate feature inventory in order to comply with a Government Accounting Standards Board (GASB) directive\(^6\) to track public asset depreciation.

Other jurisdictions have wrestled with similar issues and have redesigned their inventory systems. In North America, both Pennsylvania and Ontario have developed advanced highway inventories. Their experience yields the following best practice principles.

a. **Have a clear purpose**

Inventories are established with a purpose: to keep track of existing features, to monitor asset condition, and/or for use in capital planning.

b. **Collect adequate information to satisfy the specified purpose**

Inventories can be small in the scope of information they contain or they can be very large. Large inventories include:

- Feature/asset identification (a unique number, name, location reference).
- Physical attributes (type, length, size, dimensions).

\(^6\) GASB 34.
• Condition (detailed measurements, condition indices).
• Usage (current AADT, commercial traffic, peak hour, short-term forecasts).
• Alternative strategies to address existing problems (preferred strategies, deferral strategies, holding strategies and their effectiveness duration).
• History of maintenance (last year of resurfacing, major maintenance activities, level of routine maintenance received).
• Cost data (the cost for implementing each strategy).

c. **Appoint a single custodian**

Inventories are treated as a corporate resource and not the property of any one office or district. For accountability’s sake, one office is assigned responsibility for administering and updating the inventory.

d. **Possess a flexible schedule for updating the information year round**

Those responsible for updating the database have full access to the Inventory at any time of the year. The information may be frozen one day per year for the preparation of an annual summary.

e. **Use reliable software**

Computer systems that break down too often increase user frustration and result in wasted time and money, thus increasing cynicism among staff. Users need reliability of operation, accuracy in calculations, and timeliness of information to meet their obligations at work. The following are other considerations for the computer system:

• **A relational database**

Today’s technology uses relational databases, which store repeated information only once. This makes the system less cumbersome and increases processing speed.

• **Automatic information feed systems from field counting stations**

Many agencies have either traffic counting stations or pavement temperature monitoring information in the field. Technology today allows this information to be downloaded to the mainframe as it is collected.

In the past, “telemetry” relied on the use of telephones to transmit data; now the same process is accomplished using satellite technology.
• **Separation between the information and the applications**
  Older technologies required writing small computer programs in order to input or retrieve data. Current technology creates the information base within a given architecture that meets all of the information needs of the organization.

• **A user-friendly interface**
  Results are accessed via a user-friendly interface program that the user can understand and manipulate. Users can prepare their own reports, graphs, or charts.

• **Capability to communicate with other corporate databases**
  The system is able to communicate with other corporate databases, transferring data between sources and eliminating the need for entering data in two separate databases.

• **Graphical display capabilities**
  Any information that can be obtained in a digital format can be presented in a graphic format.

3. **Strengths and Issues**

  a. **Strengths**
     
     • Both Central and region/district staff recognize the importance of maintaining a feature inventory.
     
     • UDOT has a Feature Inventory that is operational and has been useful for planning and budgeting.

  b. **Issues**
     
     • Although the Inventory has been updated annually, it has not been subject to a major review.
     
     • Regions do not have adequate reports.
       There are standard reports that can be generated, but generating special reports requires assistance from Central.
     
     • Information is inaccurate and is not kept up-to-date.
       Milepost locations were found to be wrong in some circumstances, resulting in incorrect information regarding the location for all associated features.
     
     • Field staff lack training on data collection and inspection.
• The Inventory scope is limited.
• Age, condition, and usage data should be included in the same system.
• The existing system is not user-friendly.
• The user interface is cumbersome. The system is perceived as too slow, especially for remote operation.

4. Recommendations

Recommendation 14. Coordinate the Feature Inventory with the overall framework for asset management.

The framework for asset management will guide further development of the Feature Inventory. These guidelines will help to determine whether the Feature Inventory should be kept separate or integrated into another management system, what software to use, what security levels should be established, and what user interface will be used.

Recommendation 15. Prepare a complete development and implementation plan for any changes to the Feature Inventory.

The implementation plan should include the following steps:

• Determining the current and future purposes of the inventory.
• Identifying the business processes and procedures, including level of accuracy required.
• Defining responsibility for maintaining and updating the inventory.
• Coordinating data collection with other UDOT divisions (e.g., the Pavement Management Group).
• Conducting software evaluation and/or procurement process.
• Selecting software.
• Implementing business process and software.
• Training staff.
• Conducting ongoing upgrades, quality assurance, and training.

Recommendation 16. Allocate additional resources for the collection of inventory data.

Additional staff may be required at the station or region/district level to accommodate increased workload. Alternatively, a Central team could be assigned responsibility for collecting information statewide.
C. Pavement Preservation

UDOT Preservation Contracts, also known as Orange Book Contracts, cover projects that are less than $2 million and are limited to pavement and bridge decks. Orange Book Contracts include overlays (up to 1.5 inches), chip sealing, slurry sealing, slab jacking, slab replacement, and minor corrective work. They also include service projects such as flagging, traffic control, painting, and striping. The program totaled $45 million in fiscal year 2002, funded by both federal and state money. Because of the federal involvement, half of the program amount is required to go to Interstate and National Highway System (NHS) highways. FHWA promotes pavement preservation as a way to obtain the maximum service life for pavements.7

1. Existing Approach

a. Central Maintenance and the Regions

The pavement preservation process is decentralized. The regions analyze and evaluate pavement and deck conditions; they also identify projects and generate solutions. Central plays a supportive role that includes coordinating budgets, ensuring compliance with Orange Book requirements, assigning project numbers, processing regional requests, optimizing available funds, and helping to solve problems associated with the process. Central divides the budget allocated by the Legislature among the regions based on a formula endorsed by the Operations Engineers in their monthly meeting. Central also advertises the contracts.

As regions identify the location of a project, they notify Central and a project number is issued. The project number is used to track the project’s progress through the Project Development Business System (PDBS), which is maintained by the Construction Division.

b. Overview of the Process

The Central contract technician allocates a percentage of the budget to the regions based on a needs formula developed by the Pavement Management Engineering Team in 1996. Due to a shortage of funds, this formula is now under review.

After Central develops the budgets, they are reviewed with the regions. The regions prepare prioritized lists of preservation projects. The process is not uniform and varies by region. The project specifications and construction guidelines are also developed in the regions. The regional environmental unit handles the environmental assessments and category exclusions.

The proposed project lists are reviewed on a state level. If one region is not ready to make use of available funding, the money is moved to a region that is ready. The process also involves some bartering of contract work with state crews. Once approved by the Commission, regions are notified of their allocation and the projects are submitted to FHWA for funding approval.

Once advertised, the projects are handled by the Construction Division. The Construction Division ensures that contractors are prequalified, administers the bids, prepares the contracts, administers the contract implementation and payments, approves or rejects the change orders, and works with the Legal Office, if necessary, to address matters such as contract breaches.

c. Region/District Approaches to Generating the Candidate Project Lists

Although regions and districts propose projects based on a visual inspection of the roads, the approach from one region or district to another is far from uniform. Each region and district has developed its own process to accomplish the task.

- The Richfield District of Region 4 indicated that they generate a list of candidate projects based on a ranking of road conditions. The list is then submitted to the Pavement Management Group, which forwards a modified list with comments to Central for review.

- The Cedar District of Region 4 presented a more systematic approach. The Pavement group from Region 4 evaluates the pavements and develops strategies for addressing performance problems. Those strategies are classified under routine maintenance, preservation, betterment, rehabilitation, or reconstruction. The preservation projects comprise the core group for the program. By reviewing the available budget, the list is then modified.

- In Region 2, the Pavement Management Group identifies and proposes Preservation Contracts to extend the life of good roads.

The setting of priorities is not uniform within the regions either. Some regions indicated that they use standard criteria such as condition and usage. Others indicated they use consensus building among Area Supervisors, Station Managers, and the Maintenance Analyst.

Central was clear about the division of roles and responsibilities between Central and the regions. However, Central was not aware of the different processes being used to identify the proposed work, nor was it aware of the different criteria used for ranking the proposed work. However, it was noted that communication between Central and the regions continues to improve.
2. **Best Practices**

In a recent AASHTO survey, 34 of 40 highway agencies reported that they have established preventive maintenance programs.\(^8\) A review of accomplishments indicated some common factors among successful programs. The following are the major principles in identifying preventive maintenance work.\(^9\)

**a. Accept the philosophy of preservation across the agency**

Developing a preventive maintenance program requires a shift in thinking from rehabilitation and reconstruction to preservation. Accepting a preventive maintenance philosophy is an important factor in successfully managing an agency’s pavement program. This philosophy may be more difficult to convey than most technical issues. It requires long-term commitment and financial support from the organizational leadership. Benefits to the highway network may not be immediately recognized.

Agencies that are committed to designing and building long-lasting pavements focus their maintenance activities on preserving roadway surface courses with low-cost seals and thin overlays. These treatments protect the investment in the roadway and postpone more costly methods of rehabilitation.

**b. Apply preservation activity to roads in good condition**

Transportation engineers are accustomed to a project selection process characterized as “worst first.” However, most preventive maintenance treatments are thin surfacings that require good underlying support. If the road is badly deteriorated, the integrity of the structure is diminished and the treatment life is substantially reduced.

Pavement preservation focuses on “keeping good roads good.” Treatments must be applied in a timely manner to preserve the structure of the pavement. Distressed pavements may not be suitable candidates for preventive maintenance. Successful preservation requires treating pavements earlier in the distress cycle.

**c. Include preservation as part of a comprehensive management plan**

Jurisdictions with successful preservation programs have developed a comprehensive road investment plan covering a specific planning period. Some develop a plan every five years. Others use a rolling five-year improvement plan,

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\(^9\) Principles are drawn from the Foundation for Pavement Preservation (FP²), Pavement Preventive Maintenance Guidelines, Updated March 27, 2001 FHWA, *Focus*, December 2001, “Scanning the globe for pavement preservation innovations.” [www.tfhrc.gov/focus/dec01/innovations.htm](http://www.tfhrc.gov/focus/dec01/innovations.htm)
which is developed annually using Pavement Management System (PMS) data and funding optimization strategies.

Some jurisdictions take a different approach to management by implementing long-term maintenance contracts (10 years) that give control and responsibility for roadway system maintenance, rehabilitation, and capital improvements to private contractors. These contractors are expected to produce comprehensive road investment plans that maintain the condition of the roads at specified levels.

d. Welcome innovation to meet constraints and achieve maximum benefits

High-quality materials are costly, which makes preservation even more important. Successful programs develop mechanisms to evaluate and implement new and innovative pavement preservation processes. Some of the success stories include:

- In jurisdictions that make extensive use of chip seals, innovative approaches to improve performance include pre-coating the aggregates and using polymerized asphalts to ensure a quality seal.
- Some jurisdictions have developed a “Charter of Innovation” system through which the government and industry share the risks and rewards of developing new products and applications.
- A crack activity meter was designed to measure surface cracking and the need to repair a road surface before applying a traditional overlay.
- Use of sandwich seals with a two-coat, geotextile-reinforced treatment has resulted in surfaces with 11-year acceptable performance ratings.

e. Provide focused training

To implement a pavement preservation program effectively, top management and maintenance staff should be educated about pavement preventive maintenance methods, purpose, and priorities.

f. Educate the legislature and the public

An effective preventive maintenance program requires adequate funding. In order to ensure that funding continues, the legislature and public need to be made aware of the long-term financial benefits of preventive maintenance.
3. **Strengths and Issues**

   a. **Strengths**

   - **Good customer service from Central.**
     Most interviewees believed that paperwork processing and general customer service from Central, and particularly from the Central contract technician, are good.

   b. **Issues**

   - **Unpredictable funding.**
     Funding for pavement preservation fluctuates year to year. Region interviewees believed that a lack of consistent funding indicated that lawmakers do not understand the importance of pavement preservation.

   - **Inconsistent approaches in the regions.**
     Each region and district prioritizes according to its own system for pavement preservation. This inconsistency undermines a statewide asset management approach.

   - **Inadequate training.**
     Region and district interviewees stated that pavement preservation has not been a focus of training.

4. **Recommendations**

   The following are recommendations for improvement in Central’s pavement preservation function:

   **Recommendation 17.** Adopt a funding approach that stabilizes annual Orange Book funding commitments as much as possible to ensure continuity in meeting preservation objectives.

   Pavement and bridge preservation depend upon consistency in funding and practice for early intervention in the asset lifecycle before damage occurs and propagates. This need for finding consistency is supported by the AASHTO and FHWA reviews of current preventive or preservation practices across the U.S. FHWA identified clear process and dedicated funding as two major criteria for the success of preservation programs.

   While a preservation strategy would ideally be part of an overall pavement management plan, the preservation program at UDOT is driven by funding
availability. UDOT can take steps to try to secure additional dedicated funding for this program, but realistically a constrained and potentially varying funding level from year to year may need to be dealt with. Following are pragmatic recommendations to deal with this funding component:

- Central should explore a stable level of dedicated funding for this activity by the Legislature. Support materials documenting the benefits of preservation programs can be obtained through the Foundation for Pavement Preservation, AASHTO, FHWA, and other states.

- Central should work with regions/districts to develop a more flexible approach to project proposal and funding. This approach would be analogous to the LOS-based approach in MMQA (where maintenance service levels can vary in response to available funding), and to prioritization and tradeoff analysis methods used in capital programming to match project and program commitments to funding targets. This approach could be based, for example, on identifying three tiers of projects: a high-priority pool of projects (e.g., on the most important highways) where the benefits of preventive strategies are likely to be greatest and for which funding is highly likely; a moderate-priority pool of projects for which funding is likely in most years; and a low-priority set of projects that will be deferred if funding is reduced.

**Recommendation 18. Promote greater consistency in region/district approaches to project identification and selection.**

Given the limited funding available and the importance of preservation projects to sustain the value of pavement and bridge investment, it is important that the preservation projects represent good decisions reflecting the asset management concept of the most cost-effective solution to extending asset life. Suggested approaches involving both Central and field managers include the following:

- Work with field managers to develop good information about different pavement treatments: i.e., their cost range, the pavement life expectancy that can realistically be expected, the conditions under which each treatment is best applied, and the most effective combination or sequence of treatments that should be considered as part of a systematic approach to good pavement management. While differences in experience with and preference for treatments is to be expected, this exercise will help to promote a greater shared understanding of the cost-effectiveness of treatments under different conditions, identify specific topics that must be considered by the UDOT Methods Engineer and research program, and provide updated information for UDOT’s PMS.

- Develop project recommendations that are consistent with recommended strategies in the PMS, including updated information on treatments from the preceding step. It is important that field practice be consistent with PMS data and recommended strategies, so that a systematic approach to pavement management is sustained over time.
• Develop agreed-upon business practices and guidelines for reviewing candidate projects in the field and identifying likely causes of distress and preferred treatments in each case. This approach does not need to be overly prescriptive, but it should establish a reasonable basis for relating needed work to current pavement conditions, consistent with the suggested priority approach discussed in Recommendation 17.

**Recommendation 19. Develop a course outline for preservation work, including plan development and training material for the course.**

Best practices highlight the importance of education and training for management, staff, and contractors. Training must emphasize the importance of the roles that materials, proper workmanship, and quality control play in the success of the program. For example, traffic control is extremely important for some treatments that require time to cure. Training should emphasize the importance of cooperation and coordination of operations before, during, and after fieldwork. Technical topics should include:

- Correct methods for preservation applications.
- Proper handling of materials.
- Importance of quality control.
- Coordination of field operations (particularly traffic control).

The training should also provide background on the advantages of preservation work, and the need for systematic approaches to project identification and selection. Topics should include:

- Preservation as a key component of least lifecycle cost strategies for pavements.
- PMS treatment of preservation work.
- Using the PMS to help identify candidate projects.

Focused training should be developed for:

- Central and region/district staff in charge of planning, managing, and preservation work.
- Region/district staff who are involved in the actual construction and supervision.
- Contractors regarding technical issues and operational expectations. Training could be required as part of the prequalification process.

**Recommendation 20. Develop an external relations program.**

Legislative and Transportation Commission support is vital to maintaining adequate funding for the preservation program. Cost-effective preservation of existing assets is a wise use of public tax dollars needs to be communicated. It is also important to
communicate the need to work on highways that are in “good” condition, and the cost of transitioning from a “worst first” to a “preventive” strategy. UDOT needs to identify a realistic policy that the Legislature and the Transportation Commission will understand, support, and fund. For example, some agencies have found that a hybrid approach that combines preventive and worst-first strategies in an acceptable mix of work meets the objectives of a preservation program while avoiding the public perception pitfalls that “good” roads are being maintained at the expense of “damaged” roads. Other agencies have successfully transitioned to a true “least lifecycle cost approach,” but have done so with the backing of state law which requires such an approach and requires accountability through the provision of comprehensive PMS condition reports demonstrating the long-term improvement in pavement network condition.

D. Lands and Buildings

Lands and Buildings is a Central function that ensures the timely maintenance and replacement of UDOT maintenance buildings and facilities (including rest areas, maintenance stations, storage sheds, and the land beneath and around these buildings). The following section reviews the existing approach, best practice in the field, strengths and issues, and recommendations for improvement in the area of Lands and Buildings.

1. Existing Approach

Lands and Buildings has a budget of approximately $1.8 million, allocated to the regions by the Central Maintenance Unit Facilities Manager. The allocation is roughly equal among the regions/districts, which translates to an annual payment between $100,000 and $300,000 per region or district. However, when an extraordinary need arises in a region, that region may receive a larger portion of the budget for that year. For example, the Price District had problems with the building systems in its offices. The heating, ventilation, and air conditioning system replacement required substantial funds from the Lands and Buildings budget. Beyond extraordinary need, the budget is allocated among regions based primarily on equity and historical funding levels, rather than on facility needs.

a. Prioritization and Funding of Capital Building Projects

Budgets are finalized before July 1, the beginning of the fiscal year. In mid-June of each year, each region/district submits budget requests to the Central Maintenance Unit Facilities Manager. These budget requests vary in form and detail. However, the requests include a project list and an anticipated budget. Each region and each district of Region 4 is individually responsible for identifying and prioritizing the building projects that are included within the budget request. The Central Maintenance Unit Facilities Manager reviews the budget requests, but he does not change priorities determined by regions and districts.
b. Construction Procurement and Management

The regions manage construction projects completed with in-house labor. These projects are usually small jobs such as painting or plumbing. The Central Maintenance Unit Facilities Manager prepares bid documents and manages capital improvement projects that are not performed with in-house labor. Central performs this function in order to take advantage of specifications that have been used before and can be modified to fit the specific job. Capital development, or new construction projects, are also the responsibility of the Central Maintenance Unit Facilities Manager. However, building projects over $100,000 require the involvement of the Division of Facilities Construction and Management (DFCM), a Utah agency separate from and external to UDOT.

c. Rest Area Maintenance

Responsibility for cleaning and maintaining the State’s rest areas was recently contracted to a private vendor. The Central Maintenance Unit Facilities Manager manages this contract. MMQA is used to manage the contractor in charge of rest area maintenance by establishing and monitoring contract performance standards. The Central Maintenance Unit Facility Manager visits the 42 rest areas quarterly to inspect them.

2. Best Practices

Based on our understanding of Lands and Buildings and through our prior experience with successful facility planning studies, including those for the States of Washington and Utah, we have identified that best practice includes following a master plan.

Exhibit III-2 illustrates the components of a master plan.
Exhibit III-2: Components of a Master Plan

- **Goals**: establish the direction for the capital planning period. Goals are specific and measurable. The following are examples of potential goals for UDOT’s Lands and Buildings function:
  - To provide adequate maintenance stations in all locations.
  - To ensure that all rest areas are maintained according to MMQA standards.

- **Strategies**: are the approaches to goal implementation. While goals are “what” is to be accomplished, strategies define “how” the goals are to be accomplished. Following are examples of strategies to implement the above goals:
  - Replace obsolete stations according to capital plan and fully fund preventive maintenance for all current stations.
  - Enforce contract requirements on quarterly rest area inspections.
Standards serve as the guidelines for planning and provide for statewide consistency. Setting standards involves functional programming, or matching the facility needs to the function the facility provides. Examples of facility standards are construction standards, heating, ventilating, air-conditioning (HVAC) standards, plumbing standards, electrical standards, safety standards, and access standards.

Inventory condition information is the aggregate facility data reflecting both the extent and the condition of state facilities. The information can be used to determine the total scope of deferred maintenance, repair and rehabilitation, and the benefits of alternative strategies to address the same.

Needs assessment data represents the difference between the facility standards and the current inventory condition information. In other words, a needs assessment provides the cost of bringing all facilities up to the standards.

Communicating funding levels for the program is important to show any gap that exists between the facility needs and available resources. This gap represents what needs to be presented to policy makers, who can develop a plan to address the need.

- The Department has an accurate, up-to-date facility inventory and condition assessment that allows for prioritization of capital projects by need. Each facility should be surveyed regularly to evaluate and document its current condition.
- Agencies with automated information resources such as real property inventory databases are usually well positioned to collect, input, manipulate, and update data regarding the cost-effectiveness of maintenance and repair expenditures.
- Priority setting procedures are logical and clearly communicated to all those involved in facility planning.
- Preventive maintenance is well defined and procedures are in place to identify when preventive maintenance is needed.

3. Strengths and Issues

a. Strengths

- Most of those interviewed in the regions feel that the distribution of funding among regions is fair.
- The contract for rest area maintenance is working well.

Audit interviewees noted that rest area level of service improved after this maintenance contract was outsourced. A new contractor, combined with better contract specifications, improved the level of service even more.
b. Issues

- Central has not articulated goals or strategies for Lands and Buildings.
  The relationship between building maintenance and roadway maintenance is also unclear within the organization. UDOT managers and field personnel were uncertain whether good roadway maintenance requires well-maintained maintenance stations.

- Central has not used consistent standards for maintenance facilities.
  Several region/district interviewees stated that UDOT spends more money than necessary to construct buildings, indicating that some standards may need to be reviewed. Interviewees reported their belief that counties have built similar stations for a fraction of the cost of a new UDOT station.

- Condition surveys have not been performed on most maintenance stations. Only 10 of the more than 70 maintenance stations statewide have been surveyed.

- There is no management tracking system for identifying building needs.
  While the Central Maintenance Unit Facilities Manager speculated that needs are approximately evenly distributed throughout the regions, no system has been established to verify that equity.

- There is a backlog of Lands and Buildings needs.
  Most region/district offices are over 40 years old; most of the maintenance stations were also built in the mid-1950s and early 1960s. Many stations are too small to house the equipment assigned to them. In some areas, plows are raised and trucks are parked against the wall in order to fit them in the garage, which is dangerous for the equipment and the operators. In other areas, trucks are parked outside, which requires frequent replacement of batteries in the winter. Diesel trucks parked outside also take longer to start, which lengthens the station’s response time to snow removal or emergencies.

4. Recommendations


A master plan will require UDOT to identify goals, strategies, and standards for the Lands and Buildings. The master plan development should involve all those responsible for facility planning at the region/district level. Once the plan is developed, it should be distributed to the regions. Facility management, including project prioritization, should be done in accordance with the master plan.

Recommendation 22. Perform condition surveys on all maintenance facilities.

Condition surveys provide facility managers with a planning tool enabling them to forecast maintenance, repair, and rehabilitation requirements for both new and existing
facilities. Condition surveys also provide a better method of forecasting short- and long-term expenses. Condition surveys enable facility managers to determine necessary annual building maintenance costs, quantify the consequences of deferred maintenance, and identify the total lifecycle cost of facility ownership. Development and effective use of this information will allow agencies to protect their original investment, ensure continuous use of facilities, and reduce the possibility of expensive repairs and renovations. Routine, reliable information on facilities and conditions will:

- Rate and rank facilities according to their current physical condition and performance.
- Determine deterioration rates and the optimal time to undertake maintenance and replacement of each facility.
- Reduce the likelihood that maintenance and replacement will be unduly deferred or be undertaken before they are needed.
- Build a more effective constituency for capital upkeep by providing policy makers with reliable information and projections of the consequences of underspending for capital facilities preservation.

**Recommendation 23. Establish a building management system.**

Inventories of facilities can permit managers to track problems, identify facilities most likely to need maintenance attention, and coordinate capital repairs of other facilities at the same location.

**Recommendation 24. Prepare a case for allocating additional funding for Lands and Buildings.**

Without convincing, well-supported arguments for facility needs, policy makers will devote limited public resources to more pressing needs. Once master planning and condition surveys are completed, UDOT will have information to present to the legislature on building needs. In addition, UDOT should articulate some of the consequences of building neglect, including:

- Threats to health and safety.
- Service failure (power loss or HVAC failure).
- Excessive operating costs (wear and tear on equipment that does not fit into old stations).
- More expensive repairs and replacement costs (where minor building failures lead to a major failure).
- Social costs (absenteeism and decline in morale).
IV. Budgeting

A. Maintenance Management Quality Assurance (MMQA)

1. Existing Approach

a. MMQA Description

Utah’s MMQA was patterned after that of the State of Washington. The MMQA was designed to “provide a clear link between maintenance objectives, maintenance activities, maintenance levels of service, the budget, and actual performance.” It is a tool that can “clearly communicate to [UDOT’s] key customers, the Legislature, the Governor, the Transportation Commission, and ultimately the tax paying public, the impact of policy and budget decisions on program levels of service.” MMQA is also used to group the different maintenance activities under general maintenance functions. UDOT has designated the following 10 MMQA “activity groupings”:

- Snow and Ice Control
- Hard Surface Maintenance
- Non-Hard Surface Maintenance
- Roadside Maintenance
- Vegetation Control
- Drainage and Slope Repair
- Major Structure Maintenance
- Traffic Services
- Supervision, Training, and Support Maintenance
- Rest Area Maintenance

To meet these objectives, the MMQA consists of a number of elements.

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(1) Levels of service

The most important element of the MMQA plan is a set of levels of service (LOS). Levels of service define a quality of maintenance, either existing or proposed. LOS values are expressed through five letter grades, A through D and F. A represents the highest maintenance level, resulting in roadway and highway features in excellent condition. F represents the lowest maintenance level, resulting in roadway and highway features in poor or failing condition.

Levels of service are related to maintenance activities. For each activity, the LOS is defined in terms of the following:

- A condition indicator: some aspect of road condition that is to be measured (e.g., pavement potholes).
- A performance measure: a measure involving the condition indicator that will be used as a trigger for maintenance to be performed (e.g., number of potholes per lane-mile).
- Threshold values: the value of the performance measure at each LOS value (e.g., numbers of potholes per lane-mile corresponding to LOS A, B, C, etc.).

For some activities, such as rest area maintenance and snow and ice control, the condition indicators and performance measures are either complex or vary by type of facility (e.g., functional classification, AADT level, building component or services). In such cases the condition indicators and performance measures are organized in matrices and are referred to below as “matrix criteria.”

(2) Highway condition surveys for maintenance

A second element of the MMQA plan is a procedure for surveying condition information that is needed to determine current LOS for each activity. Conditions are surveyed semi-annually in 25 sample sections selected for each maintenance station (12 stations are surveyed in autumn, 13 in spring). Station supervisors select the set of 12 or 13 sample sections from a list of 20 randomly generated highway sections. Each sample section is 0.1-mile long. On undivided highways, both directions are surveyed; on divided highways, only one direction (all lanes) is surveyed. Condition measurements are taken for items corresponding to eight of the 10 MMQA activity groups.

Within each sample set of 12 or 13, three sections are selected as QA sections and are reviewed by a QA team comprising the Region Director, Region Operations Engineer, Region Maintenance Analyst, and Area Supervisor. The QA sections are used to compare LOS results to the station survey results.
(essentially a quality control check), help develop the budget as a function of LOS threshold, and prepare a status report on current condition.

UDOT performed a statistical analysis of sample requirements during MMQA development, using the procedure described in Appendix D. The number of required sample sections per station that was originally computed using this procedure was felt to be too great a data collection effort for the stations. Therefore, UDOT adopted the minimum recommended value of 25 sample sections as its annual sampling approach at each station. The Technical Appendix reviews the statistical significance of this sample size.

(3) LOS-activity cost relationship

A third element of the MMQA plan is establishing a relationship between LOS value and the cost of performing maintenance to that LOS. UDOT has estimated these relationships through regression analysis of data on maintenance expenditures by activity in each region and LOS values observed for these activity groups in respective regions. This approach to initial model development, using field data in lieu of managerial judgment on the relative cost to perform maintenance at different levels of service, is unique among state DOTs that base maintenance budgets on levels of service. Another unique aspect of UDOT’s approach is the identification of individual models for each activity and each region. Other DOTs, by comparison, develop models by activity group at a statewide level, with differences among regions accounted for through different baseline expenditure levels. Further information on UDOT’s LOS-maintenance cost models is contained in Appendix D.

(4) Analytic tool

A fourth element is using the Oracle database as an analytic tool to organize the above information and to exercise the cost model to compute the impact of level of service on budget.

(5) Documentation and training

A fifth element is documenting the implementation of the MMQA plan through written descriptions, work sheets, data collection forms, instructions, and training notes. All this data is then used to conduct training for users at all levels.

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11 “Baseline expenditure levels” in this context refers to the annual expenditures by a region to perform maintenance in each activity group at the current LOS value for that group.
b. MMQA Usage

MMQA usage varies throughout the Maintenance organization.

(1) Central

Central uses MMQA for the stated purpose of testing the budget implications of proposed target LOS, which can then be used to provide information in support of a budget request. In this sense, there is an implicit linkage between MMQA and MMS, since MMS expenditure data for the most recent completed fiscal year is used as a basis for the LOS-expenditure relationship described above. This linkage is not automated, however.

While none of the Central interviewees described MMQA in terms of a “performance-based approach to resource allocation” or “an implementation of maintenance quality assurance concepts,” there is an understanding at the executive level that MMQA can play this role.

(2) Region 1 MMQC

Region 1 has understood the resource allocation and quality assurance implications of MMQA and has implemented the techniques throughout its regional maintenance organization. To meet the needs of regional, area, station, and crew managers, Region 1 has made some changes to several elements of the MMQA. It refers to its methodology as “MMQC” (for Maintenance Management Quality Control) to distinguish the two systems. Examples of these changes are as follows:

- Region 1 surveys 100 percent of its maintainable assets rather than a random sample of 25 locations.
- Region 1 has changed the condition measures and units of selected activity LOS (e.g., the definition of an unacceptable edge rut, and the measure of vegetation hazards).
- Region 1 has adjusted the threshold values of selected activity LOS, e.g., it increased the LOS A threshold for Litter Pickup, and it increased the LOS A threshold for Repair and Replace Signs. It also rounded some thresholds (e.g., changed “17 percent” to “15 percent”).
- Region 1 has imposed a particular interpretation on how LOS thresholds should be used. Supervisors wait until a number of items reach the LOS threshold, then address all items at once. Advantages to this approach include economies of scale in the work operation, and a clearer record before and after of the actual condition of field items and what it takes to maintain them.
In addition to these changes, Region 1 managers propose several other changes to MMQA to make it more useful:

- Highway sections used for surveys and analyses should be selected by construction project segments rather than 0.1-mile segments based upon milepost location. Since project segments are homogeneous with respect to road structure and AADT, maintenance needs can be correlated with project performance and remaining service life. Road characteristics can also be correlated (e.g., a section that has curb-and-gutter does not experience shoulder drop-off). Also, many project segments are longer than 0.1 mile, increasing the probability that features such as guardrails and delineators are present in sufficient quantity to provide a meaningful condition measure. The Pavement Management System (PMS) recognizes construction project segments; the Feature Inventory does not.

- Certain LOS should allow for multiple units of measure. The reason is that LOS and its associated condition indicators can reflect different ideas in different contexts: e.g., a basis for reporting total distress, a basis for estimating maintenance level of effort or cost, a basis for reporting accomplishments in terms of outputs (such as damage repaired), a basis for reporting outcomes (such as impact on road users), and a basis for comparing cost or accomplishment with that of the private sector. Conversion factors could be estimated to relate the multiple measures for a given activity.

- LOS threshold values should reflect a customer orientation.

- LOS standards should be reviewed and discussed with field managers. For example, is the use of a “fist-sized” criterion for litter pieces too small?

- MMQA data need to be checked for accuracy. The MMQC process suggests that some items are close to being accurate, while others are not.

- Only data useful for budgeting should be collected.

(3) Other Regions

Other regions have not implemented MMQA to the extent that Region 1 has, and the overall opinion about MMQA might be summarized as “great in theory, problematic in practice.” Some regions have used MMQA in the past, but are no longer using it. Others continue to use it, but for selective purposes only, such as deciding if a station needs an adjustment in funding. Examples of perceptions and concerns include the following, in no particular order:
- LOS measures and thresholds are inconsistent between “condition” and “level of effort.” Serious data consistency problems exist in reporting field conditions. Some measurements are unnecessary (e.g., LOS for mowing, though performed only once a year) or should be simplified and rationalized (e.g., does not distinguish between single and batwing mowers, or consider patched potholes “fixed”). Objectivity and reliability of measurements must be improved, particularly for subjective assessments, such as reflectivity of paint. (One suggestion was to use a single inspection crew statewide.) Field staff must be involved in revising MMQA measures.

- A role must be defined for MMQA by management and communicated to the regions. In the past, inconsistent messages about MMQA’s objective included “will be used to market needs,” “will be used to set budgets,” and “will be used to improve quality.” One perception is that management has not determined how MMQA should be used. Another perception is that MMQA is a tool for staff to measure how well they are doing, and that MMQA relates effort to outcome. While the concept is sound, the results are not used in presentations to the Legislature.

- More feedback is needed. Station supervisors do not get results of the MMQA reviews. It is not clear what LOS values are appropriate: e.g., is a LOS C or LOS B good enough.

- Sample sections 0.1-mile long are too short to yield meaningful condition survey results. The purpose of data collection is unclear. Measures “seem wrong” and are poorly timed.

- The interface among MMQA, MMS, and the Feature Inventory is cumbersome.

- MMQA Training is needed. One aspect of training should be greater consistency across districts in field measurement and guidance on how to make inherently subjective judgments (such as litter pickup) more reliable.

- MMQA is a good idea, but it is not ready to be used for budgeting.

2. **Best Practices**

   Best practices in MMQA are drawn from reviews of state practices that have been conducted by the Dye Management Group, Inc. with background from a national study on the subject.  

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a. Condition of maintainable highway features

- Conditions for maintained highway features are defined by agency standards and customer perceptions.
- Standards of maintenance are defined by the agency that identifies thresholds for maintenance intervention or thresholds at which road users perceive conditions to be deficient.
- Condition data are updated regularly though periodic inspection of the highway network, following procedures that are defined for statewide use.
- Statistical sampling may be used to obtain a valid indication of highway network conditions at less time and expense than would be necessary to monitor the complete network.
- Periodic customer surveys and focus groups are conducted to understand their perceptions of current highway condition, the quality of maintenance that is being provided, and the desired maintenance level of service.

b. Maintenance Levels of Service (LOS)

- LOS are defined for all maintenance activities or for the features or services addressed by respective activities.
- LOS are related to measures of condition discussed above, or to specific levels of performance of maintenance services.
- LOS represent measures of maintenance outcomes.
- LOS are used to express both current status of the maintenance program and target values to help guide budget decisions.
- Different LOS values may be defined for different subsets of the highway network by stratifying the network: e.g., by pavement type, road functional class, daily traffic level, criticality for winter maintenance, and so forth.

c. Analytic and information support

Analytic procedures have been developed and are used to support the maintenance condition survey and determination of current LOS in the following areas:

- If a statistical sample is used, the random selection of highway sample sections.
- Methods to record the condition of each maintained feature at each location surveyed.
• Roll-up of condition results by maintenance program area\textsuperscript{13}, district or region, and statewide.

• Translation of condition results to current LOS values.

Existing MMS data is used in MMQA to the maximum extent possible. Data is rationalized if needed for use in MMQA. Data “rationalization” means the following:

• The inventory of maintainable features is complete and accurate, is updated periodically, and identifies the district and field units responsible for maintenance.

• Maintenance activities defined in the MMS cover all of the items on which crews spend time as unambiguously and completely as possible.

• There exists a well-defined correspondence between maintenance activities (and their units of accomplishment) and specific items in the inventory: i.e., highway features in the inventory are addressed when a particular maintenance activity is performed.

• Units of accomplishment are in physical measures of outcome, if possible.

• Technical assumptions needed for MMQA calculations (e.g., the volume of an “average” pothole) are estimated in consultation with maintenance employees, and in a way that results in credible, representative values.

Analytic procedures have been developed and are used to support data transfers from other systems where applicable: e.g., to convert pavement or bridge management data to equivalent condition measures needed for maintenance, and to relate them to LOS.

Analytic procedures have been developed and are used to process several steps in an MMQA approach:

• To process the input of target LOS values by maintenance program area and region/district.

• To compute the maintenance level of effort by activity and district/region to achieve target LOS values.

• To compute the total cost by activity and district/region to achieve target LOS values (e.g., performance-based budgeting).

• To roll-up LOS and cost data by program area and district or region.

• To produce and display reports.

\textsuperscript{13} A “program area” is a group of related maintenance activities: e.g., all hard-surface activities, winter maintenance activities, and so forth.
d. Executive and political acceptance

Agency executives are briefed periodically during the MMQA design and development process to ensure the following:

- Executive-level buy-in to the objectives and proposed operation of the MMQA approach.
- Discussion and comprehension of key elements by senior managers as to the basics of the highway survey methodology, the way in which LOS measures will be implemented, and the procedures and reports for performance budgeting.

Members of the Transportation Commission and applicable legislative committees are likewise kept informed of the concepts of MMQA and its characteristics:

- The concept of MMQA as a performance-based approach to program development, budgeting, and monitoring.
- Definitions of LOS across the several maintenance program areas and ways to communicate LOS values easily.
- The uses of LOS in an MMQA approach:
  - Target LOS values as expressions of maintenance policy and priority.
  - Currently observed LOS values as measures of system performance and a basis of management accountability.
- Their roles in deciding maintenance LOS values across program areas and regions/districts.
- The application of these elements in “scenario testing” or “what-if” analyses to relate levels of maintenance expenditure to level-of-service outcomes.

e. Implementation and support activities

The MMQA process is used by the agency to explore program options and to recommend a maintenance program budget to the Transportation Commission. The Transportation Commission may ask the agency to investigate other options and to report on projected expenditures and LOS impacts. The final maintenance program budget that is recommended to the Legislature is based on the MMQA process. MMQA elements and procedures are documented in the form of instructions, manuals, or guidelines. Input forms are developed and used regularly for condition surveys. Crews are assigned each year to specific highway sections for condition surveys, preferably outside their home station and district. These crews receive training in survey procedures and proper data input. Quality control procedures ensure that condition surveys are conducted consistently statewide. Periodic meetings of Central and region/district staff review the conduct and status of the
MMQA program to suggest improvement. Accepted improvements are implemented system-wide and are carried out expeditiously.

3. **Strengths and Issues**

   a. **Strengths**

   The strengths of MMQA are found in the way it has brought together the concepts of maintenance quality assurance into a working product. In most of the “tangible” elements of a quality assurance application described above (LOS, surveys of highway condition, LOS-cost relationship, analytic tools, and documentation), UDOT is on a par with other states that have implemented these applications (e.g., Washington, Colorado, and Arizona). It is in the “intangible” aspects of the best practices that shortcomings have occurred. Training is one area where UDOT may need improvement. This peer relationship with other states is not to imply that UDOT is at a state-of-the-art level; California has implemented a very sophisticated system that, in its scope, detail, and cost of product exceeds the quality assurance products of the other state DOTs. Nonetheless, MMQA is a practical, workable product that would compare well to the systems of the three other states cited above. For this reason, Arizona, Colorado, and Washington are referred to below as “peer” states.

   b. **Issues**

   The disparity of opinion on MMQA is likely due to shortcomings in the “intangible” best practices discussed above:

   - Lack of a demonstrated, clearly communicated need and rationale for MMQA.
   - A failure to engage other internal and external stakeholders during MMQA design and development.
   - The fact that MMQA has been implemented (but not necessarily designed) at a much more decentralized level than other comparable DOTs have done.
   - Lack of a statewide customer perceptions survey tied to MMQA.

   These reasons have been deduced from interviews conducted at UDOT and a comparison of UDOT’s implementation to those in Colorado and Washington.

   (1) **Lack of identified need and rationale**

   The justification for MMQA has not been clearly stated, explained, and communicated consistently. A clear sense of the critical need for this product has not been established, and the department has lacked leadership and expertise in MMQA implementation. This background differs from
experience in other states. WSDOT’s Maintenance Accountability Process was driven by strong legislative interest in maintenance budgets and outcomes; Colorado DOT’s and Arizona DOT’s efforts were led by senior maintenance managers who perceived that a better way of justifying budgets was needed. They aggressively pursued a quality assurance approach and communicated its need clearly and consistently throughout design, development, and implementation.

(2) **Failure to engage internal and external stakeholders**

Colorado and Washington engaged field personnel in proposing, discussing, and selecting the five elements of their quality assurance applications. This process ensured that elements were meaningful and practical. It familiarized field managers with the information and procedures involved in the applications, and helped to allay their fears about what the application was intended to do. It promoted consistency in practice and an understanding of definitions across districts, reinforced by training and discussions at meetings.

These peer states also engaged in discussions with their legislatures and transportation commissions to accomplish the following:

- Present the concepts of these applications (referred to variously as performance-based budgeting or maintenance quality assurance).
- Explain the definitions and meanings of LOS.
- Discuss with these bodies how they could play a role in implementing the applications – primarily by specifying target LOS as expressions of maintenance policy, reviewing the budget implications of these scenarios, and selecting the recommended policy and budget.

To the extent that UDOT conducted similar activities during MMQA development, the interviews indicate that these efforts did not go deep enough into the maintenance organization. Some degree of external stakeholder involvement during MMQA development may also have occurred, but the lack of a clear rationale and urgency for MMQA at present indicates that such discussions did not result in a strong imperative for its use. UDOT’s potential adoption of an “asset management” framework for managing its infrastructure may offer an opportunity to reaffirm the importance of MMQA and to revisit its development. The use of MMQA for performance-based budgeting and resource allocation would be entirely consistent with principles of good asset management practice, as discussed above. Before this or other initiatives are pursued, however, management should establish the rationale for MMQA and understand its implications.
(3) MMQA implementation is much more decentralized

(a) Peer state experience

While peer states have clearly involved field managers in design of their quality assurance applications, the use of these systems for maintenance budgeting is highly centralized. Decisions on LOS in peer states are made by a relatively small number of central-office executives in consultation with the transportation commission and the legislature, and focus on high-level budget estimates: i.e., statewide budgets, and possible break-outs to the region or district level, but rarely lower. Limiting these applications solely for use in the central office has critical implications for system design and implementation.

- The precision of data needed to estimate a realistic statewide budget is less than the precision needed for an area- or station-level budget where local effects are more pronounced and statewide average costs are less useful.

- The relationship of LOS to maintenance cost is not yet well-researched. Existing models used by Washington, Colorado, and Arizona are based upon judgment, recognizing that a firmer relationship will require several years of experience with these systems and comparisons of actual expenditures to actual LOS achieved. Use of existing models in these peer states for statewide or district budgeting has not presented a problem, since estimating errors in estimating costs tend to cancel over a large network. For more detailed budgets at an area or station level, however, the error in estimation these models could present a problem.

- In designing the highway condition survey, a statewide perspective requires a sample size relative to the total highway population that is less demanding than is needed for a region-level, area-level, or station-level survey, assuming the same statistical significance. An analysis conducted for Colorado DOT shows that the percentage of total 0.1-mile sections that must be surveyed for a statistically valid result varies by the length of network under consideration as demonstrated in Exhibit IV-1. The larger the network, the greater the efficiency of random sampling. The smaller the network, the closer the required sampling approaches full coverage.

- Training requirements for system use in a centralized setting focus on a relatively small number of managers in the central office. A decentralized approach implies that a greater number of managers and staff from all parts of the organization require training.
Exhibit IV-1: Sample Sections Needed for a Statistically Valid Result in Different Networks

<table>
<thead>
<tr>
<th>Length of Network For Which Survey Must Be Statistically Significant (in Miles)</th>
<th>Percent of Total 0.1-Mile Segments To Be Included in Survey Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>96%</td>
</tr>
<tr>
<td>10</td>
<td>73%</td>
</tr>
<tr>
<td>100</td>
<td>21%</td>
</tr>
<tr>
<td>1,000</td>
<td>3%</td>
</tr>
<tr>
<td>10,000</td>
<td>&lt; 1%</td>
</tr>
</tbody>
</table>

NOTE: Statistical validity based upon 10% allowable error, 90% confidence limit.

(b) **Statistical significance of sampling at the station level**

The implications of decentralized implementation were analyzed specifically with respect to the statistical sampling of road conditions. Sampling of highway condition data meets reasonable tests of statistical significance (90 percent confidence interval, 10 percent error) at the statewide and the region/district levels. It does not, however, meet these criteria at a station level.

(c) **Models relating maintenance cost to LOS**

The models used by UDOT to relate maintenance cost to LOS are also analyzed in Appendix D. Again, the implications of a decentralized implementation are evident in the level of detail at which UDOT’s models are developed in comparison with those of other DOTs, particularly with respect to “initial versions” of these models (i.e., those developed in advance of several years’ worth of consistently monitored data documenting cost and LOS relationships). Whereas UDOT models are developed individually by maintenance activity and region, other DOTs develop models initially at a statewide level by activity group, with the understanding that more detailed modeling can be done after several years of data are compiled. Statewide implementation allows the models to be expressed on a “relative” basis: i.e., indicating the proportional increase or decrease in maintenance costs with different target LOS values – rather than on an “absolute” or actual-dollar-basis, as UDOT has done.

(d) **Implications for MMQA**

MMQA was conceived with design characteristics comparable to systems intended for use in Central at a statewide level. Attempting to implement MMQA in the regions, which involves area-level and
station-level managers, pushes MMQA beyond its design parameters. It cannot achieve the precision and accuracy needed for valid estimates at local levels. Field managers who have sought to use MMQA have realized this fact and have adjusted their practices accordingly: e.g., Region 1 decided to undertake full coverage in their highway condition surveys in lieu of sample sections. Moreover, this situation has likely accounted, in part, for the disparity of opinions on MMQA, since its performance at local levels may be unreliable. This assessment is not a criticism of UDOT’s attempt to implement MMQA in the regions, but simply an observation of two important points:

- Use of comparable systems in peer states offers little guidance on how to implement MMQA for use in regions, areas, and stations.
- MMQA can be designed to work at local levels, but this strategy requires that MMQA design parameters and assumptions be revisited.

**4. Lack of a statewide customer perceptions survey tied to MMQA**

Until last year, UDOT performed a customer perceptions survey only at the annual state fair. This survey was not statistically valid and was not used to modify MMQA targets. In 2002, however, UDOT contracted with a survey firm to perform a statistically valid statewide survey. While the survey was completed, UDOT officials did not know whether such a survey would be conducted on an ongoing basis. As with the state fair surveys, this survey was also not used to modify MMQA targets.

**4. Recommendations**

The trend in maintenance management among state DOTs is toward increased use of maintenance quality assurance concepts involving LOS and performance-based budgeting. An analytic tool like MMQA is needed to implement these concepts. The following recommendations are based on the premise that MMQA should be developed for use in LOS tracking and performance-based budgeting and management, consistent with UDOT’s pursuit of asset management. The credibility of MMQA within UDOT needs to be improved so managers at all maintenance levels subscribe to its purpose and use. Implementation of MMQA across regions must be consistent in all important respects including definitions of LOS and associated condition measures, sampling strategy, inspection criteria, and quality control procedures. This does not mean that LOS definitions cannot vary by highway functional class or terrain, only that such variations need to be articulated in the MMQA manual and subscribed to by all regions. The recommendations to achieve these ends are as follows.
Recommendation 25. Appoint an action team to guide MMQA revision and implementation.

The action team should comprise representatives of Central and field managers charged with several tasks:

- Hire a contractor with expertise in successful MMQA implementation to assist with change management and oversight of trial use at appropriate organizational levels.
- Work with the contractor and UDOT executives to define a statement of purpose for MMQA and the potential end-users of the application.
- Based upon the stated purpose, revisit design parameters and assumptions and determine needed changes. Any proposed use of MMQA beyond a “highly centralized” budgeting function will require revision to certain components of MMQA, particularly in the condition survey, the precision (or level of detail) of the information used, and the quality of the LOS cost model.
- Review other MMQA characteristics about which there is disagreement, and build a consensus for revised system components. Condition measures, LOS definitions, and threshold values are key considerations here.
- Guide completion of MMQA by implementing the additional recommendations listed below.

Recommendation 26. Update condition measures and LOS definitions and thresholds.

Condition measures, LOS threshold values, and units of measure must have greater consistency and acceptance across all maintenance organizational units. Measures that are impractical to determine should be identified and revised. Maintenance activities may be combined within the MMQA framework for purposes of condition measurement, LOS definition, and budget estimates.

The potential need for multiple measures to reflect different functions in maintenance management should be recognized. “Different functions” may include, for example, summary of total damage, maintenance cost estimation, assessment of impacts to motorists, and comparison with the private sector. Multiple measures could be related to each other through a conversion factor if desired. The action team can solicit input from Central and the regions on these items, review suggestions and justifications, and recommend a consensus approach for consideration and approval by all concerned.

Recommendation 27. Develop a department-wide data collection approach to which all regions subscribe and which is conducted regularly and consistently.

Agreement on a data collection strategy should be an outgrowth of the work on MMQA purpose and selective redesign in Recommendations VI-1 and VI-2. The current situation is one in which regions differ on data collection procedures and
timing, as well as on the criteria for translating condition data to LOS. A revised data collection strategy should encompass the following elements:

- **Scope, purpose, and basic approach**: There needs to be agreement on what items will be collected, what purpose the data collection will serve, and the basic methodology. Purpose and approach are closely linked and must be considered together. For example, if the purpose is to support a statewide budget with no analyses at a more detailed level, then one particular sampling strategy is justified. If the purpose is to support not only statewide analyses but also regional, district, and perhaps even area or station analyses, then another more detailed sampling or full coverage is needed. The required sample size should be statistically significant, based upon criteria established by the action team.

- **Methodology**: Details of the methodology need to be developed and agreed upon. The units of LOS measure need to be reviewed for practicality of data collection if this has not already been done and refined as needed. Specific instructions and examples should be developed together with recommended frequency and timing of inspection. Quality control methods should be defined.

- **Training**: An Academy training program should be developed for data collection as a companion course to training on MMQA.

**Recommendation 28. Match condition sampling strategy and level of management to which data are applied.**

While statistical sampling based upon 25 randomly selected sections per station can continue to be used for now, results of these condition data should be applied only at a statewide and region level. Once data collection and interpretation have been standardized across the state, the characteristics of the data (including the mean and standard deviation) should be reviewed periodically to update the estimate of sample size. At that point, a determination should be made whether or not an increased sample size can be feasibly collected to support the more detailed information needed to apply MMQA at a station level.

**Recommendation 29. Update the method of expressing LOS-based cost models.**

Expression of cost models should be on a relative rather than an absolute basis. Models should be developed at more aggregate levels: e.g., by activity group, and statewide as opposed to region-level. These models should be reviewed by field and Central managers to discuss their reasonableness with respect to the agreed-upon thresholds for LOS intervals and the predicted costs of performing maintenance at different LOS. The purposes of this approach are to build a shared understanding of the effect of LOS on maintenance costs, to encourage a more uniform treatment of LOS itself across regions, and to work with a pool of data from all regions for estimating models at this time. Separate models for individual regions can be estimated later, after several years of data have been compiled on a consistent basis across the state.
Recommendation 30. Develop a stronger statewide management capability for MMQA.

A capability should be added to aggregate condition, LOS, and budget information from the regions to a statewide level, and to perform budgeting calculations and what-if analyses at a statewide level.

LOS values should be revised to conform to the QC inspection results.

Once data collection procedures and criteria have been standardized and are being applied in all regions uniformly, UDOT should begin to use current LOS values as measures of management accountability.

Recommendation 31. Ensure MMQA is understood and accepted at all levels of the organization.

Initial focus should be on the action team members gaining a shared understanding of the MMQA concept and purpose, and agreeing on items slated for change. As the Steering Committee moves ahead with the above recommendations, it should guide communication and training for the maintenance organization. Seminars and fact sheets should be prepared for use by department employees, with the assistance of Steering Committee members. As MMQA approaches final development, the Academy should develop and offer training courses in both the purpose and use of MMQA and LOS, and the conduct of highway condition surveys.

Recommendation 32. Conduct ongoing customer surveys and focus groups and incorporate the results into the MMQA process.

Other states have effectively included assessments of public attitudes in their MMQA processes. Washington and Arizona, for example, use statewide citizen surveys and citizen focus groups to determine what LOS citizens desire for different maintenance activities. These agencies can use this information to set LOS targets. This is both a means to be more directly responsive to citizen’s views and to provide a persuasive case to the Legislature to meet maintenance needs. While UDOT has administered customer surveys in the past, the surveys have not been designed to link to the MMQA process.

Recommendation 33. Promote the understanding of MMQA, LOS, and performance-based budgeting by the Transportation Commission and the Legislature, and assess their willingness to support a budgeting process using this performance-based approach.

UDOT executives need to better understand how asset management encourages a policy-driven, performance-based approach, describe how these concepts are embodied in an updated MMQA and maintenance LOS, and gain the support of the Legislature and the Transportation Commission in a budgeting process that uses these concepts and techniques. The Steering Committee should inform UDOT executives on MMQA revisions to date and provide briefing materials. These information sessions
should be held at several times during MMQA revision, initially to secure buy-in to the concept and willingness to engage in performance-based budgeting, and subsequently to inform these stakeholders of progress, use of target LOS values as expressions of maintenance priorities, and the types of reports available.

B. Budgeting and Accounting

Central shares responsibility for program development, budgeting, and accounting with the regions. The following section reviews the existing approach for Central’s responsibilities, best practice in the field, strengths and issues, and recommendations for improvement in the areas of program development, budgeting, and accounting.

The budgeting methods in common use among state DOTs are the following:

- **Historical-based budgeting.** This approach uses as a baseline value the previous fiscal year’s budget. This baseline value is then adjusted for inflation, additions or revisions to the maintained feature inventory, and special circumstances (e.g., one-time events or unique needs for higher-than-normal maintenance). The budgeting process entails preparing descriptions and justifications of these needed adjustments, and submitting them for approval.

- **Feature-based budgeting.** This approach budgets based on the inventory of maintained features, and is the method most often used in early versions of MMS.

  - For each maintenance activity, a “quantity standard” or “workload model” is defined with units of work accomplishment per inventory unit.

  - This workload model is multiplied by the inventory quantity in the jurisdiction of interest (e.g., foreman area or station, region or district, statewide) to compute the total estimated maintenance workload for that activity in that jurisdiction.

  - Performance standards, defined for each activity, are applied to this workload to estimate total labor, equipment usage, and materials requirements.

  - Unit costs by class of labor, equipment, and materials are applied to the resource quantities above to estimate total budget for each activity in that jurisdiction.

  - Estimated costs are summed by activity and jurisdiction to compute the total maintenance budget.

The increased unit costs needed to maintain features of higher standard are presumably reflected in the inventory. For example, if the cost to maintain paved ditches is known (from historical practice) to be significantly higher than that of unpaved ditches, the Feature Inventory is structured to include paved ditches and unpaved ditches as separate items.
• **Performance-based budgeting.** In contrast with the methods described above, performance-based budgeting is outcome- or results-based. It relies on the following elements:

  - The existing conditions of maintained features, which are translated into current “levels of service” or LOS values.
  - The specification of target values of LOS that define expected future performance as a function of the maintenance to be performed.
  - Models that relate expected cost of maintenance for each activity in a jurisdiction to the target LOS value and the current LOS value in that jurisdiction.
  - Comparison of target LOS to actual LOS to determine if targets were met, what adjustments in future LOS and funding should be considered, and accountability to agency executives and policy-making bodies.

Of the three methods (and their variants), only the performance-based approach considers outcomes based on the level of service provided, and varies the cost of doing maintenance by this target level of service. The other methods assume some constant but undefined level of service based upon historical practice, but have no means of gauging whether this level is adequate for current highway designs, traffic levels, safety guidelines, and customer expectations. The historical and the feature-based approaches budget on quantities of resources – labor, equipment, and materials – needed to maintain the highway inventory based on historical practice, but do not connect maintenance performance to improved road quality or its effects on road users. It is for these reasons that highway agencies today are defining the state-of-the-art in terms of performance-based approaches.

1. **Existing Approach**

   a. **Budgeting**

   UDOT formerly used a feature-based approach to budgeting. It is this approach that is referred to in current UDOT guidelines. UDOT planned to adopt the MMQA approach when it was introduced in 1998, but upon determining that it was not explicitly feature-based, adopted another method that is an amalgam of the feature-based and historical-based approaches described above. UDOT retains the MMQA approach, however, for LOS-based calculations and for breakdowns of region/district budget estimates by activity group/activity, and thus employs a dual analytic approach to resource allocation.

   The method UDOT now uses to prepare budgets for submittal to the legislature is based on accounting first for established cost commitments, then accounting for

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additional costs in a structured manner referred to as “building blocks.” The steps are as follows:

- Identify “fixed” costs and allow for their funding: e.g., utilities, training, and unrecoverable damage costs.
- Allow for the costs of current FTEs (the approved FTE level is set by Legislature) plus equipment and materials. The costs of these existing resource levels are essentially an historical amount.
- Changes to historical budget levels are submitted as “building blocks.” Each building block is analyzed and justified by UDOT. However, there is no guarantee that the legislature will fund at the level requested. Building blocks are submitted for the following reasons:
  - Additional features (e.g., new lane-miles resulting from construction). The maintenance required by these new features are translated into new FTE, equipment, and materials based on current practice extended proportionally to these additional features.
  - Current costs are factored up proportionally (accounting for current use of standard wage rates plus overtime for labor) to identify additional costs due to additional FTEs and other resources.
  - Other exceptional cost increases may also be part of “building blocks” – e.g., price increases in contracts or materials purchases that exceed average inflation.
- Inflation adjusted for by the Governor’s Budget Office in discussions with the UDOT Controller. On occasion, UDOT may request a higher inflation rate if there have been exceptionally large increases in maintenance costs. However, this is not done routinely, and the justification must be communicated conclusively and succinctly for the Department to consider this option.
- Central attempts to administer this budgeting process fairly among the regions/districts. If there are procedural changes that respond to one region/district’s concerns, for example, the change is implemented for all the regions/districts. If regions/districts have a continuing concern, a meeting is held between Central and region/district managers to resolve the issue with the greatest degree of consensus possible.

A parallel budget estimate is also prepared through MMQA, but this worksheet is used in a supporting role by UDOT and is not submitted to the State Legislature. The worksheet identifies, for each activity in each region, the following information:

- Planned accomplishments in terms of labor hours and maintenance activities accomplished.
• Planned percentage distribution of labor, equipment, and material, and the proposed dollars for labor, equipment, and materials.

• The total dollars projected for each activity.

• The target LOS for each activity group.

• The difference, in dollars by activity group in each region, between the MMQA Budget and the initial budget estimate described above.

The final budget estimate is submitted to the State Legislature annually for approval. The budget cycle begins on July 1 and ends on the following June 30th. This financial cycle is consistent for all state agencies. Following legislative approval of the budget, UDOT allocates the approved maintenance funding to the regions. This resource allocation is reviewed in Chapter VI of this audit.

b. Accounting

Once funds are allocated by the Legislature, they are tracked in MMS and the State’s accounting system (FiNet). MMS receives data from field personnel as work is accomplished. FiNet then receives information from MMS. MMS and FiNet are reconciled at the end of each month to ensure data are consistent.

The expenditures for each station and crew are tracked using MMS and FiNet. MMS is used to develop weekly and monthly work programs and to track expenditures. Data input into MMS is then used by FiNet to determine true costs. There are usually differences between MMS data and FiNet data. MMS uses statewide average costs for labor, materials, and equipment; and FiNet uses true, actual costs. If differences occur over five percent per month, a reconciliation takes place to equalize the data. Generally, only one to two percent differences at the central level are considered acceptable.

The Central Budget and Accounting officer currently performs most of Central’s accounting functions. She monitors and tracks monthly expenditures, comparing planned against actual expenditures. This may be done on a daily or weekly basis, depending on the time of year. When expenditures for an activity exceed anticipated limits, or do not compare to the state average, they are flagged and station managers are required to justify the costs. Regions are allowed some flexibility for using funds as long as the funds stay within the specified group. The net group expenditure must not change. Should a region fail to spend at an anticipated rate, they risk losing funds to another region. All maintenance money should be spent prior to the end of the fiscal year or it may be lost. A fiscal year-end reconciliation of MMS and FiNet takes over three months and comparisons are often difficult. An emergency fund (the Engineer for Maintenance Fund) can be used to cover unforeseen overruns throughout the year. In the past, the Engineer for Maintenance Fund was used largely to cover overruns in snow removal activities.
The Central Budget and Accounting Officer provides major reports to Central and region/district managers and analysts. She also reconciles disparities between FiNet and MMS.

Central annually awards a one-time bonus for every crew member in the region/district crews that adhere to predetermined limits set in their budget.

2. **Best Practices**

The following summary of best practices in maintenance program budgeting is based on the 30-year experience of the consultant team in maintenance management and specifically in working with several state DOTs in recent years:

a. **Use condition ratings as a basis for budget needs preparation**

Agencies that represent best practice have an accurate inventory and know its condition. These agencies set performance target levels and provide a budget to meet the targets within a known time frame. For example, Florida uses a Maintenance Rating Program (MRP) to set goals, plan, and budget. Kansas utilizes its Pavement Management System (PMS) and Maintenance Quality Assurance inspections (MQA). Minnesota has newly established an Activity Based Budgeting (ABB) system. Washington utilizes the Maintenance Accountability Process (MAP), and Virginia has the Integrated Maintenance Management Program (IMMP). California, Idaho, Montana, Arizona, Colorado, Delaware, Maine, New Hampshire and Vermont also either have practical, working production systems or are developing such systems based upon maintenance LOS values and their application to performance-based budgeting. The approaches capture both policy-related targets and condition-based performance measures, as discussed earlier. Targets are compared to actual LOS values attained to provide accountability for the allocated budget.

Performance-based approaches are still in a state of development. There has not yet been a concerted program of research nationwide to develop critical elements of this approach, notably models to estimate how the cost of maintenance varies with increases or decreases in LOS. The state-of-the-art is therefore characterized by managers developing initial versions of these models in each DOT. After several years’ data have been compiled on highway condition, associated LOS, and related maintenance expenditures, DOTs will be able to correlate observed LOS with actual maintenance expenditures for the same road segments to estimate the cost models.

It should also be mentioned that performance-based maintenance algorithms are different from those used in pavement management systems and bridge management systems, which are also performance-based. PMS and BMS apply deterioration models to data on current facility inventory and condition to project...
future trends in condition and performance. These trends are the basis for identifying preservation treatments and for calculating the cost of these treatments through an analysis period that is typically 10-20 years long. Maintenance predictions are shorter term, typically two or three fiscal years long. In lieu of deterioration models, therefore, performance-based maintenance cost models operate on current maintenance expenditures – not predictions of feature deterioration – to compute changes in these expenditures as a function of LOS. As now implemented, therefore, performance-based maintenance budgeting systems are not “feature-based” as is commonly understood. However, feature-based adjustments can be included in these analyses to account for increases or decreases in inventory, as is done in UDOT’s current budgeting approach.

While UDOT’s MMQA is an example of a performance-based method that is similar to the analytic approach used in many other states, UDOT’s implementation of this system has not yet achieved the uniform statewide application that has been successfully attained by the other states listed above.

b. Apply a single method of budgeting

Regardless of the analytic approach used, state DOTs employ, as a matter of best practice, a single method of maintenance budgeting that is applied, uniformly and consistently, by the entire maintenance organization statewide. Such an approach is characterized by a standardization and consistency of elements, allowing for variation in numerical values among districts. The approach is understood at all levels of the maintenance organization.

c. Survey customers to determine focus and expectations

Using surveys to measure external customer input in setting performance targets, planning, and scheduling at the state and local level is also a best budgeting practice. Arizona conducts statewide maintenance performance surveys every three years as part of a maintenance incentive program. Florida contracts with a consultant to conduct an annual public survey. Kansas utilizes a consultant to conduct a biennial public survey; a portion of the survey deals with maintenance issues. Minnesota performed biennial maintenance market research surveys and starting in 2001, it will conduct surveys annually. Washington has had a consultant conduct two maintenance satisfaction surveys since 1995.

d. Integrate information systems to facilitate data input and eliminate duplication of entry and review

UDOT currently utilizes numerous data systems for accounting and tracking the maintenance program. Many of the systems track the same data, and most of the systems do not communicate with each other nor share data. They are stand-
alone systems that were created for a dedicated purpose. Field people cannot easily access most of this information for managing purposes.

Most DOT’s realize that integration of data systems is important, but because of the significant investment required, most have not tried to tackle this task to date. Some have taken a staged approach and are taking on integrating one or two systems. There are a number of systems commercially available to help with this task.

e. **Set statewide performance targets that are identifiable by field personnel**

Strategic decisions that are shared help improve implementation and accountability because all involved have a vested interest in the outcome. Florida uses the MRP system to set performance targets. Kansas has the MMQA program to communicate needs. Minnesota utilizes ABB to help assemble district targets. Washington uses the MAP to communicate region needs, and Virginia has the IMMP to assist the field personnel to communicate needs.

f. **Track activity costs and productivity in real time**

It is important to provide field managers with real time data for tracking costs so they can assess budget expenditures accurately and plan and estimate the cost of future work. Most DOT’s realize that real time data systems are important, but because of the significant investment required, most do not yet provide this information. Some have taken a staged approach and are testing systems in a few isolated maintenance stations. Again, there are some off-the-shelf systems that are commercially available to help with this task.

3. **Strengths and Issues**

a. **Strengths**

The Central Budget and Accounting Officer has developed a format for the budget request that communicates well with senior management. Budgeting at the region/district level, and by activity groups, allows area and station supervisors some flexibility to perform necessary work without forcing them into doing activities that were accomplished the previous year. Since budgets are developed based primarily on historical expenditures, it is necessary, at times, to shift money to an activity that was not done the previous year.

The allocation of approved funding among regions recognizes the need for balance among labor, equipment, and materials. This balance is borne out in analyses of MMS data, which show a consistent proportioning of these maintenance resources in the overall program across regions.
It is unique for a state agency to provide monetary awards to employees who achieve budget compliance. Although the current system might be manipulated to achieve the desired results, the merit system is commendable, and should continue.

The existing system encourages accountability for allocated funds and adherence to the bottom line. Area and station supervisors prioritize their deficiencies and adjust their work programs according to the available allocated funds, always being aware of the bottom line.

Most region/district staff feels that budget allocation within the region is fairly distributed and equitable. They perceive there is more flexibility to move money within the region than there is from region to region.

b. Issues

Many think the current system does not base allocations fairly on true region/district needs. Needs are currently defined as work that should be accomplished in order to maintain existing assets in a steady state condition. There is a perception that budgets are allocated and administered inconsistently to the regions, and that some regions are allowed to overspend and obtain money from other regions that have been frugal and saved for needs which might occur late in the fiscal year.

Funds are allocated based primarily on the quantities of the Feature Inventory and history of expenditures. Condition of the inventory is not taken into account. True needs for maintenance of features should be based on their current condition.

FiNet was established as a financial system for the state and is not well-suited to maintenance requirements. There are numerous issues with the FiNet system.

- Reports are not timely. Field managers do not know true costs of activities until several weeks after they happen. Financial reports are only available at the end of the month.
- FiNet does not capture location data that is important to maintenance.
- FiNet is fed data by MMS which utilizes different costs. Information transmittal is cumbersome and slow. Translation of data between the two systems is not seamless. Information gets lost or mistranslated. Some region/district personnel view this as a problem in balancing their budget.
- The Department of Administration, which is responsible for FiNet, has not been receptive to suggested changes that could make FiNet more friendly for highway maintenance use.

A budget year ending in June causes problems for maintenance. Some major maintenance activities, such as paving, take place during the summer. Delays in
funding may also halt an operation for a season and delay it until the following year. Regions/districts may hold on to funds to insure they do not overspend. This causes a spending frenzy at the end of the fiscal year so they do not lose money in the future.

Payment for materials can be slow, which is further exacerbated by vendors that do not bill until the end of the month. The price for materials can change from the time they are ordered until they are billed. Budgets get charged at the higher price causing activities to go over budget. Field managers are then held accountable for going over budget.

MMS was developed many years ago to assist in budgeting and accounting for maintenance. The staff has numerous issues with the MMS.

- Field staff lack confidence in the MMS. Most region/district personnel have developed their own systems for tracking the budget rather than relying on data from MMS. Many believe its primary function is to allow Central to spy on them. They receive little benefit, other than a paycheck, from using it.

- The system is not responsive to local needs for real time information. It is not integrated with other department information systems. It requires manual input that can result in reporting errors or intentional false reporting. Revisions to inputs are difficult to accomplish. It is time consuming to input data.

- Using a statewide average does not provide good information for local field supervisors because it does not truly represent the work they do. It is only a general guide. The Station Supervisor’s Handbook provides more meaningful managing information.

- Work programs are difficult to revise, and require repeated input. Some needed activities may not show up on work plans because no funds were allocated for them.

- Standards are not updated regularly, nor do some units truly represent the work done. It becomes difficult to estimate productivity because different units are used in MMS than are used in the field or by industry.

- MMS does not provide location, current condition, or address quality of work.

- MMS fiscal year-end summary report for each region and station is limited. A statewide summary on hard copy is the only year-end report available. Reconciliation of MMS with FiNet at the end of the fiscal year takes more than two months.

- Many at the region/district level perceive that Central does not understand their budget issues. This perception grows, in part, because key Central staff make few visits to the regions.
4. Recommendations

Recommendation 34. Apply a single, performance-based budgeting approach.

UDOT should develop and apply a single performance-based budgeting approach that accounts for other items UDOT must manage in its resource allocation. This procedure can draw upon salient parts of current methods plus some revisions:

- The basic framework should be established by MMQA and its structuring of activities into groups, its use of LOS as measures of road condition and target performance, its data collection based on sample sections, its cost models, and its breakdown of projected labor, equipment, and materials.

- The current budgeting method can contribute the following: to account for existing FTEs, fixed costs, and other existing cost commitments, and to adjust the budget submittal for additional inventory due to new construction, and other building blocks. This will effectively make the MMQA more feature-based.

- Adjustments should be made to the allocation of approved funds to the work program to account for average wage rates by region rather than statewide, to eliminate the distortion that now occurs. Comments on the preliminary allocation should continue to be solicited from the regions, but should be incorporated within the new framework established by MMQA.

Recommendation 35. Involve all managers and the public in the budget allocation process.

Beyond Central, only a few UDOT region/district staff are involved in budget development. Local field managers and the public have little input to the budget. Shared responsibility for budgeting will improve accountability.

Recommendation 36. Resolve fiscal year end conflicts.

Budget allocations should be ready by May 1 of every year. Area managers would benefit from knowing how much funding is available for the coming year.

Recommendation 37. Provide integrated real time information.

UDOT should provide station supervisors with instant access to updated budget information so they can make accurate estimates and budget decisions for planning and scheduling work.

Recommendation 38. Base the budget upon customer expectations.

Utilize customer perceptions of need as criteria for budget development. Use customer input to make strategic and tactical decisions at the state and local levels. This is further discussed in the prior section.
V. Maintenance Support

A. Maintenance Management System

This section provides an evaluation of the systems supporting UDOT’s maintenance management functions. There is concern that the Maintenance Management System (MMS) does not meet users’ needs, is difficult to use when compared to systems implemented using more modern technologies, and may have become expensive to operate and maintain relative to alternative solutions taking advantage of current technologies. The analysis also includes the MMQA and the Feature Inventory systems, since the capabilities provided by these systems are integral to the highway maintenance process at UDOT.

1. Existing Approach

This section provides an overview of the existing MMS, MMQA, and Feature Inventory systems. These systems are used by maintenance management to plan and monitor maintenance requirements and activities. The integration between these systems is limited to an annual download of features data from the Feature Inventory to MMS. There is no integration with other maintenance systems such as pavement management, bridge management, or the new sign inventory.

a. Maintenance Management System

The MMS was developed to help region/district maintenance units plan, manage, and track the costs of maintenance activities. Price Waterhouse implemented the original system in May 1991 using mainframe software from Delew Cather. Price Waterhouse wrote the PC version of MMS in 1994 using visual COBOL from Micro Focus. In receiving and sending files, UDOT struggled with this design because of the difficulty in communicating with up to 100 PCs around the state. Keeping the data in the stand-alone PC databases synchronized with the central database proved to be impractical. The PC systems were restructured to use a Citrix network.

The Citrix concept provides a host for applications designed to run on individual PCs. This provides more centralized control over the application and the database while minimizing the processing requirements of the client PC. Instead of having a version of the application software on each stand-alone PC, only screen data is exchanged with the Citrix host. All processing and data storage occurs on the Citrix host. This approach enabled UDOT to centralize the PC processes in three servers, reducing the number of nightly data transfer points from 95 to 3, and allowing the transfers to occur at network speeds.
(1) **Functional capabilities**

The four major functions of the MMS are planning, organizing, directing, and controlling. The relationship of these functions is illustrated in Exhibit V–1 on the following page. Each of the four functions is described below.

(a) **Planning**

Planning involves developing the work program and budget. The following are the main features of this function in the current MMS:

- The system tracks approximately 93 maintenance activities, from snow and ice control to rest area maintenance. Each activity is assigned a code, title, short description, and accomplishment unit.

- The system provides a numerical rating process to evaluate the condition of features. The design could support setting required service levels to aid in the planning process. However, this function of MMS has never been fully implemented, is not understood, and is not currently used.

- The system records performance standards for each maintenance activity. The performance standards specify the estimated labor, equipment, materials, and productivity expected for that activity. Performance standards are composed of nine parts, some of which are optional: responsibility, calendar, conditions for scheduling, labor, equipment, material, average daily production, other, and method/procedure.

- The system calculates average hourly rates and unit costs for labor, equipment, and materials. For labor, the system uses payroll records to calculate a statewide average hourly wage rate, including benefits. For equipment, a dual rate structure is used. One rate represents fixed equipment costs; the other rate represents usage costs. For materials, both a unit cost and a unit of measure are necessary to accommodate the differences in types of materials.

- The system distributes preliminary estimates of activity workloads by month throughout the year. Workload distribution can be refined later under the organizing function.
Exhibit V–1: Maintenance Management System Information Flow

• The system records an acceptable deviation from the planned performance for each activity. For example, if the work program plans for 1,000 hours of snow fence installation for January, and only 900 hours were completed, the deviation is 10 percent. This deviation is compared to the acceptable deviation, and if it is beyond the acceptable deviation, the system flags the activity.

• The system supports the development of maintenance plans by organization. Organization data is split into “management units” to allow planning information to be grouped by region, district, area, station, or special crew.

• Some activities can be summarized by location. The system has a location file that stores three pieces of information: state route, beginning reference (milepost), and ending reference (milepost).

• Work programs and budgets are developed using the above data. Management units can review and/or revise their work programs and budgets. A special screen allows managers to adjust the annual work quantities or total costs in order to test the effects of different constraints or assumptions.

• The system produces another Work Program and Budget report that summarizes the planning values in MMS. Fields in the report include: fiscal year, organization code, activity group, activity, feature inventory, annual work quantity, average daily production, crew size, person days, cost distribution, total cost, and organization total.

(b) Organizing

The organizing task distributes workload to cover the planned activities, schedules activities in the short term, and identifies the Department’s labor, equipment, and material needs. The following are the main features of the organizing function in the current MMS:

• The system allows the preliminary workload distribution for each activity to be adjusted by adding or subtracting person days from each month. The total annual person days for each activity cannot change except by changing the work program.

• Resource requirements are broken down into labor, equipment, and materials. Reports are produced summarizing each resource and listing the required resources by activity and by month.

• The system produces a Workload Distribution report showing both the person day distribution of work for all activities per
management unit and the number of persons needed to complete the work program by month.

- The system also provides a Work Calendar report showing a summary of the estimated crew days to be used for each monthly work program.

(c) Directing

Directing develops short-term work schedules and assigns staff. The following are the main features of the directing function in the current MMS:

- MMS prepares two-week work schedules that outline maintenance activities, locations, and estimated labor. MMS allows managers to select activities that are behind schedule, or emergency activities. The system prevents managers from over-scheduling personnel.

- The system allows the manager to schedule alternate work if weather conditions, equipment breakdowns, or other unforeseen events prevent the planned work.

- The system tells managers if specific individuals are available for specific activities.

- Two Schedule Overview and Activity Schedule reports are produced by the system. Each report includes scheduled labor hours for each activity, equipment and material requirements, dates, and locations. One report displays the information by day; the other report displays the information by week.

- An alternate work activities report displays the alternate work scheduled.

- A Work Plan Status Inquiry Screen compares planned total costs and planned work accomplishments to the actuals.

- Although the system has the capability to produce work requests, the Department does not use this feature.

(d) Controlling

Controlling consists of collecting and evaluating data that is entered into MMS. The following are the main features of the controlling function in the current MMS:

- The system provides tracking of the work that was performed. This information is entered daily from the Maintenance Activity
report (T-91), which describes what work was done, the location of the work, the amount accomplished, and the resources used (labor, equipment, and materials).

- The system uses the data from the Maintenance Activity reports to generate a series of maintenance management evaluation reports. Evaluation reports include:
  - **Work Calendar Status report** – Compares the planned and actual crew days by month for each activity.
  - **Budget Status report** – Compares the planned and actual total costs for each activity. The report displays the variance to date, as well as a projected variance for the year. A more detailed budget status report is also available, which breaks planned and actual costs down into labor, equipment, and materials.
  - **Cost Variance report** – Shows data to compare with FiNet in order to reconcile differences between the two systems.
  - **High Dollar Activity report** – Displays labor, equipment, and materials for the most expensive maintenance activities.
  - **Detail Cost by Location report** – Shows the costs for labor, equipment, and materials using the start and end mileposts specified.
  - **Detail Cost by State Route report** – Provides costs for labor, equipment, and materials for a specified state route.
  - **Interstate Expenditures report** – Displays the costs for labor, equipment, and materials by activity for the interstate system. The report also shows the distribution of the costs and the total hours by activity.

(2) Technical environment

MMS is supported by three technical components: the MMS/PC, which provides the access and summary reporting for the regions/districts and stations; the MMS/Mainframe, which provides a central database for detailed MMS data; and the “tank,” which provides integration between MMS/Mainframe, MMS/PC, and the FiNet and payroll systems.

- Station and region/district personnel use the MMS/PC for budgeting, time entry, and planning. MMS/PC provides reports and queries at a summary level (“about 95 percent of the interaction with MMS is at this level”).
• The mainframe version maintains the detail. The region/district maintenance analysts and other region/district personnel use the MMS/Mainframe capabilities as well as the MMS/PC.

• The third component, commonly referred to as the “tank,” connects MMS/PC, MMS/Mainframe, the State’s financial system (FiNet), and the State’s payroll system. This process collects activity data from the Citrix servers, validates the coding, and computes costs using the units and rate tables. It provides a correction facility to update error records before they are processed further. It then forwards labor, equipment, and materials costs to the MMS/Mainframe system, equipment costs and materials usage to FiNet, and labor hours to payroll. This process also extracts other MMS costs (e.g., direct payment and utilities) from FiNet, reports them to MMS, and sends summary information to the MMS/PC system for reporting at the regions/districts and stations.

Exhibit V–2 illustrates the data flow between the major components of MMS.
The technical architecture of the MMS/Mainframe is as follows:

- **Hardware** – State of Utah’s IBM 9872 mainframe.
- **Operating system** – SP.
- **Software** – Cobol/Natural Adabas.
- **Communications** – CICS.

The technical architecture of the MMS/PC is as follows:

- **Hardware** – HP Servers.
- **Operating system** – Windows NT, Citrix Client Metaframe 2.0 (moving to Windows 2000 with Citrix XP client).
- **Software** – Visual COBOL from Micro Focus.
- **Communications** – Dial-up for remote access, Ethernet LAN for local users and communications to other servers and the mainframe.

The typical desktop PC architecture is as follows:

- **Hardware** – Pentium 233/66 with 32-64MB of RAM.
- **Operating system** – Windows.
- **Software** – ICA Citrix client for MMS, Netscape for Web access, Internet Explorer 5.5 is installed but not widely used.
- **Communications** – Dial-up.

b. **Maintenance Management Quality Assurance (MMQA)**

MMQA is a tool that seeks to link UDOT’s maintenance levels of service to funding levels. MMQA was designed to improve UDOT’s ability to communicate the effects of different funding levels on the quality of highway maintenance.

The ability to link asset conditions with level of service was included in the original MMS design but has never been effectively utilized. Until recently, the process was performed using a series of spreadsheets. There spreadsheets were recently converted to an Oracle database, providing access to the regions/districts and to the stations.

1. **Functional capabilities**

The MMQA system serves three major functions. First, it aids in the selection of roadways and structures upon which condition assessments will
be performed. Second, it saves the condition assessment data in a database. Third, it helps establish MMQA budget levels. Each function is described in more detail below.

(a) **Condition assessment:**

- Randomly selects twenty .10-mile roadway segments for each maintenance station, twice a year.
- Randomly selects a percentage of roadway structures for each maintenance station, twice a year.

(b) **Database**

- Stores MMQA scores from each station’s semiannual inspections.

(c) **Budgeting**

- Computes the MMQA allocations for each region/district for each MMQA group.
- Computes the total MMQA budget for each region/district.
- Computes the investment necessary to attain a particular level of maintenance for each MMQA group, based on prior years’ budgets.
- Computes the difference between the MMQA allocation and the actual budget granted to each region/district.

(2) **Technical environment**

The MMQA system has recently been converted from a spreadsheet application to Oracle. Exhibit V–3 illustrates the data flow between the major components of MMQA.
Exhibit V–3: UDOT MMQA System Data Flow

The major components of the MMQA technical architecture are as follows:

- **Hardware** – HP-UX.
- **Operating system** – UNIX Form Server.
- **Software** – Oracle database, Oracle Forms and Reports.
- **Communications** – Dial-up to the Web.

c. **Feature Inventory**

The Feature Inventory is a database that tracks infrastructure and related items under UDOT’s jurisdiction. The inventory includes real estate, lane miles of roadway, rest areas, and landscaping. Region/district maintenance analysts can generate standard reports from their offices. These reports allow the user access to different types of information such as point-to-point segments, region/district responsibility segments, or ramps and interchanges.

Features in the inventory are identified using the route number, delineated reference posts, and offsets. The record includes some dimensions (such as the length of the feature), but does not include any performance characteristics. For example, the inventory would identify the length of a bridge deck or a ramp, but it would not provide information regarding the thickness of the slab or its condition. Roadway type is identified by top layer only. The surface can be bituminous, concrete, open graded, or gravel. Composite pavements are not clearly identified in the inventory.
The thickness, age, and condition of the pavement are not recorded. Although a field exists for recording condition, it has not been used. Roadway signs in the inventory are documented by location. Arc View is used to display the information by translating the linear referencing to GIS; this is done once a year.

(1) Functional capabilities

The feature inventory is a database of facilities owned by UDOT. The inventory has two types of “data elements”: reference inventory and inventory items.

The following are the seven reference data elements stored in the database:

- **Station** – beginning and ending mileposts, station number, station name, number of delineators.
- **County** – beginning and ending mileposts, county number, and county name.
- **Intersecting roads** – mile point, road name, intersection type (left, right, both), and intersection type description.
- **Major structures** – mile point, number, length, width, type (one-way overpass, two-way overpass, one-way bridge, two-way bridge), and function (road, railroad, water, terrain, pedestrian, utility, or other).
- **City/Town limits** – beginning and ending mileposts, area type (entering or leaving city/town), and city/town name.
- **Railroad crossing** – mile point, crossing number, and crossing name.
- **Mileage adjustment equation** – beginning and ending mileposts, equation, equation factor, equation description.
- **Other** – mile point, and description.

The following are the 29 inventory data elements stored in the database:

- Snow plan plow area
- Number of lanes
- Drainage installations
- Right-of-way fence
- Crash attenuators
- Pavement striping
- Right-of-way width
- Mowable width
- Cattle guards
- Other facilities

- Access type
- Median width
- Ditch
- Snow fence
- Walls
- Pavement messages
- Vegetation management
- Traffic islands
- Pловable markers
- Road condition

- Surface type
- Shoulder type
- Guardrail
- Signs
- Road to open
- Median cross over
- Pavement width
- Litter pickup
- Snow flags
The database allows all users to view and query records, and only a limited number of users to edit, add, or delete records. Anyone with access to the database can print the following reports.

- The **Audit report** prints the entire inventory, arranged under the following eight groups:
  - Fence
  - Surface
  - Safety
  - Structure
  - Drainage installations
  - Shoulder
  - Vegetation management
  - Miscellaneous

  The report can be done by station, route, route segment, or ramp.

- The **Summary report** prints the total count, acres, surface areas, miles, or lane miles for ramps, routes, route segments, stations, region/district, or statewide.

- A **Year-End Comparison report** allows a station, region/district, or the state to see what facilities have been added or subtracted during the years selected for the report.

- An **Element Summary report** can summarize a single data element for a station, region/district, route, or statewide.

(2) **Technical environment**

The Feature Inventory runs independently on the network server at each region/district. Each region/district enters their updates as features are added or changed, usually as a result of new construction or preservation activities. The system does not record condition information.

A central process checks to see if region/district updates have occurred since the last update. When there are region/district updates, the central process consolidates the new updates into the master database. It then sends a copy of the updated database to the servers in regions/districts.

Exhibit V–4 illustrates the data flow between the major components of the Feature Inventory.
The major components of the Feature Inventory technical architecture are as follows:

- **Hardware** – PC and Novell servers.
- **Operating system** – Novell.
- **Software** – Micro Focus Visual COBOL (DOS based), ISAM file access.
- **Communications** – WAN/LAN.

2. **Best Practices**

This section describes standard MMS features that systems meeting industry recognized best practices should contain. These requirements are typical of highway maintenance management systems.

- The system must support **planning** including an analysis of maintenance needs using an MMQA approach. The analysis must consider different potential levels of service and the degree to which they respond to overall departmental policy objectives and tradeoffs with capital projects. The fulfillment of policy objectives also requires the addition or updating of activities and standards (e.g., to maintain new ITS equipment being installed on highways).

- The system must support **budgeting**. This involves the balancing of needs against fiscal constraints, and the recommendation of specific levels of service to be provided. It includes the estimated costs and impacts to the highway system.
and the benefit of the maintenance performed. A high-level allocation of resources among districts or regions/districts, and activities or functions should also be performed. A long-term leveling of resources also should be provided.

- The system should provide **customer event tracking** to record and monitor comments and complaints from the public. The system should initiate work orders in response if the problem can be addressed through maintenance. This mechanism also represents an identification of potential demand for maintenance that occurs continually throughout the year.

- Once a maintenance program has been budgeted and approved, the system should provide support for the **scheduling** of labor, equipment, and materials resources to accomplish the proposed work to the level of service indicated. The system should support short-term resource leveling to reallocate scarce labor skills, equipment, or materials among areas. Work orders should be issued for specific work.

- As work is accomplished in the field, the system should **collect resource usage** and units of **accomplishment** daily. Costs of each activity or function may then be calculated, and work orders closed.

- As data on the entire maintenance program accumulate, **management reports** should document costs, work accomplishments, resource usage, level of service provided, and impacts or benefits to the department and to highway users.

- As the annual cycle proceeds, the system should provide a **feedback process** to monitor accomplishments, costs, levels of service, and resource usage, and to adjust policy decisions, level-of-service requirements, and resource requirements as needed. Inventory data should be updated for the coming cycle. Models and standards should also be updated to account for evolving trends (e.g., higher traffic growth) or new technology.

- The system should be **integrated** with other transportation asset management systems including pavement management, bridge management, asset inventory, and sign inventory.

Exhibit V–5 presents a conceptual design of how the components of maintenance management should be integrated.
Exhibit V–5: Conceptual Design of Integrated Maintenance Management System

The conceptual design illustrates a system where the operating components of maintenance management share data with one another. This diagram presents systems that are beyond the scope of this analysis but that contain significant data relevant to the maintenance management planning, budgeting, scheduling, and reporting processes. Providing a methodology to share this data forms the basis for an integrated maintenance management process.

3. Strengths and Issues

This section presents the strengths and issues of the UDOT maintenance systems.
a. **Strengths**

The three systems meet many of UDOT’s maintenance management needs. When the systems were developed, they incorporated leading-edge maintenance management concepts. Key strengths of the systems are presented below:

- MMS provides for single entry of labor, materials, and equipment usage, reducing errors that may result from multiple input processes.
- The systems collect data near the source, further reducing the opportunity for error.
- MMS computes costs for resources (labor, equipment usage, and materials) as they are utilized rather than waiting for payroll and financial system cycles to provide the cost for an activity.
- MMQA has been redeveloped to use a contemporary technology platform.

b. **Issues**

The system issues are presented in the following categories:

- MMS issues.
- MMQA issues.
- Feature Inventory issues.
- Unmet UDOT requirements.
- System features needed to support the new requirements from Dye Management Group, Inc.’s recommendations.
- Technical architecture.

1. **MMS issues**

- The system is difficult to use. Users view the DOS screen approach as obsolete. It is difficult to train new users, and it provides limited capability to integrate data with Windows applications such as word processing and spreadsheets.
- The system is difficult to support. The applications were developed by contractors and by staff that have since retired. There is limited technical knowledge on how the system works and limited experience with the DOS version of PC/COBOL in which the system is implemented.
- The system is difficult to modify. There are technical issues related to file size and capacity that limit the opportunities to add new features.
No major enhancements have taken place since 1994. Other enhancements have been frozen for at least five years.

- Users experience poor performance. Most users at the stations access the system using dial up connections. The limited speed of these connections combined with the amount of data that is transferred to and from the Citrix servers creates slow response time. Only those operating the system on the local area network (LAN) report acceptable response times.

- Users cannot rely on the data. The separation of the PC database from the mainframe database creates synchronization problems, despite the improvements made by moving to the Citrix network. Before producing reports or relying on queries from the PC database, the users must know the status of the previous night’s processes on the mainframe, and especially whether or not they were completed correctly, and whether or not all of the data was downloaded to the PC databases.

- There are reconciliation issues between the MMS and the statewide systems (FiNet and Payroll). The labor cost posted to MMS is based on standard rates. The labor cost computed in payroll and posted to FiNet are actual costs including benefits. This creates a cost variance of two to three percent system wide. Some stations report much larger variances. Based on our research, we attribute this to a difference in how labor is classified in MMS and FiNet. Labor is reported in MMS by the station and activity for which the work was accomplished. Work is recorded in FiNet based on the stations to which an employee normally reports. One station loaning labor to another station creates a larger variance at that level because the labor is reported in two different ways.

(2) MMQA issues

- The MMQA data formats and definitions are different from MMS, making it difficult to integrate the systems. However, both systems are used to develop the region/district and station budgets, so integration would provide efficiencies.

- The dial-up access is slow at the stations, especially on the initial log on.

(3) Feature Inventory issues

- The Feature Inventory system is hard to understand by both the users and the technical staff. The creator of the system has retired and the current staff is not experienced with the design concepts used in the system. In addition, the system has poor documentation.
• The batch update process is not fully automated and must be done centrally. The process is complex and there is no one on staff that fully understands how it works.

• The system is considered to be difficult to use and maintain in its current state. Five factors that contribute to this are:
  − The level of detail required for inventory descriptions.
  − The process for locating a feature in the system.
  − Issues surrounding the currency of the data.
  − The lack of planning in the design.
  − The volume of hard-coded (imbedded) and undocumented formulas.

• The system does not record the condition of the asset.

• The system is not integrated with MMS or MMQA. However, data from the Feature Inventory is loaded into MMS annually to support the budget process.

(4) **Unmet UDOT requirements**

• The system must meet the different needs of Central, regions/districts, and stations. In addition to tracking/compliance capabilities, the system must be able to help schedule and manage resources.

• The system must provide reconciliation for data transmitted to and accepted from the state financial systems: FiNet and payroll.

• The MMS system must be able to accurately update budget data within 24 hours from input.

• The system must have a user-friendly interface.

• The system must allow skilled users to generate their own customized reports.

• The system must be linked with the Feature Inventory so that edits prevent the submission of invalid data.

• The system needs more fields for accomplishment rates in order to collect optional data for region/district reports in addition to the Central-required data.

• The system should provide an audit trail of changes to budgets, schedules, and activity.
• Users need adequate training on the systems. The station supervisor session at the Maintenance Academy should include a course on the new system.

• The central office must be able to provide adequate support for users in the field.

(5) **New requirements from DMG recommendations**

• The system should be capable of calculating the budget according to maintenance levels of service.

• The system must allow targeted and actual condition measurements.

• The system should create automatic messages when a condition measurement reaches trigger levels.

• The system must be integrated with legacy systems\(^\text{15}\) such as the Feature Inventory, Sign Inventory, bridge management, and pavement management.

(6) **Technical architecture**

• Internet connections for many maintenance stations are poor. Several stations’ Internet Service Providers disconnect users after more than 15 minutes of inactivity. Downloading some files often takes longer than 15 minutes, so those downloads are not possible for some stations. In addition, some stations share their only phone line with their fueling system, which prevents both services from being used simultaneously. While many solutions to these connection problems may not be available in remote areas (e.g., DSL) or may be cost prohibitive (e.g., T-1 lines), UDOT should continue to evaluate potential solutions as rapidly evolving technology (e.g., satellite connections) becomes more available and affordable.

• The ISS goal is to increase the standardization of systems used in UDOT to save on training and support costs. All new systems are currently being developed using the Oracle database and Oracle tools.

• Before committing to convert major systems to Oracle, ISS has converted selected smaller systems to gain experience with implementation. The division now has 18 months of successful Oracle implementation and has the capacity and experience to undertake larger projects.

\(^\text{15}\) Legacy systems are an agency’s existing software that was custom-developed or off-the-shelf software that has been heavily modified. Legacy systems are usually older, may not support the agency’s current business needs, and may no longer be supported.
• MMS and the Feature Inventory system do not use contemporary system architecture. They use the tools and database architectures that were contemporary at the time they were developed. This makes them difficult to support and enhance.

• The technical architecture (DOS COBOL) also limits the ability to upgrade the computers on which they run. Newer versions of Windows are not supporting the DOS environment. This will create PC support problems unless the applications are converted to a Windows-based architecture.

4. Recommendations

This section presents our recommendations for addressing the maintenance management requirements at UDOT. The section identifies alternatives, compares the alternatives, recommends an approach and an implementation plan for the recommended approach.

a. Alternatives

Four basic alternatives for UDOT are addressed in this section. The alternatives are based on variations of implementing the system concept discussed above. The four alternatives are presented below and detailed discussions of each follow.

• Maintain the current systems without major redesign. No further investment would be made in the technical architecture and no new functionality would be added.

• Maintain the current systems to support the maintenance management functions, but enhance their inherent capabilities to satisfy user requirements. Add improved integration with other UDOT systems.

• Enhance the maintenance systems by redeveloping them to use new technology architecture and to add capabilities.

• Replace the current system with a commercial package that would address the requirements.

A description of each alternative is presented along with a requirements evaluation, pros, cons, and cost. The costs are presented as relative costs based on preliminary assumptions about level of effort. An accurate assessment of costs would require a more detailed requirements and scope assessment, and additional information on the staffing options for development (e.g., State resources, contracted staff, or fixed-price contract with a systems integrator).
(1) **Maintain current systems**

This alternative would retain the current MMS, MMQA and Feature Inventory technology and functionality. It could include some deferred functional enhancements but would not significantly change the system, the processes, or the technology. Exhibit V–6 illustrates the system topology for this alternative.

**Exhibit V–6: Maintain the Current System**

![Diagram of system topology](image)
(a) Requirements evaluation

The current system performs many of the functions included in the best practices. However, it lacks both integration with other maintenance systems and flexible reporting capabilities. In addition, the technical design of the system does not efficiently support the system users, and there is a continued support risk because technical staff does not understand the systems.

(b) Pros

This alternative has the lowest development cost and risk since any enhancements that are done would be implemented incrementally through the system maintenance process.

(c) Cons

This approach maintains the status quo. It does not offer any improvements to the UDOT maintenance processes or information. It does not support the implementation of the Dye Management Group, Inc.’s recommendations for improving the maintenance processes.

This alternative retains the current technical environment utilizing the Citrix network. It does not take advantage of newer contemporary technologies, such as Web access.

(d) Cost

There are no development costs associated with this alternative. However there are significant opportunity costs since this alternative does not provide an opportunity to improve the maintenance data or the inefficient processes associated with the current systems.

(2) Legacy system extension of MMS

The legacy system extension approach would keep the structure and technology of the current MMS but add features to enhance its usability. These features would address some of the key requirements and provide integration with related systems (MMQA and Feature Inventory). The typical approaches to legacy system extension include adding features using the current technology (COBOL, Natural, Adabas, and Visual COBOL), creating a data warehouse to provide integration with other systems and/or enhancing query and reporting capabilities, and improving the user interface.
A data warehouse is a copy of data from the production systems that is transformed to be linked with data from other systems (e.g., developing a common key to identify assets and asset locations). It also contains the necessary elements to meet reporting requirements. The typical data warehouse is implemented with reporting tools and access so that users with varying technical experience can request standard reports and queries, or build their own custom reports and queries. At UDOT, Oracle and Oracle Tools could provide the platform for the data warehouse.

A data warehouse would allow data from MMS, MMQA, Feature Inventory, FiNet, payroll, and other UDOT systems to be combined in reports and queries.

Exhibit V–7 illustrates the system topology for this alternative. The diagram illustrates that the current interfaces and user interaction with the systems would be retained. A new process would copy data from each of the source systems to a data warehouse in a form that would allow the data to be linked to data from the other source systems.
Exhibit V-7: Extend Current Systems

(a) Requirements evaluation

This alternative provides the opportunity to address some of the new functional requirements, including integrated data and new reporting capabilities through the implementation of a data warehouse.
(b) **Pros**

This alternative retains proven software systems and techniques. It enhances them by adding new features and new technologies to improve the user interface and the availability of queries and reports.

This alternative builds on the Oracle investment and experience in the ISS organization.

This alternative can be implemented incrementally as budget and resources are available. It introduces new technology and new processes over time, reducing the risk to the organization (as compared to redeveloping MMS or implementing a commercial package).

(c) **Cons**

The current technology is considered out of date and is difficult to support. While the current technology is no longer considered contemporary, it is established, proven technology that is still widely used and is expected to be viable for the foreseeable future.

Retaining the underlying technology with the complexity of MMS and the Feature Inventory system does not provide the capability to efficiently add new features or data to these systems.

Addition of a data warehouse adds another layer of data to the system topology. Users already complain about the two levels of database in the MMS system (PC and mainframe) and the difficulty of synchronizing region/district updates to the Features Inventory.

Building a new user-friendly user interface could be difficult with the underlying technology and would not resolve the constraints of the DOS-based technology.

(d) **Cost**

The cost of this alternative cannot be assessed at this time. The costs will depend on the features added to the base system, the extent and approaches for the legacy system extension, and the complexity of these approaches. However, the overall costs are anticipated to be less than redeveloping the system or implementing a commercial package since the current programs and processes will not need to be rewritten.
(3) Redevelop current systems

This alternative replaces the existing MMS with a new maintenance management system that meets all of the requirements established for the new system. It would also integrate the Features Inventory capability and MMQA functionality with MMS. The system may use a data warehouse to provide integration with other system such as FiNet, payroll, sign inventory, pavement management, among others. It would provide a contemporary user interface and reporting tools.

(a) Requirements evaluation

This alternative could meet most or all of the current and unmet UDOT requirements. A custom development can be designed to meet all of the functional processes and to provide the desired user interface and reporting and query flexibility. The designs can also integrate the system with other maintenance information.

(b) Pros

This alternative provides the best opportunity to meet UDOT’s maintenance management requirements in a manner that is consistent with the way it conducts business.

(c) Cons

Large development projects have a high risk of cost overruns, scope creep, and schedule delays. Completely replacing MMS provides the highest risk of all of the alternatives. The risks are associated with the inherent difficulties managing projects of this size and complexity.

(d) Cost

This alternative probably would incur the highest short-term costs. One estimate is it would take 1.5 to 2 years to just convert the current functionality to Oracle. A longer time frame would be required to add new functionality and features. The level or types of resources have not been determined so an accurate cost assumption has not been developed. This alternative does offer long-term benefits and savings related to operational efficiency, system support, maintenance, and user satisfaction. More research is required to determine whether the benefits outweigh the costs. However, long-term support costs could be higher than a commercial system since commercial vendors can spread the support costs over a broad customer installed base.
(4) Replace MMS with a commercial package

This alternative replaces the existing MMS with a new system from a commercial vendor. The scope of the new system could include all of the areas defined in the system concept (e.g., MMS, MMQA, Feature Inventory, Bridge Management, Materials Management, and Equipment Management) or it could focus just on the core maintenance management functionality (MMS, MMQA, and Feature Inventory). The vendors we surveyed offer differing capabilities and approaches, but all employ contemporary technology in their systems including Web access, user reporting tools, and an integrated database. One vendor offers only the core maintenance management functionality whereas most vendors that we surveyed offer an array of integrated applications related to transportation asset management. All vendors allow the users to license just the applications they need.

(a) Requirements evaluation

Commercial systems provide robust functionality since they are developed to meet the requirements of a broad customer base. These systems also employ best asset management practices. Most systems offer a configuration capability to address unique processes required by each customer organization.

A commercial system may not address certain requirements in the particular way that UDOT desires. Each implementation of a commercial system, whether it is for asset management, HR/Payroll, or financial accounting requires management and the project team to make difficult decisions whether to change practices to match system capabilities or to change the system.

(b) Pros

Commercial systems support best industry practices using proven methods and technology. These systems generally provide significant flexibility to meet the needs of a broad variety of users.

UDOT may be able to implement more functionality quicker using this approach. A commercial system can usually be implemented incrementally with the most critical functions first. Additional modules can be added to improve the integrated capabilities as finances and resources allow. For example, UDOT could choose a vendor that provides the full range of maintenance systems but only implement the core MMS and Feature Inventory capabilities. UDOT could choose to implement other, integrated modules later to address UDOT’s future system needs.
The commercial systems typically offer the ability to easily import and export data to and from other systems.

Commercial systems usually include significant assistance in training and conversion to help with the transition and to reduce risks.

(c) Cons

While a commercial system has the lowest development risk, there are risks related to how well the system meets UDOT’s requirements, how well users accept the system, and how open the organization is to implementing changes in processes for the new system.

A commercial system would represent a significant investment for UDOT. As with any large implementation, there is a risk of cost overruns, scope creep, and schedule delays.

While the commercial systems use contemporary technology and graphical user interfaces, they may not address the slow response times experienced by some of the remote stations. Many of the commercial systems use Web access to a central database. The remote users that experience slow response time with the Citrix servers also experience slow Web access. It is important to assess the technology used for the system to assure that the system will meet UDOT’s performance criteria within the physical constraints posed by the location of the stations.

(d) Cost

Upon reviewing the cost of implementing a commercial system, we identified two costing approaches. The more traditional approach would implement the system on UDOT’s hardware. The implementation cost including software licenses, implementation support, and training was in the range of $1.0 – $1.5 million for the vendors we surveyed and for similar projects in other states. This estimate does not include additional hardware or UDOT staff time. These vendors also charge an annual maintenance fee, which typically is about 15 percent of the base license fee.

One vendor offers a hosted system option. They provide the software, hardware, database storage, and support for an annual per user fee. The system is accessed entirely via the Web. They offer implementation and conversion support estimated at approximately $50,000 and initial “train the trainer” support for $15,000 – $20,000. The annual maintenance is $3,600 per user (approximately $360,000) for the MMS related applications.
b. Comparison of Alternatives

The table in Exhibit V–8 presents a comparison of the alternatives. The first column lists the alternative, the second column shows the degree to which requirements would be satisfied, the third column presents implementation risks, and the fourth column gives system costs. All the alternatives are rated in terms of high, medium, and low.

Exhibit V–8: Comparison of Alternatives

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Requirements</th>
<th>Implementation Risk</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Maintain the Current Systems</td>
<td>Low – Does not meet new requirements.</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>2. Extend the Current Systems</td>
<td>Moderate – Improves integration. – Partially meets</td>
<td>Moderate – Incremental approach reduces risk.</td>
<td>Low to Moderate</td>
</tr>
<tr>
<td></td>
<td>requirements.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Redevelop the Systems</td>
<td>High – Could meet all requirements.</td>
<td>High – Developing a new system has high risk.</td>
<td>High</td>
</tr>
<tr>
<td>4. Implement a Commercial System</td>
<td>High – Could meet most requirements. – Provides additional</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>flexibility.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The comparison of alternatives is summarized below:

- **Maintain the current systems** – This alternative has low risk and low cost but essentially maintains the status quo. The users would see no improvement in functionality or usability.
- **Extend the current systems** – This alternative has moderate cost and risk. It can be incrementally implemented as funding is available. However, the ability to add best practices functionality or to improve the user interface would be limited.
- **Redevelop the systems** – This alternative can meet all of the requirements. The risk is high because of the inherent risk of managing the scope, budget, and schedule for complex systems development. Factors contributing to the risk are defining complex requirements, writing to code, testing the code and the system processes, and developing training materials. The costs are difficult to estimate but new development typically has a high cost. The cost
also depends on whether or not all functionality is included and how the project is staffed.

- **Implement a commercial system** – Implementing a proven system reduces the development risk and shifts the risk to user training, business process redesign, and user acceptance. The cost may be less than alternative 3 because development costs are spread to a broad installation base. Although life cycle costs typically include annual maintenance, the vendor would provide bug support and enhancements reducing the time commitment for internal staff. This alternative also provides the opportunity to implement the new functionality quicker because the software is already developed and just needs to be configured to meet UDOT-specific processes.

c. **Recommendation**

**Recommendation 39. Implement a commercial MMS package.**

Dye Management Group, Inc. recommends proceeding with Alternative 4. Implementing a commercial system will address the immediate maintenance management requirements with reasonable risk. It provides a firm, long-range strategy for implementing effective systems at a competitive cost. Based on our high-level review of UDOT’s requirements, the commercial offerings can meet most of the organization’s needs and provide cost effective flexibility to meet new requirements.

d. **Implementation Plan**

This section identifies the key work steps to select and implement a commercial package for maintenance management. It first provides a description of key tasks and then presents a typical schedule for this work.

(1) **Implementation tasks**

Implementation of a system typically follows a standard system development life cycle (SDLC). While the details and terminology of a SDLC differ depending on the company and the source, they usually include the same basic components: requirements definition, detail design, development, testing, and implementation. The SDLC for implementation of a commercial package has some differences to address the software selection and to emphasize configuration and training over software development. The key lifecycle steps applicable to implementing a commercial solution for UDOT are identified below.

- **Requirements Definition** – Conducting a detailed requirements definition is an essential first step in the process. Clear requirements will allow the competing vendors to fairly propose their products and clearly address how they meet the requirements. It also provides
essential information UDOT will require to develop an accurate scope and cost proposal. Subtasks are:

- Conduct focus groups and interviews to identify requirements.
- Classify requirements by function.
- Prioritize requirements into mandatory, desirable, and nice to have.
- Develop requirements document.
- Obtain approval from stakeholders.

**Software Selection** – Software selection involves presenting the requirements and other selection criteria in a form that is understandable to outside vendors, and to which they can articulate how their system addresses each requirement. The requirements should be stated to allow optional approaches for addressing the requirement. It should clearly identify the processing or reporting needs of UDOT. Along with the RFP, a rigorous and consistent evaluation process needs to be documented in order to give each vendor an equal opportunity to provide a competitive response. Subtasks are:

- Develop RFP.
- Conduct procurement process.
- Evaluate proposals.
  - Review vendor responses.
  - Clarify questions and issues.
  - Identify apparent best fits (2 or 3).
  - Conduct vendor demonstrations.
  - Conduct fit gap analysis.
  - Review costs.
- Select vendor.
- Negotiate contract.

**Implementation** – The implementation process for a commercial system focuses on configuring the inherent capabilities of the package to meet the processing requirements of UDOT. No commercial system is likely to meet every requirement exactly the way UDOT has historically conducted its business. This is an opportunity to leverage the system capabilities to improve business processes. The selected system should support industry best practices for maintenance management and offer flexibility to meet current and future requirements. Subtasks are:
- Initiate project.
  - Develop detailed work plan.
  - Assemble implementation team (users, technicians, and vendor’s consultants).
  - Implement software in test region.
  - Conduct team training.

- Develop detail design.
  - Match business processes to software capabilities.
  - Identify business process changes.
  - Prioritize requirements.
  - Identify deferred requirements.
  - Identify configuration approaches and issues.
  - Identify software changes and interfaces. Changes to the core software product should be avoided if at all possible unless the vendor is willing to implement and support the change.
  - Develop a change management process.
  - Develop conversion design and procedures.
  - Develop Implementation Document (detail design.)

- Develop/configure system components.
  - Configure software/develop enhancements.
  - Configure unit test and enhancements.
  - Conduct system test.
  - Develop a training program and training materials.
  - Conduct user acceptance test including conversion tests.

- Deploy system.
  - Conduct training.
  - Implement change management plan.
  - Implement the system.
  - Provide post implementation support.
  - Conduct post implementation review.
(2) **Schedule**

The schedule in Exhibit V–9 provides an approximate time frame to complete the implementation and illustrates the time dependence between tasks.
Exhibit V–9: Commercial Package Implementation Schedule

<table>
<thead>
<tr>
<th>Requirements Definition</th>
<th>M1</th>
<th>M2</th>
<th>M3</th>
<th>M4</th>
<th>M5</th>
<th>M6</th>
<th>M7</th>
<th>M8</th>
<th>M9</th>
<th>M10</th>
<th>M11</th>
<th>M12</th>
<th>M13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conduct focus groups and interviews</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classify requirements by function</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prioritize requirements</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Develop requirements document</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Obtain stakeholder approval</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Software Selection                      |    |    |    |    |    |    |    |    |    |     |     |     |     |
| Develop RFP                             |    |    |    |    |    |    |    |    |    |     |     |     |     |
| Conduct procurement process             |    |    |    |    |    |    |    |    |    |     |     |     |     |
| Evaluate proposals                      |    |    |    |    |    |    |    |    |    |     |     |     |     |
| Select vendor                           |    |    |    |    |    |    |    |    |    |     |     |     |     |
| Negotiate contract                      |    |    |    |    |    |    |    |    |    |     |     |     |     |

| Implementation                          |    |    |    |    |    |    |    |    |    |     |     |     |     |
| Initiate project                        |    |    |    |    |    |    |    |    |    |     |     |     |     |
| Develop Detail Design                   |    |    |    |    |    |    |    |    |    |     |     |     |     |
| Develop/configure system                |    |    |    |    |    |    |    |    |    |     |     |     |     |
| Deploy system                           |    |    |    |    |    |    |    |    |    |     |     |     |     |

Go Live - ♦
B. Methods Engineering

Region/district maintenance units face problems that require experience, investigation, experimentation, and technology transfer to solve (e.g., the use of water-borne paint for striping and anti-icing substitutes for salt). Some maintenance problems are experienced statewide and others are localized to one region/district. Solutions may require the development of new methods, technology, specifications, or process controls.

Methods engineering is a function assigned to Central, which provides support to all regions/districts.

1. Existing Approach

The role of the UDOT Methods Engineer is a mixture of applied research, technology transfer, field support, process control, and quality assurance. Other responsibilities include participation in the maintenance budget preparation, budget analysis, and bid and specification preparation.

Funding for this function is approximately $300,000 per year. On average, this allows for five projects to be completed annually. The Methods Engineer chooses projects based on three types of evaluations: engineering performance/functional, system performance, and lifecycle cost analysis.

The Methods Engineer works with two forums: the Maintenance Quality Panel, and the monthly meetings of the Maintenance Operations Engineers. The Quality Panel comprises all maintenance staff from Central, all maintenance supervisory staff from the regions/districts, every Area Supervisor, and every Region Director (about 75 people in total). This panel provides a means to discuss issues, obtain consensus on practices, and facilitate compliance with practices.

Study needs are identified in three ways:

- Formally, through the Maintenance Quality Panel.
- Informally, through site visits by the Methods Engineer to stations and by discussions with station supervisors.
- Informally, through regional requests for a solution to a particular problem.

Materials that are tested by the Department and are not rejected result in one of two classifications: approved or accepted. “Approved” means the material is intended for immediate use; “accepted” means the material is acceptable, but is not intended for immediate use. UDOT normally carries the cost of field-testing. If the costs are high, they are often shared with vendors. Partnerships within the Department are also actively sought.
2. Best Practices

Best practices for methods engineering were compiled from interviews with other methods engineering offices as well as from the proceedings of a North American conference on innovation and research.

a. Focus on solutions

Some problems are long term and others are more urgent; some solutions result in a high return on investment and others result in a lesser return. The long-term research projects are better managed by outsourcing, which require letting contracts. Because letting contracts is time consuming, the internal team generally should focus on emergency issues.

b. Use a formal process for soliciting ideas, issues, and/or problems for methods engineering, and a defined set of criteria for establishing priorities

For large departments, this requirement is necessary to reach a large number of staff distributed over a wide area. The research team has to be objective in identifying the needs and ensuring an equitable approach to serving all clients.

The process of soliciting needs and input from the various internal clients offers all stakeholders equal access to the team. Criteria for setting priorities make the selection process more efficient and equitable.

c. Use steering committees to include customer representatives and to guide the research

Since practical solutions are the ultimate outcome, forming steering committees that include client representatives will contribute to the success of a project. It is imperative to secure client ownership for the outcome of a project.

d. Use clear performance measures for identifying success and failure

The clients should be encouraged to expect outcomes in terms of performance measures that clearly identify what needs to be accomplished and to what degree.

e. Communicate with clients

Clients need to be aware of the progress of research. Good research practice includes maintaining continuous communication with the client, e.g., monthly meetings, e-newsletters, briefing notes, and progress reports. Documenting accomplishments in an annual report is useful for self-assessment and for communicating with clients. Annual reports are also useful in informing potential partners about the type of work that interests the Department. In addition to
stakeholders, distribution should include clients, funding suppliers, and other research groups and universities.

f. **Document the impact of research on the client’s business**

It is not enough to generate solutions and to deploy them in the field; researchers have to follow up on the effectiveness of their recommendations. Solutions sometimes require fine tuning in order to achieve the maximum impact to a client’s business. This knowledge is also valuable to the research team in the event of an audit.

g. **Manage money well**

Good financial management is essential for success. Money should be spent consistent with the plan and should be accounted for throughout the term of the study.

3. **Strengths and Issues**

a. **Strengths**

- Overwhelmingly, the regions/districts supported the need for methods engineering from Central.
- Central has an established network of support, both inside and out of government, e.g., University of Utah, vendors, and lab testing facilities.
- The current methods engineering group has experience in measuring outcomes and evaluating technologies.
- The Department has a good financial control system in place.

b. **Issues**

- The Methods Engineer lack familiarity with UDOT’s strategic direction. The relative mix of issues and priorities in research are normally addressed in the strategic directions of an agency.
- Methods engineering lacks a formal business process. For example, no formal approval process exists for problem definition statements or for study closures. Decisions in the Quality Panel are documented in the panel meeting minutes but no formal directives are issued.
- Methods engineering lacks formal reporting standards. Although cost-effectiveness was mentioned as a criterion for choice among technologies, no formal reports on cost-effectiveness evaluations of various tested
technologies were circulated. The function did not have a year-end report explaining activities and the choices made.

- Methods engineering lacks a process to institutionalize implementation.

4. Recommendations

The following are recommendations to improve the methods engineering function of Central.

Recommendation 40. Evaluate the classification of the Methods Engineer position.

High turnover of Methods Engineers has undermined the confidence regions place in this Central function. Some region interviewees believed that the Methods Engineer position should be reclassified as a Methods Technologist, equal or higher than an upper level maintenance manager. According to interviewees, this could add credibility, stability, and a career path advancement for maintenance personnel. Another alternative is to increase the outsourcing of research, through private and university partnerships, and/or through UDOT’s research branch. These alternatives should be considered to improve stability and consistency to the methods engineering function.

Recommendation 41. Establish a system to allow region/district staff to influence the prioritization of methods engineering.

The current decision-making process is too informal and lacks adequate documentation. In order to provide more structure to enhance the perceptions of key stakeholders, an action team comprising representatives from regions/districts, and Central should be established to provide guidance for research program management. The action team would:

- Establish evaluation criteria for the selection of research alternatives, considering anticipated cost, chances of success, risks, time frame expected, and outcomes.
- Solicit need statements from region/district maintenance staff, carry out preliminary evaluations of those needs, and rank needs based on evaluation criteria.

Recommendation 42. The Methods Engineer should visit each region/district frequently.

The Methods Engineer should visit each region and district a minimum of twice every year to discuss field issues with station supervisors and announce future testing. Credibility is increased when Central understands field problems and can provide solutions. Keeping dialogue open between the Methods Engineer and the station supervisors is a key success factor for the function.
Recommendation 43. The Methods Engineer should formalize reporting procedures.

The Methods Engineer should prepare periodic progress reports regarding accomplishments, key issues, and the status of projects. This report should be reviewed with the Engineer for Maintenance and circulated to key stakeholders within the Department.

The Methods Engineer should prepare an annual report that demonstrates the relevance of accomplishments and the attainment of strategic directives. The annual report could document the total cost savings, safety improvements, or performance benefits methods engineering has provided over the years. The report should also be reviewed with the Engineer for Maintenance and circulated to key stakeholders within the Department.

C. Training

Central is responsible for training region/district staff. It does so through both formal, required training and informal, elective training. The regions/districts also have training staff. This section reviews the existing approach, best practice in the field, strengths and issues, and recommendations for improvement in the area of training.

1. Existing Approach

In 1994, UDOT established a policy for the Maintenance Career Ladder. This policy clarified Department expectations for staff at various responsibility levels and the Department’s commitment towards creating skilled crews to carry out required fieldwork competently, efficiently, and safely. The Maintenance Career Ladder policy has five stated purposes:

- To establish uniformity in the administration of the Maintenance Training program and Maintenance Career Ladder.
- To establish uniform qualifications for the Maintenance Career Ladder.
- To administer NICET (National Institute of Certification in Engineering Technologies) and maintenance tests throughout the Department.
- To establish a uniform system throughout the State for Maintenance training and certification data contained in the Maintenance Training and Certification Database.
- To establish and operate the Maintenance Training Academy.

The policy committed UDOT to providing maintenance employees with training to help them master the requirements for positions they are pursuing. It also committed

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16 UDOT 06A-8.
17 NICET is an examining body whose function is to evaluate the qualifications of those who voluntarily apply for certification in engineering technology fields. It is a not-for-profit division of the National Society of Professional Engineers.
the Department to creating an Academy for staff training and testing, as well as to rewarding employees who complete training.

As shown in Exhibit V-10, the Maintenance Career Ladder includes the following classifications:

Exhibit V-10: Maintenance Career Ladder

<table>
<thead>
<tr>
<th>Position</th>
<th>Class</th>
<th>Work Experience</th>
<th>Training</th>
<th>Other Licenses</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Maintenance Worker II</td>
<td>HOS I</td>
<td>2 years related experience</td>
<td>Training Academy (Level 1 of M3 Program; complete at end of first Year)</td>
<td>Commercial Driver License CDL (A) / X; Equipment Certification 1</td>
</tr>
<tr>
<td>(Probationary Staff)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highway Operations Specialist II</td>
<td>HOS II</td>
<td>2 years related experience plus</td>
<td>Maintenance Academy Grad; Maintenance Exam Level II (materials, drawings, top 20 activities)</td>
<td>CDL (A) / X; Equipment Certification 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 year of UDOT experience</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highway Operations Specialist III</td>
<td>HOS III</td>
<td>2 years related experience plus</td>
<td>HOS II qualification; Environmental Concerns III, with Exam; Maintenance Exam, Level III (materials, top 20 activities, MMS)</td>
<td>CDL (A) / X; NICET Level II Equipment Certification 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 years of UDOT experience</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lead Level</td>
<td>Lead Level</td>
<td>2 years related experience plus</td>
<td>HOS III qualification; Maintenance Exam, Lead Level (Reporting, top 20 activities, materials, compaction), plan reading course</td>
<td>CDL (A) / X; NICET Level III</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 years of UDOT experience</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance Training Specialist I</td>
<td>Maintenance Training Specialist 1</td>
<td>2 years related experience plus</td>
<td>HOS II qualification; Participant in Region Snow Plan</td>
<td>CDL (A) / X;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 years of UDOT Maintenance experience</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance Training Specialist II</td>
<td>Maintenance Training Specialist 2</td>
<td>2 years related experience plus</td>
<td>HOS III qualification; Train the Trainer (minimum 40 hours); attend Maintenance Training Academy; Third Party tester CDL; must complete 3-day course on Video production and editing; Must attend training on NICET procedures; Must attend course on Maintenance training equipment certification</td>
<td>CDL (A) / X; NICET Level II; Maintenance Training Equipment Certificate; Must be certified trainer on 13 specific Maintenance activities.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 years of UDOT Maintenance experience, minimum 1 year of which as Maintenance Trainer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Position</td>
<td>Class</td>
<td>Work Experience</td>
<td>Training</td>
<td>Other Licenses</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>--------------------------------</td>
<td>---------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------</td>
</tr>
<tr>
<td>Maintenance Training Specialist III</td>
<td>Maintenance Training Specialist 3</td>
<td>2 years related experience plus 3 years of UDOT Maintenance experience, minimum 2 years of which as Maintenance Trainer</td>
<td>Must be Trainer II; Maintenance Exam/Supervisor Level; Plan reading course</td>
<td>CDL (A) / X; NICET Level IV;</td>
</tr>
<tr>
<td>Station Supervisor/Highway Operations Supervisor</td>
<td>Station Maintenance Supervisor</td>
<td>2 years related experience plus 5 years of UDOT Maintenance experience</td>
<td>Maintenance Exam/Supervisor Level; MMS; Plan Reading Course</td>
<td>CDL (A) / X; NICET Level IV;</td>
</tr>
<tr>
<td>Region Maintenance Operations Analyst</td>
<td>Maintenance Analyst</td>
<td>2 years related experience plus 5 years of UDOT Maintenance experience</td>
<td>Lead Level qualified; Maintenance Exam/Analyst Level, including MMS</td>
<td>Valid Utah Driver’s License; NICET Level IV;</td>
</tr>
<tr>
<td>Region Maintenance Area Supervisor</td>
<td>Area Supervisor</td>
<td>2 years related experience plus 5 years of UDOT Maintenance experience</td>
<td>Station Supervisor/Analyst qualified; Maintenance Exam/Area Supervisor Level, including MMS</td>
<td>Valid Utah Driver’s License; NICET Level IV;</td>
</tr>
</tbody>
</table>

Each of the above positions requires a level of maintenance knowledge, training, and competence. When a vacancy occurs, the level of training required to fill the position is specified. To be able to apply for the position, applicants provide evidence of having met the training, qualification, and certification requirements.

### a. The M3 Program

The Department established four levels of learning to be completed over a four-year period. The Department established a partnership with the College of Eastern Utah (CEU) and created a memorandum of agreement known as the M3 Program. “M” represents maintenance and “3” represents training, testing, and tenure. The scope of each level is described in Exhibit V-11 on the following page.

The M3 program sessions run for two weeks in the fall, one week in the spring, and one week in the summer for final examinations. Students are tested according to CEU standards for scholastic subjects and UDOT standards for Academy subjects.

The program is currently being expanded to prepare employees for the Transportation Tech classification. The purpose of the new classification is to produce employees that can function in both maintenance and construction. To accomplish this objective, the program is considering expanding the curriculum.
to include two additional weeks of training on materials: one week in the Academy and one week in the M3 Program.

Exhibit V-11: M3 Curriculum

<table>
<thead>
<tr>
<th>Year 1 – Level 1 (The Training Academy)</th>
<th>Semester-Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>HETR-2988 UDOT Rules &amp; Regulations (Academy)</td>
<td>3</td>
</tr>
<tr>
<td>HETR-2988 UDOT Equipment Training (Academy)</td>
<td>3</td>
</tr>
<tr>
<td>BCIS-1900 Elementary Typing and Keyboarding</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year 2 – Level 2 (CEU)</th>
<th>Semester-Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGL-1010 Introduction to Writing</td>
<td>3</td>
</tr>
<tr>
<td>MATH-0970 Fundamentals of Mathematics</td>
<td>4</td>
</tr>
<tr>
<td>BCIS-1010 Computer Literacy</td>
<td>3</td>
</tr>
<tr>
<td>HETR-2988 UDOT Equipment Training (on-the-job training)</td>
<td>3</td>
</tr>
<tr>
<td>WILD-2988 Environmental Studies</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year 3 – Level 3 (CEU)</th>
<th>Semester-Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BUSN-2030 Business English and Communication</td>
<td>3</td>
</tr>
<tr>
<td>MATH-0990 Preparatory Algebra</td>
<td>3</td>
</tr>
<tr>
<td>BCIS-1300 Intro to Internet/Web Page Design</td>
<td>2</td>
</tr>
<tr>
<td>BCIS-1405 Word Processing I</td>
<td>2</td>
</tr>
<tr>
<td>PSYH-1310 Human Relations in Business &amp; Industry</td>
<td>3</td>
</tr>
<tr>
<td>PSYH-2988 Supervisory Skills</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year 4 – Level 4 (CEU)</th>
<th>Semester-Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH-1020 Table Mathematics</td>
<td>3</td>
</tr>
<tr>
<td>BUSN-1091 Business Presentations</td>
<td>2</td>
</tr>
<tr>
<td>BUSN-2390 Organizational Behavior</td>
<td>3</td>
</tr>
<tr>
<td>PHYS-1050 Technical Physics</td>
<td>3</td>
</tr>
<tr>
<td>HETR-1610 General Maintenance</td>
<td>4</td>
</tr>
</tbody>
</table>

**Additional Electives (CEU)**
(Previous college credits may apply)

**b. The Training Academy**

The first level of the M3 training program is referred to as the Training Academy. The curriculum is fully designed, controlled, and delivered by the Department, although it takes place on the CEU campus. The objectives of this Training Academy program are to:

- Prepare new employees who have no previous background in maintenance.
- Upgrade the skills of existing workers.
- Improve safety at work by teaching proper techniques and reducing accidents.

The first level of training consists of one week of formal classroom lectures on general topics in maintenance and one week of hands-on training in equipment and field observation of maintenance operations. The training provided during
these two weeks is the same for everyone in the State. Later, the curriculum includes on-the-job training that focuses on the specific areas of concern in the employee’s region/district and is provided under the supervision of the region/district’s Training Specialist.

(1) Academy structure

The Academy faculty comprises three region and three district trainers, representatives from Central, lecturers from Department staff who teach in their respective areas of knowledge and expertise, and some lecturers from vendors. In addition to training, the Training Specialist has a number of responsibilities. For example, he or she keeps certification records on the 12 equipment types; tracks each employee’s advancement on the ladder; updates the region’s database of re-certifications and keeps paper copies for the designated units in the Department; designs and administers tests and proxies; schedules academy attendance and M3 Program attendance and promotions; prepares custom-made, demand-responsive training programs in other needed subjects required for his or her district; and arranges for computer training using the State’s mobile computer center. The Central Unit Training Specialist administers the program in consultation with district trainers.

(2) Academy program

The Academy program targets new workers within their first six months of service. It introduces employees, at an early stage, to the concepts of safety in the workplace, risk management, first aid and CPR, and safe handling of equipment. This program is designed to keep the employees, colleagues, and the public safe. Classroom instruction emphasizes the theory underlying key maintenance activities. The hands-on training focuses on safe equipment handling and maintenance.

The Academy program covers the subjects listed in Exhibit V-12. The current curriculum is the result of a number of modifications made over three years based on student and curriculum evaluations. For example, this year’s curriculum includes an additional four hours of hands-on equipment training in response to evaluations from earlier sessions. The program is flexible in order to accommodate new knowledge and to incorporate emerging concerns.

After two weeks at the Academy, the employees return to their station, where they receive further on-the-job training on specific equipment.
**Exhibit V-12: The Academy Basic Training Curriculum**

- Maintenance Operations
- Department Standards
- Vegetation Management
- Environmental Issues
- Legal Loads (Permits)
- First Aid/CPR
- Loss Control
- Equipment Policy/Procedures
- Equipment Management
- Gas Cards
- Equipment Accounting
- Repairs/Service Equipment
- Shop Operations
- Fire Extinguisher Safety
- Rest Area/Station Maintenance
- Traffic Control
- Safety Operations
- Flagger Training
- Sander Calibration
- Tractor Mower Certification
- Air Compressor Certification
- Truck Certification
- Loader Certification
- U.H.P. Truck / Troopers
- Radio Training
- EEO Personnel
- Snow and Ice Control
- Defensive Driving

(3) **Incentives to continue beyond the Academy in the M3 Program**

Those who intend to pursue a career in maintenance may advance to Levels 2, 3, and 4, where they may obtain an “Associate of Applied Science” degree from CEU. To encourage diversity of knowledge and flexibility in the deployment of staff, UDOT created a pay raise incentive for maintenance staff who cross-certify in construction or materials through NICET. UDOT no longer administers NICET Certification but offers its own certification programs.

(4) **College compensation**

UDOT compensates CEU for its costs at variable rates for the first, second, third, and fourth years of the M3 Program. The University provides students with laptops and the Department pays for the books used by students in the M3 Program as well as tuition fees. If students complete the level, they are allowed to keep the books at no charge; if they drop out, they are expected to pay for the books. This policy serves as an incentive for employees to continue their education. If students finish the M3 Program, CEU allows them to keep the computer; otherwise, they are expected to return the computers to CEU.

The training costs are shared between regions and Central. Central allocates a budget to the Academy based on the number of new staff that are entitled to training. Central Maintenance allocates the budget among the regions,
taking into consideration two criteria: regional needs for training and equity among the regions. The allocated budgets allow each region to send a certain number of employees to the program. Should a region wish to send additional employees beyond the allocated number, the region is expected to cover the additional training costs. For example, the Academy budgets 40 hours of training per new employee. Regions can augment this amount with their own budgets. This year, due to its high turnover, Region 2 needed to send 21 new staff to training. Region 2 paid for 11 of the employees because Central allocated a budget for only 10 employees.

(5) Mobilizing for attendance

There are numerous incentives to encourage staff to pursue Academy training. Some of these incentives are institutionalized requirements and others are the result of staff trying to emulate the path of other successful employees. Examples from the institutionalized measures include:

- The Department has made it mandatory for six-month probationary employees to receive Academy training if they wish to remain in their jobs.
- UDOT designates Academy graduation as a requirement for certain jobs.
- UDOT requires periodic re-certification on equipment.
- UDOT has requirements for refreshing knowledge (for example, station supervisors need a refresher course every three years).
- UDOT recognizes cross qualification for maintenance and construction with a percentage raise in salary. Such staff are referred to as “transportation technicians.”

(6) Evaluation

The Academy carries out two major types of evaluations. The first consists of questionnaires which gauge needs, evaluate course contents, and request assistance from vendors and manufacturers putting the program together. The Academy uses the results from the evaluations to develop partnerships with vendors and other educational institutions. For example, the Academy has partnered in the past with the Utah State University Technology Transfer Center in the production of audio-visual materials for the Academy courses.

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18 The Transportation Technician program is designed to increase the utility of maintenance and construction field staff by enabling construction workers to work on maintenance crews during the winter and maintenance workers to work on construction crews during the summer. The program will be examined in more detail during the next phase of this audit.
The second type of evaluation focuses on the evaluation of program outcomes. This evaluation is carried out at three levels: the individual, the unit, and the program. At the individual level, tests are administered before and after training and the results are used for instructor evaluation.

At the unit level, staff training should yield benefits in terms of safety, productivity, and improvements in quality of work. However, such benefits occur only after a period of time.

At the program level, the Academy relies on the Career Ladder as a basis for evaluation. Essentially, the evaluation focuses on the degree to which graduates are able to attain career ladder objectives. Consequently, the Academy tracks graduates both in and out of UDOT. Graduates who remain with UDOT are tracked with respect to their position on the Career Ladder.

c. The Annual Maintenance Conference

In addition to formal training, UDOT region/district managers receive informal training from the Annual Maintenance Conference. All region/district personnel from station supervisor up attend the Conference. Participation takes different forms, from listening to open debates on issues to sitting on a task force with other colleagues to review specific issues and develop recommendations. The conference is also a chance for informal networking and technology transfer.

In 2002, the Annual Maintenance Conference began with sessions on the direction of the Maintenance Division and public relations. The rest of the conference was comprised of “breakout sessions,” where employees had a choice of four or five different concurrent sessions to attend. Breakout sessions included:

- Retirement
- Erosion Control
- Snow Plow Safety
- Utah Power and Light
- Methods and MMQA
- Homeland Security (FBI)
- Contact Sensitive Solutions and Asset Management
- Equipment
- Procurement
- Shop & Work Ideas
- Risk Management & Accidents
• Buy Rite Procurement
• Blue Stake

2. Best Practices

The following best practices in training programs have been drawn from a review of literature on adult education and a benchmarking review:

a. Clearly define the target audience

For any program to be successful, it has to cater to a specified group of trainees. Diversification of audience tends to widen the scope of the training and causes the subject matter to become shallower.

b. Clearly articulate the learning objectives (outcomes)

These are specific and concrete results that the training program promises to deliver. Results that have immediate impact on efficiency and/or effectiveness of operation are more sellable than general, long-term results. Good programs, however, have a balance of both types of results.

c. Provide good, accessible instructors and a low student-to-instructor ratio

The instructor must be articulate, perceptive, and should be able to deliver instruction using simple methods or techniques. Answers to questions should help students clarify their thoughts. Since students sometimes prefer to ask questions privately, accessibility outside the training session is important.

Each instructor has a limited span of attention. Adding students to the group within the span of attention does not usually reduce the quality of instruction. However, once the span of attention is surpassed, there are negative impacts due to additional students, the extent of which depends, among other factors, on the instructor abilities and quality of other trainees. The student to teacher ratio has always been used as an indicator of teaching quality.

d. Provide a manual for guiding the student during and after training

Good training programs support classroom instruction with clearly written easy-to-follow materials that reinforce the essential information provided in the course. Good materials also provide links and references to resources not specifically covered in the course.
e. **Modify the program based on student evaluations and technology updates**

Good programs request input from students to help develop scope, to assess usefulness of training materials, and to rate subject matter as to priorities. Student feedback is used to reshape the program for future sessions. Good programs also use current technologies and anticipate future technologies where possible.

3. **Strengths and Issues**

The strengths and issues of the training program are based on an analysis of the function, comparative evaluation to best practices, and regional perceptions and opinions.

a. **Strengths**

- The Training Academy and the M3 program have clear audiences (e.g., Academy addresses new employees and M3 addresses the needs of maintenance career oriented staff), specific objectives for learning (e.g., Academy offering a broad base of knowledge covering the essentials and M3 offering formal education), appropriate setting for learning (i.e., CEU), accessible trainers (there is one in each region/district), reasonable student to teacher ratios (e.g., 25-30).

- The majority of interviewees in the regions endorsed Central’s training program, especially the Academy’s.

- The creation of a career ladder that is tied to variable training requirements is a good incentive to keep staff interested in improving their abilities.

- The training committee has also been responsive to suggestions from the trainees, thus offering great program flexibility.

- Every attendee of the Academy completes a feedback form that helps to reshape the program annually.

b. **Issues**

Several areas where training could be increased or improved were identified by interviewees:

- **Testing/Evaluations/Documentation**
  
  Academy students are tested and also complete evaluations of the course and its materials. However, UDOT has not compiled and assessed student test scores. In addition, course evaluations have not been summarized. In order to evaluate the program, this information needs to be compiled and analyzed.
• **Equipment**
  Most program participants will be career equipment operators. The equipment they operate is potentially dangerous if the operator is not proficient in its use. Furthermore, lack of skill is destructive to the equipment itself. These concerns have led to a desire for more hands-on equipment training in the Academy. Although the Academy has already responded to this need by adding four more hours of hands-on training, interviewees felt that organized station-to-station training is more appropriate. Class size would be small and crews would be allowed longer practice time. While the Academy offers trainees more time on the equipment if they wish outside of class time, most trainees do not take advantage of the additional time.

• **Communication skills**
  Some interviewees expressed a desire for more training in the area of communication and writing. The M3 Levels 2, 3, and 4 address communication; however, Station Supervisors are not required to complete those levels, even if they require more communication training.

• **Management systems**
  Some of the employees interviewed would like to see the scope of technical topics, such as MMS and MMQA, introduced into the program. Since all maintenance workers use different parts of those systems in varying degrees, the Department should train staff on the operation and use of those systems and processes.

• **Management**
  Training requirements for certain levels of management, such as Area Supervisors and Maintenance Analysts, are not addressed in the training program. Training in supervisory and management skills, conflict resolution, negotiation, public speaking, and human resources management are valid needs and impact performance.

• **Advanced training**
  Interviewees indicated that the M3 program needs expansion beyond the fourth year. Employees need to be exposed to engineering design, roadside safety features, and safety improvements in order to enhance their performance on the job. Maintenance activity is highly influenced by these areas and good knowledge of the essentials will enhance effectiveness and efficiency of maintenance crews.

The replacement of the NICET certification by M3 certification has created inequities for tenured staff who lack NICET certification by one or two activities and do not wish to start anew in the M3 Program. Although management gave a
two-year notice regarding its intention, the move has created some negative feelings among staff and middle management. This negative feeling can translate into negative impacts on morale and productivity.

The current program does not match methods with learning needs. This weakness was reflected in concerns cited by Central and the regions/districts that training is taken for granted and treated as a “cure all.”

4. Recommendations

Recommendation 44. Conduct rigorous evaluations of training.

UDOT is investing significant resources in training. While the program has received accolades, UDOT lacks key documentation to support the program’s success. UDOT needs to perform much more rigorous ongoing evaluation of the program using test scores, student-based evaluation, input from managers and field staff, and accident rates. These ongoing evaluations need to be fully documented and should be circulated to both Central and region/district management.

Recommendation 45. Reassess the approach towards equipment training.

In order to reassess its approach to training maintenance staff on equipment, UDOT should:

• Collect information on the safety record for various stations.
• Review equipment operator skills and accident patterns on a station-by-station basis, and determine to what extent each station requires equipment training.
• Schedule training needs to accommodate station supervisors’ schedule, making use of equipment downtime and inclement weather.
• Increase accountability and consistency in training programs. Central needs to provide clear guidance to each region’s trainer and the operations (or district) engineer. Operations engineers need to hold trainers accountable for training outcomes.
• The region and district trainers should be in charge of developing performance measures, quantifying these measures, and providing summary evaluations.

The concerns relating to proficiency in equipment handling vary from station to station, depending on the tenure of operators. Lack of proficiency normally translates into greater accident rates. UDOT does not have a system for tracking the number and severity of accidents and is therefore encouraged to create a system to compile that kind of data.

The organization and delivery of training could be enhanced. For example, regional trainers schedule mass training sessions that do not apply to all who attend. Lack of
coordination between the Equipment Division and Station Supervisors often leads to a lag between the delivery of equipment and the presentation of training. This results in operators using equipment prior to receiving training. Some regions forbid operators from using equipment until training has been received, which puts pressure on Station Supervisors to pursue early training.

A team comprising a representative from the Academy, a Station Supervisor, and an Area Supervisor should review the skill needs and the statistical analysis of accident information from various stations. The criteria for improvements should be clearly defined and applied to the training program.

Suggested criteria should include:

- Practical experience on the same or similar equipment.
- Safety record (number of accidents).
- Staff performance appraisal observations.

**Recommendation 46. Include additional topics in Station Supervisor and Area Supervisor training.**

Some functions recently delegated to Station Supervisors and to Area Supervisors require communication skills in order to develop successful and productive relationships. Some of the skills required include negotiation, conflict resolution, and management. Currently, none of these topics are covered in the Station Supervisor or Area Supervisor training.

**Recommendation 47. Provide training on the Maintenance Management System.**

Notwithstanding the problems experienced in operating MMS, those who are knowledgeable in that system can compile a one or two day course focusing on:

- The rationale underlying the MMS system.
- How to use the system to improve productivity and efficiency of field operations.

If the MMS is replaced, the training should obviously be geared to the new system and should be offered on a frequent basis.

**D. Procurement**

The UDOT Procurement Division (Procurement) plays a major role in the Maintenance Division’s business. Procurement advertises and awards statewide contracts for materials used by Maintenance in its day-to-day activities, such as asphalt, paint, and salt. Procurement’s warehouses stock everything from roadway signs and delineators to rakes and shovels. In turn, the Maintenance Division is one of the biggest customers for
Procurement. The following section reviews the existing approach, best practice in the field, strengths and issues, and recommendations for improvement in the area of procurement support for Maintenance.

1. **Existing Approach**

Procurement currently supports the Maintenance Division in several ways:

- Procurement uses specifications developed by Maintenance’s methods engineers to bid on statewide contracts.
- Procurement meets annually in late summer with the regional directors to address concerns, including maintenance issues.
- Procurement holds a product fair once a year. The purpose of the fair is to bring vendors and customers together in order to identify and satisfy customer needs.
- Procurement attends the biannual Maintenance Quality Panel to address procurement issues and identify concerns.
- Procurement provides training sessions throughout the year. At the annual Maintenance Conference, Procurement teaches station supervisors proper procedures for working with Procurement. Procurement teaches a course on state procurement rules and regulations. They will also come to the regions upon request, to teach this same course or address bid law compliance problems. Procurement has also taught a class at the Academy.
- Procurement responds to questions from region/district managers concerning proper bid laws, and has assigned specialists to field questions on particular commodities.
- Region managers may request that Procurement handle the bidding process if they have difficulty finding competition for particular supplies or services.
- Procurement responds to problems when they occur. Procurement has delegated authority to waive procurement rules, when necessary, if Maintenance prepares a memo explaining why the variance occurred. This enforcement role has decreased as training has improved the regions’ knowledge of the State’s regulations.

2. **Best Practices**

Best practice in procurement has been derived from professional experience and several successful federal procurement programs, including the United States Department of Education and the United States Department of Agriculture. In addition, a list of best practices developed by Stanford University’s purchasing office was used for private sector perspective. The following are some examples of best practice employed in the industry:
a. **Provide quality customer service**

Be responsive to customer needs, and add value to all transactions. This may be accomplished by:

- Developing a strong partnership with customers, providing each customer with a known contact who is available when needed.
- Finding innovative and workable solutions to customer problems.
- Continuously seeking customer input through formal and informal channels.
- Educating customers on proper procedures and procurement regulations.

b. **Set high standards for business practices**

Provide good management, communication, and efficient procurement processes.

c. **Acquire, store, and distribute quality materials in a timely manner**

Use contemporary technologies such as e-procurement, materials tracking and warehousing systems, and online procurement capabilities.

3. **Strengths and Issues**

a. **Strengths**

- Procurement has established a committee to improve customer service.
  
  Procurement chairs the Buy Right Committee, a standing committee created to address problems with quality and functionality of procured products. The Committee has cross-functional teams, including administrative personnel, station supervisors, field crew members, and warehouse staff. The Committee reviews specifications and makes decisions about adding or removing items from inventory. The Committee has reportedly increased satisfaction with the quality of the products that Procurement provides.

- Procurement has recently refocused its attention away from detection of procurement violation to prevention.

  By teaching classes, answering questions by phone, and assisting with the bid process, Procurement reportedly has not only reduced problems, it has also improved the relationship between itself and its customers.
b. Issues

- Station supervisors reported problems in obtaining prices for certain items from the Central Warehouse.

Although department-specific items such as road signs and delineators have clear prices, they reported that items such as gloves, coveralls, and shovels are not priced by the warehouse. Instead, station supervisors must wait until they receive FiNet reports at the end of the month to determine actual cost for their station budgets.

- Many region/district field staff reported that they do not understand procurement process and regulations.

Identifying true costs, proper procedures for obtaining materials, and state limitations for purchases all were areas of concern.

- There have been delays in awarding statewide contracts for asphalt and paint.

The asphalt contract lapsed before a new contract was awarded. As a result, some station managers resorted to costly emergency procurements in order to obtain the necessary asphalt. Many of the materials used in maintenance are needed during the summer work season and should be available in June and July.

- Some procurement technology is outdated.

Codes used for maintenance materials are 11 digits long. Codes must be manually typed each time a material is bought or used. This not only takes time, but also increases the chances of data entry errors.

4. Recommendations

Recommendation 48. Procurement should include information on accessing current inventory item pricing in its training seminars.

Procurement stated in interviews that prices are available over the Internet for all items in their warehouses. However, several station supervisors reported that the information was not available. Procurement should ensure that station supervisors have access to this information by adding a segment on accessing inventory prices to its training seminars.

Recommendation 49. The Central Engineer for Maintenance should work with Methods Engineers to meet deadlines with Procurement.

Advertising and bidding for materials should be done well in advance of Maintenance’s scheduled work. While this is how the procurement process has been planned, Procurement reported that for the past three years, Methods Engineers have
changed the asphalt specification just prior to bidding the contracts. According to Procurement, this last-minute change has created the contract lapses in prior years. In order to avoid future lapses, Procurement should give the Engineer for Maintenance deadlines for statewide contract specifications. The Engineer for Maintenance should then hold Central’s Methods Engineer accountable for meeting those deadlines.

**Recommendation 50. Procurement should investigate new technology for data collection of warehouse and inventory information.**

There are numerous types of new technology available to improve, speed up, and accurately record warehouse information. One such technology is bar coding, which is used by the Washington State DOT. If UDOT employs a bar coding system for equipment parts, as recommended in a prior audit, Procurement should share the same technology. A representative in Procurement has indicated that it evaluated bar coding and did not find it cost-effective. However, we recommend reevaluation because of the benefits identified elsewhere.

E. Vegetation

Support for vegetation maintenance is a Central function that involves training and providing technical assistance to the regions on effective erosion control, noxious weed control, and vegetation establishment and control. The primary objective for the vegetation maintenance program is preservation. Aesthetics is a lower priority. The program aims to prevent erosion and the destructive effects of uncontrolled roadside weeds, as well as to provide habitat for wildlife. The following section reviews the existing approach, best practices in the field, strengths and issues, and recommendations for improvement in the area of vegetation maintenance.

1. Existing Approach

The Central Roadside Vegetation Manager provides overall direction for the Vegetation Program. In addition, the Roadside Vegetation Manager researches and provides solutions and directs limited funding to resolve vegetation problems raised by the regions.

The Roadside Vegetation Manager directs the research for this program area. This position prepares proposals for federal grants and is active in national associations in order to stay current on innovative technology. The current Roadside Vegetation Manager is a Certified Professional Roadside Manager (CPRM) by the National Roadside Vegetation Management Association (NRVMA), and is currently the chairman for the national certification committee, and is also scheduled to present at the Fall 2002 conference.

Actual vegetation maintenance is accomplished by field maintenance personnel. Some regions/districts have a crew designated to handle all vegetation maintenance activities.
In others, the vegetation maintenance is accomplished by maintenance technicians as part of their regular work program.

UDOT is implementing an Integrated Roadside Vegetation Management (IRVM) approach to roadside maintenance. IRVM is a decision-making and quality management process for maintaining roadside vegetation that integrates the following:

- Needs of local communities and highway users.
- Knowledge of plant ecology (and plant processes).
- Design, construction, and maintenance considerations.
- Monitoring and evaluation procedures.
- Government statutes and regulations.
- Technology.

The IRVM approach promotes the appropriate selection of cultural, biological, mechanical, and chemical methods to economically manage roadsides for safety, environmental concerns, and visual quality.

The Roadside Vegetation Manager has established relationships with the State’s wildlife management agency and other agencies within the State to align program goals with UDOT. The Utah Division of Wildlife Resources (DWR) initiated the Utah Rural Roadsides for Wildlife Program (URRPW). The program is based on a concept of cooperation between state government, county government, individuals, and other interest groups, such as Pheasants Forever, to promote roadside habitat enhancement.

Utah has officially designated 18 plants as noxious weeds. Counties within the state may add weeds to the list; one county has even subtracted a plant from the list. It is essential that local maintenance crews work with the local agencies for effective noxious weed control. UDOT is responsible for preventing the spread of noxious weeds over 5,900 miles of roadside.

2. **Best Practices**

Best practices in vegetation have been compiled through benchmarking surveys and interviews with experienced maintenance staff.

a. **Participate in a continuing education program in order to stay current with the latest techniques**

Vegetation maintenance is a specialized area of highway maintenance that requires unique expertise not required in other areas of highway maintenance. Knowledge of plant ecology, herbicide application, and specialized equipment
are examples of the specialized expertise required for a successful vegetation management program.

This ongoing education may be accomplished in several ways:

- Participating in national, state, and regional conferences.
- Pursuing continuing education programs offered by local colleges and universities.
- Seeking knowledge of ongoing research.

b. Adopt an integrated pest management (IPM) approach to vegetation maintenance on roadsides

IPM is a coordinated decision-making and action process that uses the most appropriate pest control methods and strategy in an environmentally and economically sound manner to meet agency vegetation management objectives. The primary elements of IPM include:

- Preventing pest problems.
- Monitoring for the presence of pests and pest damage.
- Establishing the tolerance for density of pest populations.
- Treating pest problems below threshold levels using the appropriate strategy.
- Evaluating the effect and effectiveness of the treatments.

Washington State calls their program Integrated Vegetation Management (IVM). UDOT has identified their program as Integrated Roadside Vegetation Management (IRVM).

A primary goal of an IPM program is to reduce or eliminate the use of herbicides. Although herbicides have proven to be successful and cost-effective in controlling weeds, many think they have detrimental effects on the environment. Environmental groups and wildlife preservationists have put enormous pressure on highway maintenance programs across the nation to reduce or eliminate the use of herbicides. Problems with herbicides may include significant weed resistance to registered products, contamination of surface and ground water, increased regulation and litigation, withdrawal of products from the market, increasing costs, employee concerns about herbicide exposure, and complaints from adjacent landowners and the general public about non-target impacts.

California has developed a “Tool Box” of alternative weed-control methods that do not rely on the use of herbicides. Other states have utilized highly specialized application equipment to target weed species in order to minimize the amount of
herbicide applied. Treatments with highly selective herbicides also target a relatively narrow group of plant species, minimizing off-target damage.

Many states have begun emphasizing the establishment of native plant varieties on roadsides. Native vegetation adapts better to local site conditions, provides effective erosion control, and has greater resistance to local pests. Native plants also offer better habitat and forage for roadside wildlife and blend with the adjacent natural environment. Another major feature of native plant species is they require only occasional maintenance and survive and regenerate despite the climate extremes along roadsides.

3. Strengths and Issues

a. Strengths

• The Roadside Vegetation Manager provides effective leadership, useful training, and answers to concerns.

Although many in the regions believed that funding for the Vegetation Program is inadequate, most pointed out that the Roadside Vegetation Manager does an excellent job finding funds for pressing concerns in their region.

• UDOT’s roadside planting and management practices set a standard followed by most counties.

UDOT supports the URRWP and is responsible for managing an estimated 1,500 miles of roadside in Utah's pheasant country. UDOT strongly advocates county cooperation with the URRWP.

• Recent actions have reduced the environmental impact of UDOT’s vegetation management program.

Chemical spraying statewide has been reduced in recent years from $750,000 to $450,000 per year. Mowing costs have also been reduced through a mowing “delineation policy” that allows taller grass on the roadside as better wildlife habitat.

b. Issues

• Differences in the organization of the regions and districts have reduced Central’s confidence in the ability of the local crews to successfully accomplish major vegetation objectives.

While some regions have a special crew that is trained and certified in vegetation maintenance, other regions do not. It is not always clear within the regions who has vegetation maintenance responsibility. Accidental
elimination of desired vegetation has sometimes been caused by employees who lack knowledge of vegetation objectives.

- Communication between UDOT’s Maintenance and Preconstruction Divisions is often lacking.

Some landscape designers from Preconstruction plant vegetation (such as wildflowers) that Maintenance classifies as noxious weeds. Maintenance then kills the new plants during the next spraying cycle. Not only does this represent a waste of money, it breeds ill will between the divisions.

- Some regions/districts must be pressured by Central to spend money that was allocated for vegetation maintenance.

These regions/districts do not clearly understand the objectives and goals of the program.

- Some interviewees in the regions indicated that they do not agree with the MMQA performance measures for vegetation condition.

4. Recommendations

**Recommendation 51. Determine the effectiveness of dedicated vegetation crews in each region/district. If the approach is proven to result in better outcomes, UDOT should establish a special crew in every region/district.**

Knowledge of vegetation maintenance objectives and experience with known effective techniques is critical for delivery of an effective vegetation maintenance program. Since this is a very specialized expertise not available to the rank and file maintenance staff, it is important to have properly trained people to do this work. One way to do this is through dedicated vegetation crews. Building institutional memory is vital.

**Recommendation 52. Obtain maintenance input early in project design, before projects are constructed.**

Design personnel generally lack an understanding of maintenance requirements. Once designs are developed and completed, they are difficult to amend for maintenance considerations. For maintenance to provide substantive input to project design, they must do so early in the process before plans are well developed. Only at this stage can changes be made easily. In some cases, maintenance may not be included in the design loop. Designers assume maintenance will understand what is intended, even if it means implementing a new concept such as planting wildflowers that have, in the past, been designated as noxious weeds. Early interaction between designers and maintenance can also help convey new design concepts unfamiliar to maintenance, and prevent accidental elimination of desired plant materials.
Recommendation 53. Increase knowledge and training on vegetation objectives and the methods used by maintenance managers to improve understanding of the vegetation maintenance program.

Many rank and file maintenance personnel are well versed in vegetation maintenance objectives, but their immediate supervisors or managers are not. Since the managers are responsible for deploying maintenance crews to particular areas of each region/district, they should understand what is to be accomplished and the financial ramifications of their decisions. Only through a complete understanding of vegetation objectives and methods can this be accomplished.

Recommendation 54. Obtain input from maintenance personnel on all levels before developing MMQA performance measures.

Many view MMQA as having great potential as a maintenance management tool, but believe it requires substantial modification before being fully effective. A major criticism is that field personnel do not agree with the criteria used to determine the condition of a given feature. This is especially true with many vegetation maintenance activities. In order for MMQA to be credible, it is important for all levels of maintenance personnel to have trust and confidence in the system.
VI. Region/District Operations

A. Region/District Organization

This section reviews the organization of region maintenance units, best practice in the field, strengths and issues, and recommendations for improvement.

1. Existing Approach

Chapter II provided a distinction between the role of Central and that of the regions/districts. In summary, region/district maintenance units are responsible for delivering the day-to-day care and operation of the state highway system. Responsibilities include evaluating field conditions, selecting appropriate maintenance strategies, assigning work crews, accomplishing appropriate maintenance tasks, and accounting for the deployment of resources. Central is primarily responsible for supporting the region/district operations. Areas in which Central provides such support are detailed in previous chapters, including the maintenance management system, the feature inventory, training, budgeting, methods engineering, pavement preservation, facilities procurement, and vegetation management. Although Central provides this support to the regions/districts, it does not have direct authority over the region/district maintenance units. All region/district maintenance managers report to a region director instead.

a. Region/District Maintenance Unit Roles and Responsibilities

Region/district maintenance units are involved in all stages of the maintenance work, from planning and budgeting to field work. Exhibit VI–1 shows the business model for the region/district maintenance units. The model illustrates the major roles, responsibilities, and work products produced by the regions/districts.
Responsibility for region/district maintenance is divided among several standard positions. Each region/district maintenance unit has an operation engineer/district engineer, a maintenance analyst, area supervisors, station supervisors, and a maintenance trainer. All the regions and the Cedar City district also have a maintenance engineer. Below are descriptions of the primary duties for each
position, developed from UDOT’s website and in consultation with maintenance analysts from the regions/districts.

(1) **Operations Engineer/District Engineer**

The Operations Engineer/District Engineer is responsible for all UDOT maintenance activities within their respective region/district. Approving region/district work programs and budgets and recommending adjustments are additional responsibilities. They are the first line of contact with local governments as well as the general public regarding transportation issues within their region/district. The Operations Engineer/District Engineer reports to the Region Director.

(2) **Maintenance Engineer**

The Maintenance Engineer is responsible for the administration of the maintenance division operations of each district. This includes personnel matters, budget administration, equipment management, engineering design and construction for maintenance projects, administration of lands and buildings, and the handling of surplus property. The maintenance engineer also handles contact with local governments, highway users, property owners, and contacts with other agencies. They participate in the District Safety Committee, region design functions, and region construction functions.

(3) **Maintenance Analyst**

The Maintenance Analyst prepares and monitors the region/district maintenance budget. The Maintenance Analyst is also responsible for updating the feature inventory and keeping costs current on special maintenance activities. In addition, the Maintenance Analyst may audit daily T-91 reports.

(4) **Maintenance Trainer**

The Maintenance Trainer provides training opportunities for all career maintenance employees in all maintenance areas, including equipment operations and safety practices.

(5) **Area Supervisor**

Area Supervisors are accountable for all maintenance stations in their respective areas. Area Supervisors also schedule activities for and preservation of surfaces on all highways, and handle concerns from the traveling public and businesses.

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19 Although the below descriptions summarize the roles of each region/district position, each employee may have additional duties as assigned by region/district management.
(6) **Station Supervisor**

Station Supervisors are responsible for managing the daily operations of the maintenance station. Station Supervisors are accountable for delivering the station’s maintenance plan within budget.

(7) **Maintenance Crew**

Each maintenance station has a crew, whose goal is to maintain and preserve State and Federal highway infrastructure. Crews carry out and oversee maintenance activities.

Appendix G contains the organization charts for each region/district.

b. **Contract Maintenance**

In addition to region/district maintenance crews, some maintenance activities are performed by private contractors or other public agencies by contract. With two notable exceptions, the decision to contract for maintenance is left to the regions/districts. As previously noted, Central manages a contract to maintain most of the state’s rest areas; the regions/districts contract for “Orange Book” contracts.

Regions/districts vary in their level of contract maintenance. One region contracts out frequently for flagging, pavement markings, concrete work, and other routine maintenance. Conversely, two districts only contract out regularly for carcass removal. The most common reason cited by region/district staff for contracting out was that the activity has historically been contracted out. One district reported that it fully utilizes its FTEs and tries to use contracted maintenance to make up the difference between what its own forces can complete and the target levels of service that have been set for the district. All regions/districts noted that they have insufficient funding and/or staff to meet their desired level of service.

2. **Best Practice**

Best practice has been compiled from organizational and change management consulting experience as well as from the Maintenance Management for the 21st Century Forum held in Arlington, Texas in June 1999.

a. **Succession planning helps to address increasing rates of attrition**

State DOTs across the country are faced with potential holes in their leadership structure due to retirements and flight of employees to the private sector. In order to ensure that the organization can successfully fill those leadership positions, a

[20] Regions/districts cannot increase their FTEs without Central approval.
succession plan that recognizes the problem and provides a strategy to develop employees for leadership positions should be in place. One important prerequisite to successful succession planning is “open dialogue about the potential and readiness of successors.”21 Too often, upper management is resistant to discuss candidates for succession. However, if the organization fails to openly discuss its succession plan, it fails to prepare both the candidates and the organization for the inevitable attrition of leaders.

b. Performance management is used to motivate employees and hold them accountable for results

Our experience has indicated that an emphasis on performance is more important than any specific organizational structure. Region maintenance units should be given significant latitude in determining how best to accomplish work as long as they meet performance objectives. This latitude can encourage innovation and productivity in the regions.

Performance management is a key component of best practice in managing human resources. In a performance management system, employees and managers jointly agree upon goals by which the employee will be evaluated at the end of the year. Pay raises and/or bonuses are linked to the attainment of performance goals. Conversely, failure to meet performance goals could lead to denial of raises and promotion or, eventually, termination. Ideally, the performance management system is aligned with the strategic business plan. In this way, the goals of the strategic business plan are implemented by integrating with the goals of individuals’ performance management plans.

c. A systematic process is used to determine whether maintenance activities remain in-house or are contracted out

Contracting out maintenance activities is often a sensitive subject for DOTs. In some states, Legislatures or DOT managers have mandated a certain level of contracting out, without regard to the costs and benefits of the approach. However, the decision to contract out “should be based on the agency’s need to be more efficient and effective, not on some arbitrary policy decision.”22

Well-designed maintenance contracts can have several benefits, including:

- Meeting higher customer-defined levels of service than the agency can complete itself.

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• Eliminating the need to own and maintain equipment that is only sporadically used.
• Leveling out seasonal peaks and valleys in maintenance work.
• Taking advantage of the newest technology to increase efficiency.
• Increasing quality and reducing costs.\textsuperscript{23}

However, maintenance contracting is not always appropriate. Some of the potential disadvantages of contract maintenance include displacement of state maintenance staff, loss of control over asset management information, and higher costs – especially if the power of competition is not present.\textsuperscript{24}

In order to evaluate whether contracting out a particular maintenance function is cost effective, some agencies have developed systematic processes. The Arizona Department of Transportation (ADOT), for example, has developed a process where maintenance activities are routinely evaluated according to the availability of competition for the work, complexity of the work, and level of risk to the department, among other factors.\textsuperscript{25}

3. **Strengths and Issues**

a. **Strengths**

UDOT has a decentralized organizational structure that encourages regions/districts to be innovative and creative in finding solutions to common problems. Monthly meetings among the operations engineers and district engineers, along with the annual maintenance conference allow for dissemination of lessons learned among regions/districts.

Performance management is used throughout UDOT, from Central to the regions/districts. However, the region/district management is responsible for creating and implementing performance management plans.

\textsuperscript{24} Ibid, pp. 7–8.
\textsuperscript{25} Ibid, 42.
b. Issues

- Lack of succession in planning

Almost one-third of non-engineer UDOT employees\(^{26}\) are over 50. Forty-eight percent of UDOT employees are over 45. Nine percent of workers have served UDOT for thirty years or more. After 30 years of service, a UDOT employee can retire with full pension benefits. Although UDOT has recognized that attrition will affect the Department’s future performance, UDOT has not developed a formal succession plan. According to the UDOT Human Resources Director, an informal succession plan was developed under the previous UDOT Executive Director, but it was never documented. The absence of a succession plan threatens the continuity of maintenance programs and corporate knowledge. Central has realized some of these problems with the retirements of staff in charge of MMS and the Feature Inventory.

- Insufficient links between performance plans and key department programs

Sample performance management plans reviewed by the consultant team had clear goals (objectives) and performance metrics. However, Level of Service targets developed in MMQA had not been tied to the performance management plans reviewed. Only some regions/districts reported that their performance management plan goals are related to the goals from the Department’s Strategic Direction. Some regions/districts reported that a good performance review can result in a raise and a poor review can result in denial of a raise or termination. But raises are only given if the Legislature has appropriated funds for them. Therefore, if an employee has performed exceptionally on his or her performance plan, but the Legislature has not approved raises for the Department, the employee’s performance will not be rewarded.

- Lack of a systematic approach to maintenance contracts

The decision to contract out maintenance activities is appropriately left at the region/district level. Each region/district has different characteristics that impact the potential for a maintenance contract to be successful – for example, availability of private sector competition, expertise of current maintenance crews, and possession of specialized equipment. However, the regions/districts did not report having a systematic approach for evaluating the option to contract out. Without such a methodology, it is difficult to be conclusive about whether the regions/districts have the appropriate level of contracting out.

\(^{26}\) UDOT has not tracked statistics on Maintenance Division employee retirements. The overall UDOT figure for non–engineering personnel are used under the assumption that they accurately represent those of the Maintenance Division.
4. Recommendations

Recommendation 55. Develop a departmental succession plan.

UDOT should develop a formal succession plan. The plan should analyze current and future attrition rates and preparedness of current staff to replace expected retirees. The plan should also link to the Department's performance management and training programs.

Recommendation 56. Provide leadership to the regions/districts in developing effective performance management plans.

Central, with help from UDOT Human Resources, should provide guidance to the regions/districts on effective performance management. In order for performance measures and MMQA to be taken seriously by UDOT region/district personnel, the Department must institutionalize the right incentives. Managers and staff should be evaluated on how they meet level of service targets set in the MMQA process. Guidance from Central should include example goals and performance measures for each region/district position that link to the Strategic Direction and target Levels of Service.

Recommendation 57. Ensure that performance is rewarded.

In order for performance management plans to be effective in motivating employees, staff need to be confident that they will be rewarded for achieving their goals. UDOT should consider replacing the flawed current bonus system with a system that ensures attainment of performance goals will be rewarded.

Recommendation 58. Develop guidance for the regions/districts for evaluating whether or not maintenance activities should be contracted out.

While regions/districts should conduct an analysis of the benefits and costs to contracting out at their individual levels, Central should develop guidance for developing a methodology for the analysis. At minimum, the analysis should include:

- Availability of current maintenance crews.
- Need and availability of specialized equipment.
- Need and availability of specialized personnel, as well as the potential to train current personnel to perform the specialized task.
- Need and availability of staff to cover peak workloads.
- Overall cost saving potential.
- Ability of the department or a contractor to address emergency roadway services.\(^{27}\)

B. Transportation Technician Program

1. Existing Approach

UDOT’s Transportation Technician Program seeks to cross-train construction and maintenance personnel to enable maintenance staff to serve as construction inspectors and to enable construction staff to assist maintenance in winter activities. The stated benefits of the program are as follows:\(^{28}\)

- A better organization through better educated and trained employees.
- Better ability to manage the workforce and reduce overtime and overhead.
- Better career mobility for employees.
- Better safety for employees and others.

The program entails a four-year curriculum for training and education, after which employees choose the unit (maintenance or construction) to which they will be permanently assigned. The Program is now in its third year. All full-time employees in the appropriate maintenance and construction ranks are eligible to participate. Exhibit VI–2 shows the total number of Transportation Technicians enrolled in the Program in each region.

Exhibit VI–2: Region Transportation Technicians\(^{29}\)

<table>
<thead>
<tr>
<th>Region</th>
<th>Number Enrolled</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>2</td>
<td>35</td>
</tr>
<tr>
<td>3</td>
<td>19</td>
</tr>
<tr>
<td>4</td>
<td>27</td>
</tr>
<tr>
<td>Total</td>
<td>92</td>
</tr>
</tbody>
</table>

2. Rotation of Assignments between Maintenance and Construction

Rotation of Technicians between maintenance and construction is based on needs in the respective functions. It is scheduled using a 2-year outlook, with typically 17 months in maintenance and 7 months in construction for maintenance employees. Construction employees in the Program are typically assigned to

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\(^{29}\) Numbers include both maintenance and construction employees, but the majority are in maintenance – only six are in construction.

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maintenance for 3–4 months in the winter. Rotation assignments are staggered from one year to the next, so that only some Technicians are rotated each year. Numbers of rotations vary each year.

Analyses of cost savings attributable to the Program that have been done by UDOT Region 2 document the benefits to construction in several areas:

- Personnel services: i.e., savings in labor costs to construction, attributable to the fact that regular time for maintenance Technicians working in construction is paid from the maintenance budget.
- Reduced overtime, due to the fact that maintenance Technicians are able to provide services during regular time (paid by the maintenance budget) that would otherwise require additional overtime by construction employees.
- Vehicle cost recovery, due to the fact that construction Technicians sent to maintenance with construction vehicles enable cost recovery for equipment usage during the period in which these construction vehicles are used for maintenance.

In July 2001, the total value of Region 2 cost savings was estimated as $590,000 annually. No corresponding analysis was provided for maintenance. In fact, during the initial years of the Program, maintenance will incur a net cost due to the cost attribution practices above. However, some immediate benefits to maintenance have been realized through Technician assistance in performing labor-intensive maintenance activities. In the longer term, as Technicians (from construction) receive more training and acquire commercial driver’s licenses (CDLs), it is expected that savings to maintenance will accrue from reduced overtime for winter maintenance. As of July 2002, however, benefits still accrue to construction alone, with the Transportation Technician Program resulting in a net cost to maintenance based on Region 2 analyses of the Program.

b. **UDOT Cost Tracking**

The following cost tracking practices pertain to the Transportation Technician Program at UDOT:

- The cost of regular time employment of all Transportation Technicians is borne by maintenance, regardless of assignment. Thus, Technicians assigned to maintenance and Technicians assigned to construction are paid by maintenance.\(^\text{30}\)

\(^{30}\) If a “regular” construction employee (i.e., an employee not in the Transportation Technician program) is detailed to assist maintenance, regular time for that employee is paid by construction. Overtime is covered as described above.
• The cost of overtime is paid by the organization to which it is assigned. Thus, overtime by a Technician assigned to maintenance is paid by maintenance; overtime by a Technician assigned to construction is paid by construction.

• The usage costs of construction vehicles that are used for winter maintenance as part of a Technician’s assignment to maintenance are paid by maintenance.

As a result of these practices, the human resource and financial implications of the Transportation Technician Program are not immediately apparent at a statewide level when consulting routine financial reports. Reported maintenance labor expenditures include an unstated amount for work done by Technicians when they are assigned to construction.

Discussions with the Comptroller’s Office identified the rationale for this method of cost accounting.

• Budgets and agency FTE allowances are established by the legislature. Since separate budget line items and FTE allowances apply to construction and to maintenance, it is not possible for UDOT to “transfer” labor budget or FTEs between construction and maintenance during a fiscal year to track Technician rotations.

• Maintenance has the majority of staff enrolled in the Transportation Technician Program, as noted earlier.

• A financial management decision has been made to budget dollars and FTEs for Transportation Technicians in maintenance, since this is the unit in which they will spend most of their time (typically 17 of 24 months).

• For consistency, construction employees who join the Program cause UDOT to transfer the respective FTE slots and labor budget to maintenance; these changes are submitted for legislative approval. While these Technicians spend most of their time in construction, maintenance is budgeted for their wages, and their time and labor cost are reported by maintenance. While theoretically this situation could cause misleading interpretations of staffing, labor cost, and productivity data (since maintenance is covering cost for employees that provide no maintenance services two-thirds of the year), the small number of construction employees who have to date joined the Program are felt by UDOT to have negligible statistical effect.

2. Best Practices

The Transportation Technician Program has a number of objectives summarized above. Best practice would suggest that:

• The Program be executed in a manner that achieves these objectives.

• Information about the Program be communicated to potential candidates.
• Employees have the opportunity to avail themselves of the Program’s benefits and advantages if desired.
• Progress in achieving desired benefits be tracked statewide.

There are also best practices that apply generally to the administration of a program like this from the perspective of resource allocation:
• Information on rates of participation across the organization.
• Transparency in understanding the impacts of the program on current operations.
• Knowledge of the full costs and benefits of the program.

3. Strengths and Issues

a. Strengths

Major strength of the Program seems to be that Transportation Technicians become more well-rounded employees. Technicians from construction understand better the implications of construction quality for road performance and subsequent maintenance needs. Technicians from maintenance understand better how quality is managed in construction through inspections and materials sampling. Employees in the Program thus gain a broader set of skills, and acquire a vested interest in the future of the road network.

b. Issues

Several issues have been raised by some region/district maintenance analysts:

The Program results in loss of maintenance manpower at a time when peak work demands occur through the summer. The loss of maintenance employee labor must be made up through seasonal hires and contract workers, including prison labor. While these additional forces help in labor-intensive activities, they do not have the range of skills of regular employees, and some initially have lacked CDLs. There is a double impact on the maintenance budget: the Technicians’ time while in the construction program, plus the added costs of hiring and training seasonal workers.

Seasonal staffing needs in maintenance establish the context for understanding the implications of the Transportation Technician Program. Exhibit VI–3 lists equivalent full-time staff that are required by maintenance each month, illustrating

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31 Practices in seasonal hiring vary across regions. For example, Region 1 employs five seasonal employees in winter, 35 in summer. Region 2 hires five seasonal employees in summer and five in winter, and also makes use of regular construction employees (in winter) and contract prison labor all year.
the seasonal variation in labor demand. These statistics include UDOT employees, seasonal hires, and contract labor (which includes prison labor).

**Exhibit VI–3: Statewide Maintenance Labor Requirements by Month**

<table>
<thead>
<tr>
<th>Month</th>
<th>Maintenance Labor Required (FTEs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>July</td>
<td>905</td>
</tr>
<tr>
<td>August</td>
<td>960</td>
</tr>
<tr>
<td>September</td>
<td>715</td>
</tr>
<tr>
<td>October</td>
<td>800</td>
</tr>
<tr>
<td>November</td>
<td>735</td>
</tr>
<tr>
<td>December</td>
<td>615</td>
</tr>
<tr>
<td>January</td>
<td>580</td>
</tr>
<tr>
<td>February</td>
<td>570</td>
</tr>
<tr>
<td>March</td>
<td>630</td>
</tr>
<tr>
<td>April</td>
<td>640</td>
</tr>
<tr>
<td>May</td>
<td>765</td>
</tr>
<tr>
<td>June</td>
<td>970</td>
</tr>
</tbody>
</table>

According to this distribution, peak labor needs are in June through August, when maintenance labor demands are more than 50 percent higher than winter requirements. While it is well understood that UDOT maintenance staffing levels for full time employees are established by the winter Snow Plan (and were about 530 FTEs statewide when the data in Table 1 were compiled), winter is not the peak season for maintenance labor needs according to these data – the peak season is summer, which coincides with summertime construction requirements and the period of rotation for Transportation Technicians to construction. The shortfall in summertime maintenance labor is made up through increases in seasonal labor and contract labor (including prison labor) statewide, although the degrees of increase in these labor categories differ by region as discussed above.

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32 These figures are from a chart of statewide maintenance manpower requirements obtained from Region 1. Numbers are approximate owing to the scale on the chart, but are sufficient to indicate the basic seasonal variation.
It should be acknowledged that there is debate within UDOT regarding the premises and implications of the seasonal distribution listed above. Questions such as the following have been posed:

- While these statistics indicate the seasonal distributions of work that have occurred, can maintenance activities be shifted to other months of the year so as to not be affected as much by rotations of Technicians to construction?
- Would more current data give a more accurate picture? (The report providing the data above is several years old.)

We examined these questions using data on maintenance labor hours reported for fiscal year 2001. While these more recent data do not include contract labor as do the totals in the exhibit, they do permit an assessment of the basic variations implied by the exhibit. This audit analysis confirms that peak labor use during fiscal year 2001 occurred in summertime – June through August – for both UDOT employees and for seasonal hires.

The other question regards the potential adjustment in activities to “smoothen” work demands throughout the year. While the Comptroller’s data do not identify maintenance labor use by activity group, the evident trend throughout the year is already one of reasonably level demand (varying between 445 and 505 FTEs for full-time and seasonal hires), with the exception of the summer months June–August noted above (580 to 730 FTEs) and a spike in December (730 FTEs). Thus, the summer peak stands out from the baseline workload during other months. Moreover, the data included an analysis of maintenance activity by its amenability to shifting to other months of the year. Activities were classified, for example, as those that can be performed during any month of the year, those that had some but not total flexibility, those that were temperature dependent, and so forth. Thus, the data already include an assessment of the degree to which activities can be shifted to level monthly work demands. Thus, the thrust of this question has already been addressed. Our analysis supports the conclusion that peak maintenance demands occur in summer, considering all categories of labor.

UDOT Region 2’s analysis of Program benefits was reviewed and discussed both with Region 2 and with the Comptroller’s Office. The conclusions of the audit are as follows:

- The analysis of the benefits to construction is a partial analysis of the impacts of the Program. Impacts to maintenance are not explicitly shown, and the cost of the education and training component of the Program is not reflected.
- As a first-order approximation, the cost savings to construction (cited earlier) are offset by additional labor and equipment costs to maintenance

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33 The one–month spike in December may reflect winter maintenance activity.
with respect to this Program. This balance is not exact because of some effects on seasonal hires and overtime in the two units when transfers of Technicians occur. Nonetheless, as a broad statement, the costs and benefits of the program to maintenance and construction are essentially a wash at the Departmental level.

- The statement above excludes the cost of educating and training each Technician. These educational and training costs are borne by maintenance (including costs of Maintenance Academy training, university curriculum, and employee wages while in class). The benefit of these costs is a better-trained, more well-rounded employee.

4. Recommendations

Recommendation 59. Ensure that ongoing analyses of the impacts of the Transportation Technician Program reflect the full range of its benefits and costs in both maintenance and construction.

The internal analyses of Program costs and benefits reflect only partial impacts:

- They quantify only the benefits to construction; net costs currently borne by maintenance are not explicitly reported.
- They apply only to a single region (Region 2).
- They do not include the cost of education and training that come under the Program.

A full analysis of the impacts of this Program would consider all costs and benefits, effects on both maintenance and construction, and a statewide perspective encompassing all regions and districts. If the experience in Region 2 is replicated in other regions, one would expect to see net benefits to construction and net costs to maintenance. These net costs would be expected to be reduced somewhat over time as the Technicians detailed to maintenance from construction acquire commercial driver’s licenses and are able to participate in a fuller range of winter maintenance activities. Changes in the cost/benefit implications of the Program would also be expected to vary as a function of the level of participation from maintenance and from construction, respectively. This more complete information can assist UDOT in assessing staffing changes that might be needed to compensate for the effects of the Program, particularly in summertime maintenance labor needs.

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34 “Additional cost” in this context refers to the fact that labor and equipment costs appear in the maintenance account, but maintenance does not receive any services for these expenditures. This reference should not be misconstrued as “unbudgeted,” since maintenance is budgeted and receives an FTE allowance for all Transportation Technicians.
Recommendation 60. Review implications for staffing levels once the more complete analyses in Recommendation 59 are performed.

The current maintenance staffing complement is based upon wintertime maintenance needs identified in the Snow Plan. Given the operation of the Transportation Technician Program and the fact that peak maintenance work occurs in summer, UDOT should evaluate the implications of these summer demands to ensure that its work force is aligned to meet both maintenance and construction needs most efficiently. Such an analysis should consider the following factors in the near-term and longer-term as the Program evolves:

- The “optimal” mix of labor among full-time employees, seasonal hires, and contract labor. “Optimal” refers to both the mix of skills and certifications needed to perform maintenance or construction services in each season effectively, and the costs associated with each category of labor.

- Growth in Program participation and the relative mix of maintenance and construction employees enrolled in the Program.
  - If the Program grows, more employees will be subject to rotational assignments, and the implications for satisfying work demands in both maintenance and construction need to be understood.
  - Program staffing allowances and budgeting are now predicated on the fact that most enrollees come from maintenance. A relative increase in construction employee participation in the Program will change the dynamic of rotational assignments and the number of employees available for construction and for maintenance services respectively. The implications of these shifts need to be understood on a seasonal basis.

Recommendation 61. Provide clearer statewide information on Transportation Technician Program operation and impacts.

The Program as now configured is administered at the region level. UDOT Human Resources tracks the numbers of participants in the Program statewide, and the Comptroller’s Office manages changes in FTE assignments and budget allocations as employees join the Program. However, there does not appear to be any “roll-up” to the statewide level of regional data on current Program operation and staffing impacts. Current statewide reports of maintenance labor usage do not differentiate Transportation Technician participation or assignments to construction units. Lack of statewide information inhibits Central’s understanding of the ongoing rotational assignments in this Program each year, potential implications on staffing and costs in both maintenance and construction, and evolving costs and benefits of the Program (the Program has not yet completed its initial four-year cycle). This lack of information may also contribute to a misperception of the resources actually available to maintenance crews, since current statewide reports of FTE allowances, labor usage,
and associated salary and wage costs in maintenance now include all Transportation Technicians, regardless of whether or not they are actually working in maintenance.

C. Region Resource Allocation

1. Existing Approach

Following legislative approval of the maintenance budget, a resource allocation of the approved amount is made to the regions for review and comment. This step is necessary to accomplish the following:

- To allocate the budget as passed by the legislature (appropriated maintenance dollars by region) among activity groups and activities.
- To reconcile differences between what the legislature approved versus what had been requested.
- To adjust labor, equipment, and materials dollars in each region to achieve a “balanced” maintenance program.

The work program allocation is developed initially in Central, using both the approved legislative budget and the MMQA breakdown of budget by labor, equipment usage, and materials for each activity. Historical trends may also inform this allocation: e.g., expenditures tallied in the MMS and the prior two years’ data for utilities and other fixed costs and associated increases. A trial breakdown is then submitted to the regions for review and adjustment.

- Regions may redistribute funds among activities within a group, but not between groups unless permission is granted from Central. For example, regions may transfer funds between landscape maintenance and fence maintenance, which are both activities under Vegetation Control. However, regions may not transfer funds from Vegetation Control to Roadside Maintenance without approval from Central.
- Regions may not divert any funds from snow and ice control to other groups. Any excess funds are held in reserve in this group for other weather emergencies, such as flood-related maintenance.

As part of their trial allocations, regions are given a labor amount based on their FTEs and the statewide average labor rate as determined by the UDOT Comptroller.\(^{35}\) Region managers compare this labor amount to amounts available for equipment and materials. If the two amounts are about equal, regions judge the work program to be sufficiently in balance. If the resource mix is not in balance, regions will recommend

\(^{35}\) Labor costs are distributed using the statewide average wage rate, even though it is understood that this procedure introduces distortions between higher-wage (more senior labor) and lower-wage (less senior labor) regions. While this procedure has been approved by the regions, UDOT could not explain why a method based on more precise labor-cost data, which are available in FiNet, are not used.
adjustments to bring the program more into balance and to avoid an overly “labor intensive” or “capital intensive” budget that cannot realistically fund all of the resources to complete activities. Recommended adjustments are submitted to Central for consideration. Discussions may be held between Central and regions if needed. Following agreement, the final allocations are issued to the regions.

MMS data for FY 2002 were reviewed to assess the relative distributions of costs for labor, equipment, and materials. The results in Exhibit VI–4 show a high degree of consistency in the ratios of these resources for the total maintenance program across regions, supporting one of the bases discussed above for the allocation of resources and the way in which these allocations are reviewed by regions. The actual ratios that are supported by these data are 40-20-40 for labor, equipment, and materials.

**Exhibit VI–4: Distributions of Labor, Equipment Usage, and Materials by Region**

These individual cost components also have a strong correlation to FTEs and to lane-miles by region, following the pattern for total costs in Exhibit VI–5 through Exhibit VI–8.

MMS data were also reviewed to see to what degree expenditures are related to FTEs and to roadway inventory in terms of lane-miles and paved surface area. These comparisons will indicate whether or not actual resource allocations and resulting expenditures reflect the procedure described by UDOT above, and whether or not they also reflect the budgeting premise that FTEs are roughly correlated with highway inventory. Data presented below are by the six regions/districts in UDOT’s maintenance organization (referred to as “regions” below for brevity).
a. Total Maintenance Cost vs. FTEs

Total maintenance expenditures for FY 2001 (labor plus equipment usage plus materials) are compared to FTEs by region in Exhibit VI–5. The data indicate a strong linear or proportional relationship (correlation statistics are shown on these figures). This result supports UDOT’s contention that the budgeting resource allocation is driven strongly by the FTEs distribution.

Exhibit VI–5: Total Maintenance Cost vs. FTEs in Each Region

![Graph showing the relationship between Total Maintenance Cost and FTEs, with R-squared = 0.97.]

b. FTEs vs. Lane Miles and Surface Area

Correlations between FTEs by region and respective measures of maintained inventory were tested to see if the budget distribution by FTEs reflected essentially a feature-based distribution. Plots of FTE versus lane-miles and FTE versus paved surface area are shown in Exhibit VI–6 and Exhibit VI–7, respectively. The curves show generally good correlation between FTE and inventory quantity, recognizing that not all maintenance activities (and therefore

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36 This and ensuing exhibits are read by noting how close points are to the line drawn. The closer the points, the stronger the relationship. R–squared further shows the strength of the relationship: the higher the number, the stronger the relationship.

37 Lane–miles includes all mainline travel lanes, ramps, turning lanes, climbing lanes, and pullouts. Surface area refers to all paved areas that are maintained. In addition to lane–miles it includes gore areas, chain–up areas, parking ramps at ports–of–entry, storage lanes, park–and–ride lots, paved turn–arounds, and roads under UDOT responsibility on college campuses. It does not include raised medians or islands.
their resource requirements) are associated with roadway lane miles or paved area. The correlation with lane-miles is statistically stronger than that with surface area; lane-miles will therefore be cited in subsequent relationships relating to highway inventory.

Exhibit VI–6: FTEs vs. Lane-Miles Maintained by Region
c. Maintenance Cost vs. Lane Miles

Given the relationships in Exhibit VI–5 and Exhibit VI–6, it is not surprising that the relationship between total maintenance expenditures and highway lane-miles also exhibits a strong correlation as shown in Exhibit VI–8. While a feature-based budget allocation is no longer followed literally by UDOT, the historical roots of maintenance budgeting in this approach and the way in which adjustments for new inventory are calculated results in the finding that maintenance dollars expended in each region are closely related to the respective numbers of lane-miles.
d. Budget Increases Responding to New-Construction Additions to Inventory

Earlier interviews with UDOT managers suggested that funding increases are not keeping pace with additions to inventory. This situation cannot be verified from the current analyses, and, if it is felt to be significant, it would be better addressed by an examination of the legislative record over the past five to ten years (i.e., budget amounts that have been requested to maintain additional inventory versus amounts approved and funded). In other words, Exhibit VI–5 through Exhibit VI–8 indicate that UDOT has been “fair” in distributing available funds by highway inventory and FTE; they do not indicate, however, whether the level of maintenance dollars is sufficient for the activities that need to be performed.

e. Resource Allocation Using MMQA

An MMQA Budget worksheet is developed from the current highway conditions and LOS that are gauged through the field surveys, specified target LOS values that apply to each activity group, and the MMQA cost models. This worksheet identifies, for each activity in each region, the following information:

- Units of measure for accomplishment, plus planned accomplishments in terms of these units and in labor hours.
- The planned percentage distribution of labor, equipment usage, and material, and the proposed dollars for labor, equipment usage, and materials.
• The total dollars projected for each activity.
• The target LOS for each activity group.
• The difference, in dollars by activity group in each region, between the MMQA Budget and that computed using the Current Budgeting method described earlier.

MMQA can also be used to investigate the consequences of different budget levels on changes in LOS that can be provided. This has been done in the past, when the MMQA and the Current Method budgets have been in close agreement. The agreement between these two budgeting methods has not been as close recently.

Another aspect of MMQA application to resource allocation is the use of current LOS values as measures of performance accountability. Interviews with UDOT managers indicate that these LOS data have been used more as a training device to illustrate the importance of meeting targets and of focusing resources where targets need to be attained. Awards have been used as incentives both for achieving targets and for measuring highway condition correctly. However, no action has been taken as part of maintenance resource allocation to hold regions accountable for targets, out of concern for possible misinterpretation of the purpose of MMQA and “sending the wrong signals” regarding incentives for improvement. Thus, resource allocations, as well as budgets, are driven more strongly by considerations of maintenance resources (FTEs and the materials and equipment usages needed to employ FTEs productively) than by levels of service.

f. Funding Allocation to Maintenance Stations

Identification of funding needs and allocation of approved maintenance budgets to stations is managed at the region/district level. The process is need-based, accounting for the unique circumstances at each station. While the regions/districts differ in some of the details of the process, it generally entails the following steps:

• The Maintenance Analyst reviews the road conditions (from semi-annual inspections) and other factors affecting each station, including scheduled construction Statewide Transportation Improvement Projects (STIP) projects and proposed betterments and pavement preservation work. Region 2 in particular also considers the urban/rural character of the highways served by the stations.
• The analyst builds base-level needs using information from several sources, including MMS cost and accomplishment histories, feature inventory quantity and condition data, MMQA data, performance data by activity from

38 The analyst considers the prior year’s expenditures, and, in some cases he considers even longer histories. For example, Region 2 looks at a three–year average for snow removal expenditures.
the Supervisor’s Handbook, and comparisons of each station’s MMS statistics (e.g., accomplishment per labor hour) to region or district averages.

- The region/district issues a memo to station supervisors requesting information on any special budget needs by activity, and what changes are proposed from the prior year.

- The analyst compiles the above data for consideration at a meeting of the operations engineer, maintenance analyst, and area supervisors. This team decides the station resource allocations based on indicated needs, traffic levels served, proposed betterments, special projects, and the labor distribution and crew sizes among stations.

- Once the fiscal year is in progress, stations can make adjustments within activity groups. Stations may also “trade” resources between groups in special circumstances, as long as the overall region or district expenditures by activity group do not deviate from their approved levels.

As a result of this process, the allocations from the regions/districts to the stations are not as clearly attributable to lane-mileage as those allocations from the state to the regions/districts illustrated in Exhibit I–5. Lane-miles are one contributor to need, but other factors also influence station-level needs in a given fiscal year, including altitude, terrain, classes of highway maintained, traffic volumes, and degree of urbanization. In addition, recent completion of construction projects (which may add to the feature inventory), ongoing rehabilitation projects (which may temporarily preclude the need for certain routine maintenance activities), damage due to unusually severe weather, and other one-time situations may create a unique demand for maintenance at one particular maintenance station.

It is to be expected, then, that each region/district has varied maintenance unit costs, with some extreme outliers. Exhibit VI–9 shows how these differences appear for one representative region.
This exhibit plots total maintenance expenditures in FY 2001 versus lane miles for each station. A “best-fit” trend line is also shown. Region 2 comprises both urban and rural stations. Urban stations (e.g., three stations for Salt Lake City and West Jordan) have expenditures per lane mile that typically fall above the trend line, while rural stations (e.g., Wanship, Tooele, and Grantsville) have expenditures per lane mile that typically fall below the trend line. An apparent deviation from the central cluster, Cottonwood, is explained by a combination of two circumstances: It is the location of ski resorts, requiring significant expenditures for snow and ice control to keep roads open in winter; and it has the responsibility for major highways such as I-215.

Region/district maintenance analysts track statistics such as these through the fiscal year to identify anomalies in cost or resource usage in comparison with stations of similar characteristics, discuss underlying causes with station supervisors, and agree on remedies.
g. **Equipment Allocation to Maintenance Stations**

Procedures to allocate equipment to stations is based on the following considerations:

- Much of the station equipment complement is according to the snow plan:
  - Items such as trucks, plows, and sanders are assigned one piece for each FTE worker at a station.
  - Numbers of loaders assigned are based on numbers of stockpile locations.
  - Assignment of graders follows a similar process, but not every station may need one for the entire year. For example, in winter some graders (with plows and wings attached) may be moved to higher-altitude stations.

- Pickups and one-ton trucks are assigned according to staffing, for transportation to work sites and foreman inspections and surveys.

- Specialized equipment is housed either at a central location (e.g., region or area office) or, if shared between crews, at one of the crew locations. Specialized equipment is coordinated by the equipment specialist (who may be the Area Supervisor) based on station requests. Examples of shared equipment include rollers, bulldozers, tar pots, the E-Vac, and large mowers. Some specialized equipment at the region/district level may come with its own crew (e.g., pavement lay-down machine). Sharing generally works well, and its use is increasing.

- Utilization data are managed to promote sharing (this was being done before the imposition of the two-tiered equipment charge, but the charge makes the advantages of sharing more obvious to end users).

- The UDOT fleet is generally felt to be in good condition, to last a reasonable service life, and to provide adequate support to work performance. Needed equipment that is not available can be rented.

2. **Best Practice**

Best practices in resource allocation entail the following:

- Guidelines for resource allocation should be consistent with guidelines underlying budgeting.

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39 For example, if a roller and tar pot for hard surface maintenance are shared between two crews, the roller may be housed at one crew site, and the tar pot at the other site.

40 Where appropriate, regions manage equipment to balance utilization. For example, equipment assigned to urban stations in Region2 accumulate less mileage per year than comparable equipment in rural stations, so equipment is rotated between urban and rural locations.
• The resource allocation process should explicitly acknowledge the factors affecting allocation decisions and adjustments: e.g., geographic distribution or “equity” criteria needed to fund special projects or requirements, differentials in salary rates or materials prices, and so forth.

• Funding should be realistic to complete the planned work program, or adjustments should be made in the work plan to conform to funding available. (If budgeting is based upon LOS, then LOS values likewise need to reflect actual resource allocations.)

• The mix of labor, equipment usage, and materials that are funded to complete the work program should be balanced.

• Allowances are made for specific local conditions that need to be addressed by individual stations (e.g., winter maintenance needs of high-mountain stations, or traffic-related needs and work zone constraints faced by urban stations).

3. Strengths and Issues

a. Strengths

The analyses of MMS data for FY 2001 and 2002 support the basic premises and methods of the current budgeting approach and allocation of approved budgets to the region-level work programs. Maintenance expenditures are strongly correlated with both labor force FTEs and inventory lane-miles. This correlation holds both for total maintenance expenditures and for expenditures for labor, equipment usage, and materials individually. At a high level, these results support the position that maintenance allocations to regions are “fair.”

A fair and realistic set of procedures also governs the allocation of resources at the region/district level to maintenance stations. This process balances objective measures of maintenance needs (such as inventory quantity/condition and traffic volumes) with characteristics that uniquely affect maintenance demands at each station. The process of identifying resource needs and distributing approved levels of resources to stations is a collaborative one in which stations have the opportunity to identify and justify needs for consideration by area and region/district managers. A number of sources of information are applied by regions/districts in determining the recommended allocations among stations. Once the fiscal year is underway, stations have the flexibility to make adjustments in their allocations.

Communications with the stations are maintained for both funding allocations and equipment scheduling. Funding requests and considerations of special needs are reviewed in detail by maintenance activity. Equipment needs are scheduled on a calendar and coordinated across stations.
b. **Issues**

- **Inadequate use of MMQA for Resource Allocation**
  
  While UDOT’s MMQA system has the elements that are typically found in corresponding systems used by other state DOTs, the way in which this system is implemented precludes its use on a production basis. From the perspective of resource allocation:

  - The MMQA approach currently is not able to roll-up budget estimates to a statewide level.
  
  - Cost models have been estimated by UDOT individually by activity and region and thus are developed at a very disaggregated level. Other DOTs estimate such models initially at a statewide level using managerial judgment. These models are often estimated for groups of activities, with the intention of using these models until a body of data can be compiled to estimate new models statistically.
  
  - The MMQA lacks buy-in and credibility among UDOT managers, which inhibits its acceptance and greater use in resource allocation. This issue was raised in the context of resource allocation agreement between the MMQA-generated budget and that produced by the Current Budgeting method. More general aspects of this issue have already been discussed in the initial draft report of this study that has been discussed with UDOT.

- **Data Limitations**
  
  The allocation of approved funding among regions recognizes the need for balance among labor, equipment, and materials resources. This balance is borne out in analyses of MMS data, which show a consistent proportioning of these maintenance resources to the overall program across regions. However, procedural steps do not always take advantage of the data available: e.g., labor dollars are allocated by FTEs and a statewide wage rate, rather than an average rate computed for each region.

  Region/district to station allocations rely on information such as the Feature Inventory and MMQA. This data needs to be kept up to date with a precision that is needed to determine specific station needs.

4. **Recommendations**

**Recommendation 62. Move to MMQA as the basis of resource allocation.**

This recommendation mirrors a corresponding recommendation in Chapter IV, to have MMQA as the central framework for both budgeting and resource allocation. This
recommendation implies that the basis of resource allocation would include existing and target values of levels of service by activity group within each region.

**Recommendation 63. Improve the accuracy of wage rates now used.**

Adjustments should be made in allocating approved funds for the work program to account for average wage rates by region rather than statewide; this will eliminate the distortion that now occurs. Comments on the preliminary allocation should continue to be solicited from the regions but should be incorporated within the new framework established by MMQA.

## D. Station Location

This section reviews the UDOT policies for selecting new maintenance station locations, current practices, best practice in the field, and recommendations for improvement. This analysis has incorporated interviews with the Central Maintenance Unit Facilities Manager and UDOT Operations Engineer, UDOT policies related to building maintenance stations, a September 1992 Station Location Study prepared by the Division of Facilities Construction and Management (DFCM), and benchmarking interviews with other states.

### 1. Existing Approach

UDOT policy does not prescribe steps to be taken in deciding specific station locations. Rather, the policy details requirements for planning future stations and major rehabilitations of current stations. The following are relevant excerpts from UDOT policy:41

- The Central Maintenance Unit Facilities Manager determines the need for additional land and buildings and/or the modification of existing buildings. The Central Maintenance Unit Facilities Manager develops a five-year program of needs and estimates of costs and determines whether the work will be performed by state forces or by contract.
- The Engineer for Maintenance reviews requests for land and/or building projects.
- The Engineer for Maintenance writes to the State Building Board to ask if public hearings are necessary for work that will be performed under contract.
- The State Building Board advises the Engineer for Maintenance if hearings are required, and the Engineer for Maintenance notifies the Region Director or the Central Project Manager of public hearing requirements.
- The Region Director or Central Project Manager Coordinates public hearing for location with the Chief Location Engineer and the Community Relations Division.

41 UDOT 6A–2.4, UDOT 6A–2.5.
• The Transportation Commission conducts hearings and decides on final location and plan.
• After approval by the Commission, The Region Director or Division Head sends detailed topography map to Engineer for Maintenance showing recommended location of proposal building and finished floor elevation.

With few exceptions, future UDOT stations are planned to be built on the current locations. New stations are rare; most new construction has replaced an existing facility. Instead of a five-year plan that UDOT policy calls for, a 25-year plan is created for all maintenance stations. The plan is not a master plan; it includes minimal information about the date the facility was constructed, the region in which the building is located, and the date replacement is scheduled. The plan is a collaborative process, with the Central Maintenance Unit Facility Manager, the Engineer for Maintenance, and the UDOT Operations Engineer deciding on which stations need to be replaced or rehabilitated. Four factors are used to determine if rehabilitation or replacement is necessary:

• Structural integrity of the building.
• Building size. As noted in Chapter III, several maintenance stations are too small to house the equipment the station uses.
• Maintenance yard size. Although UDOT has an informal standard yard size of 8–10 acres, one current station has a yard size of less than one acre.
• Location. As areas have developed around some maintenance stations, the traffic may hinder response times.

According to the UDOT Operations Engineer, several stations currently meet three of these factors. In order to prioritize among those stations, the group uses likelihood of receiving funding from the Legislature as a final criterion.

The group does not discuss actual locations, or if sites could or should be moved or consolidated. UDOT relies on the region/district to propose particular sites for replacement stations. Central may encourage the region/district to consider factors in the site selection, but the final decision is made by the region/district.42

Since 1994, the department has constructed 12 new stations, two of which were built on the existing sites and seven on new sites to replace an existing station. The remaining three stations are additional stations built to accommodate additional maintenance workload. Exhibit VI–10 shows the distribution of new stations throughout the state.

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42 This is contrary to UDOT policy 6A–2.5, which provides that the Transportation Commission selects the final location.
Exhibit VI–10: New Stations Since 1994

<table>
<thead>
<tr>
<th>Region/District</th>
<th>Station Name</th>
<th>Date Constructed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region 1</td>
<td>Park Valley</td>
<td>1998</td>
</tr>
<tr>
<td>Region 1</td>
<td>Richmond</td>
<td>2002</td>
</tr>
<tr>
<td>Region 2</td>
<td>Grantsville</td>
<td>1998</td>
</tr>
<tr>
<td>Region 2</td>
<td>South Valley</td>
<td>1999</td>
</tr>
<tr>
<td>Region 3</td>
<td>Duchense</td>
<td>1995</td>
</tr>
<tr>
<td>Region 3</td>
<td>Provo/Orem</td>
<td>1997</td>
</tr>
<tr>
<td>Region 3</td>
<td>Santaquin</td>
<td>2000</td>
</tr>
<tr>
<td>Price</td>
<td>Emery</td>
<td>1995</td>
</tr>
<tr>
<td>Richfield</td>
<td>Richfield</td>
<td>1997</td>
</tr>
<tr>
<td>Richfield</td>
<td>Escalante</td>
<td>1998</td>
</tr>
<tr>
<td>Cedar City</td>
<td>Parowan</td>
<td>1996</td>
</tr>
<tr>
<td>Cedar City</td>
<td>Cove Fort</td>
<td>1998</td>
</tr>
</tbody>
</table>

While the plan originally called for replacing two stations per year, funding has not allowed that to be accomplished. For the current fiscal year (2003), no station replacements are programmed.

According to the plan, replacing stations at two per year would have taken over 50 years to accomplish. To address problems sooner, UDOT has attempted to expand and remodel some of the older stations that are still in good condition, have an acceptable yard area, and are located satisfactorily to the service area. The following are 11 stations that have had additional buildings built or have been expanded since the development of the replacement plan:

Exhibit VI–11: Expanded Stations Since 1994

<table>
<thead>
<tr>
<th>Region/District</th>
<th>Station Name</th>
<th>Date Expanded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region 1</td>
<td>Bothwell</td>
<td>2000</td>
</tr>
<tr>
<td>Region 2</td>
<td>Salt Lake East</td>
<td>2002</td>
</tr>
<tr>
<td>Region 2</td>
<td>Salt Lake West</td>
<td>2002</td>
</tr>
<tr>
<td>Region 2</td>
<td>Salt Lake</td>
<td>2002</td>
</tr>
<tr>
<td>Region 2</td>
<td>Murray</td>
<td>2002</td>
</tr>
<tr>
<td>Richfield</td>
<td>Loa</td>
<td>2002</td>
</tr>
<tr>
<td>Richfield</td>
<td>Junction</td>
<td>2000</td>
</tr>
<tr>
<td>Richfield</td>
<td>Mount Pleasant</td>
<td>1998</td>
</tr>
</tbody>
</table>
2. Best Practice

In the early 1990s, the California Department of Transportation (CalTrans) developed a Maintenance Station Location Model (MSLM) that evaluated maintenance station location in order to facilitate decisions to open new stations, relocate existing stations, or close existing stations. To develop the model, CalTrans surveyed state DOTs to pinpoint a balance between facility expense and costs related to travel time. Exhibit VI–12 shows that with few maintenance stations, travel costs are high, but facility expenses are low; with many maintenance stations, travel costs are reduced, but facility expenses are drastically increased. Where the two lines cross will result in the optimal number of stations.

Exhibit VI–12: Optimizing the Number of Maintenance Stations

Despite the development of the model, CalTrans has not implemented it as a formal process. The department encourages the use of travel time analysis to help identify advantageous sites but, ultimately, CalTrans allows its district management to select the final sites. Accordingly, the criteria developed in the central office have not been consistently applied in the regions.

As previously mentioned best practice in facility management includes operating under a master plan. A master plan contains goals, strategies, standards, inventory condition information, needs assessment, and funding levels. One key component is the functional programming required as part of standard setting. Establishing a functional program for maintenance stations involves articulating factors that influence the buildings’ utility. For example, factors that affect the performance of maintenance stations include:

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44 Add Booze Allen footnote here.
• Access to utilities and services.
• Access to the service area.
• Response times.
• Size of workload.

Another best practice in locating new stations is anticipating building needs and buying right of way before it is needed. This is especially important in urban or urbanizing areas, where land parcels large enough to accommodate a maintenance station may be difficult to find. As DCFM’s 1992 study noted, it may be necessary to buy land years before a planned station is to be built. Such advance purchase of right of way requires a good master planning process and may require legislative change.

“Equivalent value exchanges” are becoming best practice for state DOTs. These deals have arisen from development pressure, particularly in urban and urbanizing areas. Equivalent value exchanges allow a DOT to swap an existing maintenance station and yard for a parcel and buildings of “equivalent value.” The Washington State Legislature has authorized state agencies to conduct such exchanges. While the Washington State Patrol has taken advantage of the new law, the Washington Department of Transportation (WSDOT) has not yet had an opportunity to perform an equivalent value exchange.

CalTrans allows its districts to avoid the costs related to building new stations, as well as improve response times, balance workloads, and make more efficient crew size decisions, by swapping service areas or buying labor, equipment, and materials from another district. For example, one district may have a maintenance station near its district border. The bordering district may enter into a binding agreement with the first district to assume maintenance responsibility for roads and roadsides across the district borders. The agreement may involve paying the district for its services, or it may involve trading the service area responsibility for another at a different border. The critical factor in making such agreements work is a firm grasp of activity and service area costs.

3. Strengths and Issues

a. Strengths

In response to intense development pressure in some maintenance station locations, combined with the need for updated facilities, the Utah Legislature passed legislation\(^{45}\) that allows UDOT the flexibility to trade properties with interested developers. The law requires UDOT to obtain appraisals of the properties. The developer has to build or improve buildings on his property to make them suitable for UDOT operations. As long as the appraisal analysis shows UDOT is not contributing money to the deal, the trade can take place.

\(^{45}\) 63A–5–104.
Since the law passed, UDOT has completed deals for two new stations: Provo Canyon and Kimballs Junction.

b. Issues

UDOT currently does not operate under a master plan. The department thus lacks a functional program, which makes it difficult to make informed decisions about ideal station locations.

The Legislature has not allowed UDOT to purchase land in advanced, though UDOT has attempted to save money with this approach. According to the UDOT Operations Engineer, the department will petition the Legislature this fiscal year for the right to acquire land before being ready for construction.

UDOT’s policies do not reflect current practice.

4. Recommendations

Recommendation 64. Establish a master plan for Lands and Buildings, as recommended in Chapter III.

A master plan can provide direction not only for project prioritization, but also for station location decisions. The functional programming necessary to develop standards for a master plan require the department to analyze many factors that influence the proposed station’s ultimate location. Access to the service area and response times are especially important in this analysis.

Recommendation 65. Require maintenance stations to periodically review service areas as part of a master planning process.

The efficiency of service areas changes over time, as infrastructure, traffic patterns, crew sizes and other factors change. In order to ensure that individual stations are operating most efficiently, service areas require periodic review. Reviews could either be scheduled (e.g., every five years) or they could be triggered by established thresholds (e.g., a 10 percent increase in lane mileage since the last review). Such reviews could, for example, result in consolidation of maintenance stations, conversion of substations to full stations, or the addition of stockpile sheds.

Recommendation 66. Encourage inter-region/district service purchases or swapping in order to maximize efficiency.

Regions and districts have long borrowed employees from each other. However, this practice is largely ad hoc and has not been analyzed in terms of the effect it could have on improving service area efficiency. A recent example is the Heber City maintenance station in Region 3. While the building is in need of replacement, a new maintenance station was recently built less than 15 miles from the region’s border in Region 2.
strategy to address the Heber City maintenance station building needs would be to bring Region 2 and Region 3 together to discuss the possibility of the new Region 2 station assuming maintenance responsibility over the Heber City station roads closest to the border. The Heber City station could be converted into either a substation or a stockpile shed. Other Heber City station roads could become the responsibility of the closest Region 3 maintenance stations.

**Recommendation 67. Revise policies and procedures to reflect actual practice.**

Once a master plan has been developed, UDOT should amend its procedures to reflect its practices. Accurate written procedures not only formalize the department’s practices, they also help ensure that the practices are uniformly applied and consistent with the department’s strategic direction. Conversely, the absence of accurate procedures increases the likelihood of inconsistent treatment of needs and reduced accountability.
VII. Maintenance Work Methods

A. Snow and Ice Control

Snow removal and ice control are vitally important elements of a maintenance program. The mobility and safety issues surrounding snow and ice activities merit careful program development and execution. Because of their unpredictability, snow and ice activities are among the most difficult activities to manage.

1. Existing Approach

UDOT’s maintenance standards deal with snow and ice activities at a very general level. Implementation of the standards, work practices, and management approaches appear to vary considerably at the regions and districts. Based on discussions with field personnel, the following observations are made.

UDOT has established Level of Service (LOS) standards for snow and ice, which are outlined in the activity standards. In general, the LOS for a given road segment depends on the road classification and traffic volume. Exceptions are provided for special conditions. The region/district managers are responsible for implementing the policies. In practice, the LOS standards seem to be loosely implemented.

The Department is experimenting with anti-icing techniques and materials. Anti-icing, as distinguished from de-icing, is aimed at preventing snow and ice from bonding to the pavement. De-icing is defined as removing snow and ice after some build up on the pavement has occurred. Anti-icing may prove to be a more cost-effective approach to maintaining roads in a “bare pavement” condition. From early indications, UDOT is having success in implementing the new anti-icing practices.

Route planning is done by some field units. In route planning, each road segment is assigned a specific LOS and routing sequence. Specific drivers and equipment are assigned to each route segment. In practice, UDOT managers feel the route plans have only marginal benefits because the weather patterns can vary to a great degree under real conditions.

Operators receive training in snow and ice equipment and must be recertified every two to three years. Field managers do not feel that refresher training or pre-season dry runs are beneficial.

UDOT has implemented Road Weather Information Systems (RWIS) technology in some locations. RWIS is an integrated system that measures pavement temperature, ambient air temperature, wind, and other environmental conditions. The data is sent real-time to a
central computer for analysis. The aim is for field managers to have the information needed to make snow and ice resource deployment decisions. UDOT field managers feel that the efficacy of the systems varies by maintenance station in accordance with the general acceptance of the system by the station manager. Not all stations have RWIS technologies; however, all have computers with access to the Internet and weather information. Some field units subscribe to a commercial weather forecasting service.

The number of resources assigned to snow plowing and salting depends on the time of day and severity of the storm. Maintenance stations with small staffing contingents may have to commit the entire staff to plowing and salting. If the storm persists for an extended time, the crews will begin operating in twelve-hour shifts.

After a storm, if the conditions permit, the Department attempts to plow back the road shoulders and clean up abrasives in critical areas. In the spring, after the winter snow season, UDOT cleans and sweeps the accumulated abrasives from bridge decks.

Salt and abrasives are generally stored in uncovered bins. A limited number of maintenance stations have covered storage sheds.

In attempt to provide internal communication and knowledge transfer (in snow and ice practices as well as all maintenance areas), the Department conducts a number of meetings and conferences including the following:

- Spring Maintenance Conference.
- Monthly Operations Meeting.
- Twice Yearly Quality Panel.

The Department does not contract with commercial firms for snow and ice removal activities.

2. **Best Practice**

a. **Policy Setting**

For maintenance activities such as snow and ice, policy setting deals primarily with establishing levels of service (LOS) for the highway system. The LOS generally establishes the amount of snow that is allowed to accumulate on the roadway and how quickly the road is cleared after a storm has subsided. The established LOS policies have a direct impact on the resources and funds required for the snow and ice program.

Best practices involve two key components:

- Citizen input in the policy making process.
- Budgeting procedures that correlate budgets to various service levels.
b. Pre-Season Route Planning and Preparation

To achieve maximum effectiveness, snow and ice activities must begin well before the winter season. Best practices include the following components:

- Updating and/or re-confirming established LOS objectives.
- Identifying the designated LOS for each specific road or road segment within a management jurisdiction.
- Assigning designated trucks and operators to specific routes.
- Conducting new and refresher training for equipment operators and crews.
- Conducting dry runs of each route segment to re-familiarize each operator with his/her assignments.
- Making detailed notes during the dry run to highlight physical route characteristics that the operator will need to be aware of during chemical application or plowing.
- Testing each piece of equipment for its readiness.
- Calibrating equipment.

c. Storm Operations

Readiness is the most important element of a good snow and ice program. If crews are caught without warning, the snow can accumulate quickly, making it difficult to maintain high service levels. It is much more time consuming and costly to remove snow and ice after it has bonded to the pavement.

Key best practices are:

- Implementing available technologies, such as a Road Weather Information System (RWIS) to track developing storms (see paragraph below).
- Implementing clearly defined call-out procedures to assure that crews are on stand-by if and when a storm actually develops.
- Maintaining ongoing road patrols during the storm to assign or divert resources to the most critical areas.
- Executing chemical applications and plowing in accordance with established levels of services for each route.

RWIS is an advanced technology being used by a number of snow-belt states. The effectiveness of RWIS varies according to the degree of its sophistication and to the general philosophy of the agency in using technology. The most important factor is to know when a storm is approaching. The National Weather Service and commercial services are available for storm tracking. Whether using
the more sophisticated RWIS technology or a weather forecasting service, best practice dictates that maintenance supervisors have information well in advance of an approaching storm.

d. Post-Storm Operations

Post storm clean-up is important for safety, aesthetic, and environmental reasons. Key best practices include the following:

• Plowing back shoulders for safety and to allow room to push snow off the road in ensuing storms.
• Cleaning up roadside where accumulated abrasives present an aesthetic or environmental concern and to avoid stopping up storm drains.
• Cleaning, maintaining, and repairing equipment to assure efficient equipment operation in the future.
• Debriefing crew to assess the overall effectiveness during the just completed storm.

e. Post-Season Activities

Snow and ice activities are nearly a year-round endeavor. It is important at the end of the winter season to regroup from the many months of focused snow activity in order to begin to prepare for the following season. Best post-season practices include the following:

• Conducting roadway clean-up.
• Assessing the overall effectiveness of the just completed snow removal program.
• Preparing and executing a schedule for equipment cleanup, repair, and replacement.
• Cleaning up stockpiles and assuring that they will be free from leaching or runoffs that could cause environmentally undesirable situations.
• Preparing chemical and abrasives contracts for early delivery in the fall.

f. Administration

General administrative best practices in snow and ice maintenance include:

• Technology/knowledge transfer, both internal and external, to share ideas and keep apace of the practices that work best for UDOT.
• On-going research effort to stay abreast of new trends in snow and ice technology and to test their applications in UDOT.

g. Contracting

Many agencies now use private contractors to supplement their in-house forces. Private contracting can offer a cost-effective way to keep down the financial investment in equipment.

3. Strengths and Issues

a. Strengths

The informal delegation of policy decision-making to the field level may be both a strength and an issue. Executing a snow fighting plan is very difficult because of the many variables that arise. Thus, it is beneficial to give considerable leeway to field managers. However, in doing so, the Department also experiences considerable variations in practices and levels of service. The Department will need to re-confirm that it wishes to continue this business practice.

Other key strengths include the following:

• The Department is experimenting with state-of-the-art technologies such as RWIS and anti-icing chemicals.
• UDOT has implemented a comprehensive operator training and certification program.
• Frequent maintenance seminars and meetings provide an excellent forum for internal and external knowledge transfer.
• The Department’s unofficial guideline of assigning one truck for 30 lane-miles of highway seems to be an efficient allocation of resources.
• Bridge washing and cleaning conducted in the spring, after snow season, helps to prevent deterioration as a result of salting operations.

b. Issues

Key issues surrounding UDOT’s snow and ice program include the following:

• Variations in field implementation of snow and ice policy results in considerable variation of service levels between regions, districts, and maintenance stations.
• Route planning and preparation, while an important management function, is practiced very loosely in the field.
• The Department may not be taking full advantage of cost-effective technologies available for storm tracking and weather information.

• Yearly refresher courses, even for the most seasoned operator, may be beneficial prior to the start of the snow season.

• Although the Department has a long-term program for providing covered storage for salt and abrasives, many sites without covered storage may be environmentally detrimental and could be causing material waste.

• The Department may not be utilizing the advantages of private sector contractors for a portion of the peak snow removal work load.

4. Recommendations

Recommendation 68. Re-confirm UDOT’s practice of varying levels of service by geographic areas.

UDOT should re-confirm that it is acceptable for field units to implement varying Levels of Service for snow and ice. With the current practice, roads similar in classification and traffic volumes may not be receiving similar service levels. Although there could be operational reasons why service levels should vary, the Department may be able to achieve more cost-effective service statewide without sacrificing mobility or safety.

Recommendation 69. Provide more training to section managers on the benefits and cost-effectiveness of route planning.

Route planning is an effective method of implementing consistent Levels of Service. It also provides operational efficiencies because resources can be deployed expeditiously. Real-time conditions may dictate occasional deviations from the route plan. However, overall more effective and efficient operations should result.

Recommendation 70. Develop and conduct annual refresher training.

Although operators are well trained in equipment operations, UDOT should develop a brief training course on snow and ice operations. Even the most experienced operators and manager would benefit from a brief course conducted in the fall, prior to the snow season. The refresher course should include, among other items:

• Basics of snow and ice operations
• Safe equipment operations and work practices
• Equipment care and maintenance
• Reporting requirements
• Coordination with internal and external agencies
A one-day “shakedown” by each maintenance section, prior to the snow season, to include the training, dry runs of each operator’s routes, and equipment preparation and calibration would help to prepare the crews for the oncoming snow season.

**Recommendation 71. Continue upgrading to covered storage facilities for chemicals and abrasives.**

Although it is a costly undertaking, the Department should continue its long-term program to provide covered storage. Covered storage provides many benefits in eliminating environmental damage and costly loss of material.

**B. Hard Surface Maintenance**

Maintenance is crucial to maximizing the potential lifecycle of transportation assets such as pavements. Without a strong, pro-active maintenance program, many pavement designs will not perform as expected and will likely require earlier and more expensive treatments during their performance period.

**1. Existing Approach**

Pavement maintenance is performed by crews operating from the maintenance stations. The type of work that these crews carry out is highly seasonal. Between May and early October, the work includes fog seals, surface rejuvenation, chip seals, grader placed hot-mix asphalt, thin overlays on flexible pavement surfaces, and patching on Portland cement concrete pavement surfaces. Occasionally, maintenance crews rent asphalt lay-down machines and operators and place their own hot-mix asphalt overlays. Pothole repair is carried out in the winter months when such distresses tend to appear; potholes are typically repaired when it is not snowing. Crack sealing is also performed during the colder months, when cracks are at their widest.

Funding constraints play a large role in determining what types of projects UDOT’s maintenance crews work on, as well as how many of these projects can be completed in any year. For example, a project size constraint of $100,000 limits the magnitude of the work that UDOT can perform; work beyond that cost is always contracted out. Furthermore, major surface work on interstates is always contracted out because the traffic control requirements exceed UDOT’s capabilities.

The need for the work is triggered in different ways. The decision to seal cracks or repair potholes is made by the station supervisor and area inspector. At the region/district level, in addition to regularly riding the roads as part of their day-to-day activities, inspectors identify pavements that require maintenance attention during semiannual inspections. In this evaluation, they are taking a close enough look at the pavement to identify the need for crack sealing or patching.
Other treatments, such as chip seals, are triggered by UDOT’s pavement management program in one of two ways. At the network level, pavement management has worked with the regions/districts to develop a schedule of pavement maintenance. For example, on certain lower volume bituminous-surfaced pavements, a seal coat is applied after 6 years and a thin overlay is applied after 12 years. At the project level, this schedule can be adjusted based on the results of the pavement management survey, which is conducted every 1 to 2 years and includes both a ride and distress assessment. Skid measurements are occasionally taken. If a road is scheduled for a treatment but does not need it, the treatment is not automatically applied.

The materials that are used for pavement maintenance are the same materials that are on the State’s approved list for use in contract work. Sometimes this is acceptable and sometimes it is not. For the oils and sealants that they use, they are always looking for a material that will work better than the existing specifications. For chip seals and thin hot-mix asphalt (HMA) placements, they also use the State specifications and have found these to work well.

Much of the initial training that maintenance workers receive to enable them to perform pavement maintenance work is “hands on.” Operation of the various equipment is taught twice a year at the training academy.

There is not extensive evaluation of the initial quality or long-term performance of the finished project, beyond some internal quality assurance. All maintenance treatments that are applied under contract are administered by the Construction Division and are performed under specifications that are likely to include a level of testing and inspection.

2. **Best Practice**

There is no definitively “best” way of performing pavement maintenance that can be held out as a standard to which others should aspire. There are several trends which are believed to represent the best of current practice, however.

a. **Quality Assurance**

Quality Assurance (QA) concepts are an increasingly common component of HMA Quality Control (QC)/QA projects, and have started to migrate to maintenance activities. A recently completed NCHRP study, Project 14-12, resulted in the development of a maintenance quality assurance program for highway agencies.

b. **Maintenance Management Systems**

The use of maintenance management systems within DOTs to track equipment, labor, and material use is widespread. In addition to such standard capabilities as issuing and tracking work orders, inventory control, storing maintenance histories, and existing and future needs projections, the most sophisticated
systems are able to accomplish “real time” data logging through the use of portable devices equipped with remote access capabilities. Several state agencies are using maintenance management systems that have the ability to share information directly with the agency’s pavement management system to improve overall decision-making capabilities.

c. Contract Maintenance

Many agencies are moving toward contracting with private industry for large parts of their maintenance program. This change has been driven by a number of factors, including labor shortages, budget shortfalls, legislative mandates, or a combination of reasons. Maintenance contracts range from directed, activity-based contracts (e.g., mowing three times a season) to comprehensive, performance-based corridor maintenance contracts (covering all work required within the right-of-way).

d. Pavement Preventive Maintenance

A traditional view of pavement maintenance activities includes what is done to a pavement to preserve its condition. Historically, maintenance activities have been reactive in nature, fixing defects as they occur. Crack sealing, pothole patching, and spall repair are all examples of traditional pavement maintenance activities.

Many agencies are now attempting to move more toward a preventive maintenance philosophy. Preventive maintenance is not meant to supplant traditional maintenance activities, but rather is an additional set of tools to extend the life of pavements in good condition. The result is that pavement lifecycle costs are lowered, pavement conditions are improved, and the traveling public travels on safer, smoother roads with fewer work zones.

Key components of preventive maintenance programs include guidelines for when to apply the preventive maintenance treatments, how to measure the performance of the treatments, and how to dedicate funding that is distinct from routine maintenance and pavement rehabilitation. Successful programs have aimed at achieving a specific goal, such as improving a measurable pavement condition indicator, reducing costs, extending pavement life, and so on. With such goals, the agency is able to track its performance over time. At least one agency tracks and publicizes pavement performance on a district by district basis.

For some agencies implementing preventive maintenance practices, extensive training has been required to promote the philosophy within the entire organization. For most agencies, the types of treatments are very similar to those used under a traditional program. The major difference occurs in the timing of the treatments application. In a preventive maintenance program, the treatments
are typically applied earlier in a pavement lifecycle than under a more traditional “stopgap” approach.

Another difference in a preventive maintenance program is the use of dedicated funds for planning maintenance activities. Preventive maintenance applications are not reactive in nature; then rely more on a planned series of treatments designed to extend pavement life. As such, it is imperative that those responsible for applying preventive maintenance treatments have the ability to schedule and plan for the application of these treatments.

e. Integration

Another element of traditional pavement maintenance is that the work performed by force account is not commonly linked to a specific segment of pavement, or a segment that matches the parameters used in pavement management. This has made it difficult to differentiate the performance of pavements that have received maintenance and those that have not received maintenance. The best practice is to record detailed information in a management system: what maintenance treatment is applied, the milepost limits of where it is applied, and when it is applied. Wherever that information is stored, it should be available to the pavement management system so that the performance of maintenance treatments as well as the performance of pavements that have received different maintenance treatments can be tracked. Furthermore, to the extent that it is applicable, pavement management data from annual surveys is used to identify pavements that are candidates for preventive maintenance.

3. Strengths and Issues

UDOT’s maintenance program has a number of strengths and issues when compared to the state of the practice in this area. Each of these characteristics is discussed in this section of the report and recommendations for improving the maintenance practices in the state are further outlined in the following section.

a. Strengths

(1) Treatment selection

UDOT’s maintenance program includes a full range of maintenance treatments, including chip seals, crack seals, rejuvenating seals, microsurfacing, and thin HMA overlays. When compared to the treatments used by strong maintenance programs, the list of treatment types is comparable. The State has had mixed results with the use of microsurfacing due to stripping. With further study, these issues could be addressed more completely.
(2) Emphasis on preventive maintenance

UDOT has established its Orange Book program as a way of scheduling preventive maintenance treatments. This program is in line with other preventive maintenance programs with a few notable exceptions, as discussed below. However, the emphasis that the Department has placed on preventive maintenance is an important first step in a successful preventive maintenance program.

In June 2002, each region also adopted Region 2’s “Plan for Every Section.” The plan for every section is a database of all the region’s road segments and the treatments that have been applied. The database which is linked to UDOT’s pavement management system was designed as a planning tool to ensure that the proper pavement treatment schedule is applied to each segment.

(3) Project Selection

As discussed, project selection is conducted at two levels depending on the type of treatment needed. At the region/district level, projects are identified for crack sealing and patching projects. Other treatments, which are less reactive in nature, are recommended as part of a pavement management analysis. This approach is in line with practices in other states.

(4) Pavement management at the region/district level

UDOT has expanded its pavement management activities to include Pavement Management Engineers in each District. This approach puts the analysis tools needed for programming preventive maintenance treatments in the hands of the individuals making these decisions. At least two other states have moved in this direction and several other states have indicated their desire to move in this direction.

b. Issues

(1) Performance tracking

At the present time, UDOT does not have a method of tracking all of its maintenance applications in a manner that is consistent with the pavement management system. To be able to track and compare the effectiveness of maintenance treatments, a common referencing and reporting system should be developed.
(2) **Goal setting**

According to the information provided during this study, the goal for the preventive maintenance program is not well known among the maintenance personnel. An organization with a strong preventive maintenance program will have established a goal for the program and laid out a strategy for achieving the goal (usually through the use of funding and condition targets) over a certain length of time. With a goal in place, an agency can benchmark its progress towards achieving the goal and further promote the benefits of the program. This is an important part of integrating a preventive maintenance program into an organization and changing the organizational mindset. For example, Michigan set a 10-year goal of 95 percent of its expressways and 85 percent of its non-expressways being in good or fair condition.

(3) **Training on techniques**

A key to a successful maintenance program is making sure that the treatments that are being used are designed and constructed properly. UDOT has developed a maintenance manual to help provide some consistency in the application of maintenance techniques, but additional training should be provided. The FHWA’s National Highway Institute (NHI) is in the process of developing a training course on the application of maintenance techniques that should be provided to all maintenance personnel in the state. The course is expected to be available in late 2003.

(4) **Lack of dedicated funding**

As discussed earlier, an effective preventive maintenance program requires the planned, timely application of appropriate maintenance techniques. Without a dedicated funding source, it is difficult for an organization to develop maintenance treatment schedules that can be applied consistently. UDOT is like many agencies in that often the Districts will apply whatever maintenance treatments they can, where it is needed, with the available funding. This sometimes means that preventive maintenance treatments are being used as a stopgap application rather than as a strategy that extends the serviceable life of a pavement.

(5) **Region/district autonomy in project selection**

Although the State’s pavement management system is used primarily for project and treatment selection to optimize the use of available funds, there is a certain degree of autonomy among the region/districts to select projects. While a certain amount of autonomy is important, the State currently can not be assured that there is consistency in the way projects are selected and treatments
are applied. As a result, any long-term goals that may be established by Central may be difficult to achieve without some buy-in from the region/district offices. This is an institutional issue that is facing many transportation agencies interested in improving the overall condition of their road network.

4. Recommendations

To strengthen UDOT’s pavement maintenance program, we recommend the following:

**Recommendation 72. Formalize the State’s preventive maintenance program.**

As part of this formalization, the State should identify its long-term performance targets and use the pavement management system to establish a reasonable timeframe for achieving those targets. Based on the information provided, UDOT should identify a source of dedicated funding for preventive maintenance and clearly establish the types of projects to be included in the program. Progress towards meeting the performance targets should be tracked on a regular basis and communicated throughout the organization. Additionally, individual goals for each region/district should be established and the progress towards meeting performance targets in each region/district should be reported.

**Recommendation 73. Provide training on treatment applications.**

As discussed earlier, FHWA’s NHI is in the process of developing a training course that discusses the application of a variety of maintenance treatments. UDOT should request this course as soon as it becomes available and seek participation from as many maintenance personnel as possible.

**Recommendation 74. Strengthen the integration of pavement maintenance and pavement management information.**

In order to better track the effectiveness of its maintenance treatments, UDOT must move towards a maintenance reporting method that can feed into the pavement management system. Ideally, the State’s goal should be complete integration between maintenance and pavement managements so that any pavement maintenance performed is recorded and tracked. The ultimate objective should be a consistent method of monitoring pavement performance, triggering treatments, and recording pavement maintenance and rehabilitation work across pavement maintenance and pavement management.

**Recommendation 75. Develop and implement QA procedures.**

In order for maintenance treatments to be most effective, it is important that the quality of the construction techniques be as high as possible. To improve its construction practices, UDOT should develop and implement a method to measure the quality of both force account and contract maintenance activities.
C. Non-Hard Surface Maintenance

Non-Hard Surface Maintenance covers activities on two maintenance features – unpaved roads and unpaved shoulders. Only a small percentage of UDOT’s roads are unpaved. Thus, unpaved road maintenance consumes a relatively small amount of the maintenance resources and budgets. On the other hand, a majority of the State’s roads have some type of unpaved shoulders requiring a continuous program of shoulder maintenance.

1. Existing Approach

The work descriptions and work procedures described by the Activity Performance Standards present the general methods used by UDOT to maintain non-hard surfaces.

a. Unpaved Roads

Unpaved road maintenance is performed mostly in the spring and fall months when moisture is present and conditions are most suitable for this type of work. The work methods described by the Activity Performance Standards represent industry norms for grading and reshaping unpaved roads.

Aggregate is added to the road surface if needed. UDOT uses three common sources for the aggregate. The aggregate may be obtained by blading existing materials from the road surface and re-distributing it where it is needed for reshaping the road. Gravel pits are another common source. Commonly referred to as “bank run” material, this aggregate is used in its native form from the gravel pit sources. The third source of material is purchased from aggregate suppliers. It is commonly called “road base” or “base course,” and conforms to UDOT specifications for the material class.

UDOT attempts to grade unpaved roads twice per year. Scheduling the work is done on an as-needed basis when the condition of the road surface warrants.

b. Unpaved Shoulders

Most of UDOT’s roads have a 2-foot to 8-foot paved shoulder extending from the edge of pavement. Unpaved shoulders then extend from the edge of the paved shoulders to a ditch, if present, or to the roadway slopes.

The work methods described by the Activity Performance Standards represent industry norms for grading and reshaping unpaved shoulders. Aggregate for shoulder activities is obtained from the same sources as described above.

Work on shoulders is scheduled on an as-needed basis. UDOT does not have a regularly scheduled maintenance cycle on shoulders. Work needs are identified either during road inspections, from observations made by the crews, or by call-
ins from external sources. When roads are resurfaced, reworking shoulders is typically included in the contractor’s scope of work.

There is some feeling within the Department that shoulder maintenance is one of the most neglected activities in the maintenance program. This causes the existing shoulder conditions to be less than acceptable.

2. **Best Practice**

a. **Unpaved Roads**

   Best practices for maintaining unpaved roads are fairly straightforward. There has not been much advancement in materials or equipment; unpaved road maintenance methods are much the same as they have been for many years.

   The best work methods for unpaved roadways include the following:

   - Establishing/re-establishing proper crown and road cross-section.
   - Grading the edge of the traveled way to channel water to a defined ditch or slope.
   - Adding properly graduated aggregate to assure road surface strength and stability.
   - Compacting the road surface for stability and for preventing pre-mature rutting and surface deterioration.

   A dust palliative or liquid asphalt may be applied to the road surface to help prevent dust, retain fines in the road surface, and slow absorption of water into the base.

b. **Unpaved Shoulders**

   Shoulder maintenance is an important element of a good road maintenance program. Well-maintained shoulders provide many benefits by accomplishing the following quality objectives:

   - **Safety** – providing a safe area for vehicles leaving the roadway and paved shoulders.
   - **Drainage** – effectively channeling water away from the roadway and paved shoulders to either a defined ditch or slope.
   - **Road Stability** – providing support to the edge of pavement or edge of paved shoulder to prevent the edges from breaking away and causing damage to the pavement structure.

   Best industry practices include a regular cycle of shoulder maintenance to ensure that these objectives are achieved. Depending on the volume and type of traffic,
shoulders normally require maintenance once per year. Some shoulders areas may require more frequent attention, such as those used frequently by large vehicles.

The best work practices, similar to those for unpaved roads, accomplish the following:

- Reshaping the shoulders for proper slope and drainage.
- Adding properly graduated aggregate to restore strength and stability.
- Compacting the shoulders after they have been worked to ensure stability.

Some agencies apply a liquid asphalt or chip seal to the shoulder surface to help preserve it.

3. Strengths and Issues

In general, UDOT’s work methods appear to be in line with industry norms. The following key issues were noted.

- **Shoulder Maintenance Cycle**
  UDOT does not have a defined cycle of shoulder maintenance. The work is scheduled primarily on an as-needed basis. There is a perception that the shoulders are in less than acceptable condition.

- **Aggregate Gradation and Specification**
  UDOT uses native materials from either the roadway or shoulders and bank run from available gravel pits. Depending on the volume of traffic on the unpaved roads or shoulders, this material may not have the proper gradation for strength and compaction.

- **Lack of Compaction Equipment**
  Currently, UDOT uses either dump trucks or end loaders to compact surfaces. This may be adequate for low traffic volumes, but might not be sufficient where good compaction is needed.

4. Recommendations

**Recommendation 76. Develop a regular cycle of shoulder maintenance.**

In order to achieve the appropriate level of service for shoulders, UDOT should implement a regular cycle of shoulder grading and reshaping. Since most maintenance stations have a relatively small contingent of personnel and equipment, a special region/district-wide crew might be warranted. A region/district-wide crew could be properly staffed with trained personnel and equipment and dedicated to shoulder maintenance at the appropriate time of the year.
Recommendation 77. Review the applicability of gradated materials.

UDOT should review whether the practice of using native materials and bank run gravel is appropriate for unpaved roads and shoulders. A crushed aggregate having a dense uniform gradation and top size of 1.5 inches is best suited for strength and compaction.

Recommendation 78. Add a wheel compactor as part of the standard crew.

The Department should add a wheel compactor as part of the standard shoulder and unpaved road crew. It is probably not cost-effective to assign a wheel loader to each maintenance station. However, if the Department implements a region/district-wide crew, a compactor could be provided for that crew. Alternately, a compactor could be provided for each region/district and assigned to each maintenance station on a rotating schedule.

D. Roadside Maintenance

The roadside is generally defined as that area between the outside edge of the roadway shoulder and the right-of-way boundary. Proper maintenance of the roadside takes into account varied objectives. According to the AASHTO Maintenance Manual, “The roadside should be maintained in a condition that contributes to safe travel and operation, presents an orderly appearance, provides convenient travel, enhances a pleasing travel experience, preserves the roadway investment, and protects the roadway investment, insofar as available resources permit rational allocation to roadside maintenance.”

1. Existing System

Maintenance of the roadside is the direct responsibility of each region/district and is accomplished by station maintenance crews. Removing rocks, animal carcasses, and other large debris from the roadway is the highest priority of UDOT’s Roadside Maintenance program, as it is considered safety related. Litter control is generally considered a low priority and is primarily done when higher priority work cannot be scheduled. Fence repair is an essential activity to prevent UDOT liability. In rural areas, fences prevent cattle from entering the highway right of way. In urban areas, fences are used to prevent pedestrians from entering the highway right-of-way. The UDOT Station Supervisors Handbook provides for the following roadside maintenance activities:

- 7S39 LITTER CONTROL (Other) (Annual). This activity involves removing all litter and debris from the right-of-way that is either unsightly or potentially damaging to mowing equipment. Litter can be as small as a simple piece of paper or as large as a discarded appliance.

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• **7S45 ROUTINE ROADSIDE (Other).** This activity involves removing dead animals and large debris from the roadway. Although this activity is entitled “Routine Roadside,” the activity actually occurs on the roadway.

• **7S54 ROCK REMOVAL.** This activity involves driving the highway to identify and remove safety hazards such as fallen rocks and other large debris on the roadway and shoulders.

• **7S44 FENCE MAINTENANCE.** This activity involves maintaining and repairing fence on the highway right-of-way line to ensure access control.

2. **Best Practices**

Litter control is considered an aesthetic enhancement and is not related to the safety of the traveling public. As a result, most transportation agencies try not to spend much money on litter control. Many states are utilizing an Adopt-A-Highway program to control litter on the roadside.

Some transportation agencies are able to utilize inexpensive labor provided by local and State Department of Corrections’ inmates to remove litter. The transportation agency enters into an agreement with Department of Corrections’ agencies for supervised crews of a specified size to perform litter control for a specified cost. Both agencies benefit from this arrangement. The correction agency can provide meaningful work and exercise for low risk inmates, and the transportation agency receives the benefit of low cost labor.

Carcass removal can be a time-consuming and distracting activity for a department of transportation to undertake. Some departments have found that outsourcing dead animal pickup is a cost-effective solution.

When fence continuity is important to a highway agency, regular fence inspection is essential to identify problems and breaks in the fence. Some departments of transportation have developed a program of videotaping fencing to document their inspections.

3. **Strengths**

UDOT does employ an Adopt-A-Highway program. Also, regions/districts with prisons within their borders have used prison crews for litter removal. Several regions/districts reported outsourcing carcass removal. Interviewees indicated that fence maintenance is considered a high priority and liability issues have thus been avoided.

4. **Issues**

UDOT’s grouping of maintenance activities for roadside maintenance is unusual. Roadside maintenance in other states often includes maintenance activities that UDOT identifies in Group 5, Vegetation Control, and Group 6, Drainage and Slope Repair. In contrast, rock and carcass removal from the roadway is often not included in roadside maintenance.
Although UDOT has an Adopt-A-Highway litter control program, there is no MMS charge number to track the associated expenses. The absence of such cost accounting may lead management to believe that the service is free. However, the cost to administer the program and dispose of the litter collected by Adopt-A-Highway can be significant.

5. Recommendations

Recommendation 79. Regroup maintenance activities that occur on the roadside.

Combine the vegetation control activities with Roadside Maintenance. The new group could be called Roadside and Vegetation Maintenance. Rock removal may be better classified under Group 6, Slope Repair.

Recommendation 80. Provide a charge number for Adopt-A-Highway activities.

Although Adopt-A-Highway volunteers pick up litter, the Department still incurs expenses for administering the program and disposing of the litter. These expenses should be captured for future identification.

E. Vegetation Control

Vegetation control maintenance activities involve growing or managing plants on the roadside. It includes all activities for maintenance of formal landscape plantings, informal plantings, and naturally occurring roadside vegetation.

1. Existing System

The maintenance of all plants along the highway is the direct responsibility of each region/district. Organization of the vegetation control personnel is entirely determined at the region/district level. Some regions/districts have a crew designated to handle all vegetation maintenance activities within the region/district. In others, vegetation maintenance is accomplished by maintenance crews as part of their regular work program.

The UDOT Station Supervisors Handbook provides for the following maintenance activities:

7M12 VEGETATION MANAGEMENT.

This activity involves tracking special projects funded by Central.

7S32 MOWING.

This activity involves mowing vegetation within the highway right-of-way to improve appearance, control growth, and control seed production and plant propagation.
7S33 VEGETATION CONTROL (Other).

This activity involves hand mowing, hand trimming, and burning vegetation within the highway right-of-way.

7D34 VEGETATION CONTROL (Chemical).

This activity involves applying chemicals for the purpose of vegetation eradication or growth retardation.

7D35 VEGETATION CONTROL, CUTTING BRUSH, AND TRIMMING AND REMOVING TREES.

This activity involves trimming and cutting brush and trees for elimination of hazards. The work may be done with hand tools or motorized equipment.

7S42 LANDSCAPE MAINTENANCE.

This activity involves all plant maintenance associated with formal landscape plantings, including but not limited to fertilizing, weed control, maintenance of sprinkling systems, and replanting trees, shrubs, and ground cover plants.

UDOT is in the process of implementing an Integrated Roadside Vegetation Management (IRVM) approach to roadside maintenance, as described in Chapter V. While some regions/districts have implemented this approach, others have not.

2. **Best Practices**

As noted in Chapter V, vegetation maintenance is a specialized area of highway maintenance that requires unique expertise not required in other aspects of highway maintenance. In order to keep current on the innovative approaches to vegetation management, ongoing training and education is essential.

A key aspect of Integrated Pest Management (IPM) is a year-round dedication to vegetation management. This affords personnel the opportunity to be properly trained, spend time strategically planning for future needs, and build institutional memory of past problems.

3. **Strengths and Issues**

a. **Strengths**

   UDOT’s IRVM program, described in Chapter V, is a sound application of IPM.

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47 IPM is described in more detail in Volume I.
b. Issues

Personnel can be given vegetation control duties they are not adequately trained to accomplish. Accidental eradication of desired vegetation could occur. Knowing the correct timing of vegetation control activities is critical. If control work is not done at the proper time it can become counterproductive and less effective. Many vegetation control activities need to occur during the growing season. This is a time when other maintenance activities typically take place.

Most of the MMS vegetation control activity numbers do not directly connect to MMQA outcome measurements. For example, Vegetation Control (Chemical) can be used to Control Vegetation Obstructions, Control Nuisance Vegetation, and do Landscape Maintenance, in addition to Noxious Weed Control (5A1). This same issue is true for most other vegetation control activities. There is no direct correlation between MMS activity expenditures and MMQA condition outcome measurements for most vegetation control activities.

4. Recommendations

Recommendation 81. Increase specialized training for all personnel involved in vegetation control activities.

Knowledge of vegetation maintenance objectives and known effective techniques is critical for delivery of an effective vegetation maintenance program. Since this is a very specialized area of expertise that the rank and file maintenance crew member is unfamiliar with, it is important to have properly trained people to do this work.

Recommendation 82. Target regions/districts that have not fully implemented IRVM for additional education and training.

If UDOT is truly going to establish its IRVM program, it will have to promote a new way of doing business. Practices such as seeding, fertilizing, and planting natives and sustainable vegetation should become standard practice. However, some regions/districts do not clearly understand the objectives of the program and require pressure from Central in order to perform any vegetation control activities. These regions/districts should be educated by the Central Roadside Vegetation Manager and guest speakers in order to make the case for UDOT’s approach.

Recommendation 83. Make a better connection between MMS and MMQA.

Currently there is no direct correlation between an MMS activity expenditure and the outcome condition rating identified in MMQA. If MMQA is to provide credible data, it is important that these connections make sense to the people using them.
F. Major Structure Maintenance

1. Existing Approach

Maintenance stations have limited capacity and resources to perform major structure repairs. The majority of structure maintenance is performed by Central crews and by contract.

Maintenance stations perform minor structure repairs such as:

- Deck patching.
- Crack sealing.
- Deck washing and cleaning.
- Minor slope repairs.

UDOT performs biannual bridge inspections in accordance with federal regulations and guidelines. These detailed inspections involve close examination of each bridge component and may use snooper trucks where needed. Maintenance needs are defined during these inspections.

When maintenance needs are determined, the decision is made as to whether the work can be done by Central, or by station crews, or by contract. The work is then scheduled and executed.

The maintenance stations sweep and clean bridge decks in the spring, after the snow season, to remove accumulated winter abrasives. UDOT does not have a regular bridge washing program for pressure washing the bridge under-structure and abutments.

In addition to bridge maintenance, this series of activities also includes:

- 7S58 – Graffiti Removal
- 7D47 – Cattle Guard Repair/Maintenance
- 7D60 – Structure Inspection

Graffiti removal and cattle guard maintenance are performed on an as-needed basis by the station crews. These activities consume relatively few funds and resources.

Structural inspections are performed twice a year by field maintenance staff in conjunction with the overall roadway inspections. The inspections are not as detailed as the biannual inspections and primarily involve a cursory review of the bridge from the deck and from ground level. Minor bridge repairs identified during the twice-yearly road inspections are prioritized and scheduled for station crews. Major repairs are referred to the UDOT Structure Division.
The Department uses PONTIS, the Bridge Management System (BMS) supported by AASHTO, to collect condition data and bridge history information. The application of PONTIS is outside the Maintenance Division’s responsibilities and was not reviewed in detail as part of this study. PONTIS includes the following major components:

- Bridge inventory.
- Inspection and condition rating.
- Information systems for inventory, history, and condition.
- Life-cycle cost analysis of bridge preservation options.
- Predictive models for long-range budgeting.
- Network level investment analysis.
- Performance monitoring.

2. Best Practices

Bridge maintenance and repair involves both routine and specialized activities. Routine activities include washing, deck patching, and minor structural repairs. Specialized bridge repairs normally result from deterioration of older bridges or from bridge damage caused by an accident or natural disaster. Specialized activities involve more technical repairs and are normally done by special bridge crews and contractors with specialized equipment.

Best practices for routine bridge maintenance include the following:

- Detailed biannual inspections and analysis performed in accordance with federal laws and regulations.
- Regular inspections to determine routine and minor maintenance needs.
- Bridge sweeping and cleaning on a regular basis to keep bridge drains working properly and to remove accumulated winter abrasives.
- Crack and joint sealing on bridge decks to prevent intrusion of water to the substructure.
- As part of the preventive maintenance program, painting schedules are established for steel bridges. The re-painting schedule for each structure depends on the environmental conditions present at the site. The maintenance program includes a long-term bridge painting plan, schedule, and budget.

Carrying out these activities on a preventive maintenance schedule to keep the bridge structure from deteriorating is the most cost-effective maintenance approach over the lifecycle of the structure.
3. **Strengths and Issues**

   a. **Strengths**

   The Department’s bridge maintenance program appears to be in line with industry norms. UDOT performs both regular and biannual bridge inspections. Maintenance crews perform several of the routine treatments that extend the structures’ life spans. Although Maintenance does not have custody over it, the Department does maintain a Bridge Management System.

   b. **Issues**

   The maintenance stations perform spring deck washing and sweeping. However, it does not appear that high-pressure washing of the substructure is performed. There appears to be no defined preventive maintenance approach for bridges.

4. **Recommendations**

   Based on observations as outlined above, the following recommendation is offered.

   **Recommendation 84. Establish a preventive maintenance program for bridges.**

   The Department should establish a rigorous preventive maintenance program for bridges. The preventive maintenance program should include, among other activities:

   - Regular washing and cleaning cycles, including high pressure washing of abutment and pier seats and the substructure.
   - Painting, both spot and full painting.
   - Bridge deck crack and joint sealing.

   The preventive maintenance program may be implemented in conjunction with the Bridge Management System. Many of the preventive maintenance activities could be performed by UDOT’s field maintenance crews. The Department should consider staffing and equipping an adequately trained special crew for each region/district.

   Note: Since the Structures Division has most of the responsibility for bridge inspection and maintenance, practices in those areas were outside the scope of this study.

G. **Drainage and Slope Repair**

   Drainage maintenance activities involve removing water from the roadway surface via ditches, catch basins, inlets, culverts, drains, retention basins, and other structures. Drainage maintenance also involves conveying natural waterways from one side of the highway to the other. Drainage maintenance has important safety implications and prevents damage to
the highway, associated structures, and adjacent property. Safety issues arise if water is not sufficiently removed from the road surface and shoulders. During the winter months, water present on the road surface may freeze and create a dangerous situation. Good drainage maintenance is an essential component of a preventive maintenance program. If water is not adequately drained from the roadway, it may enter the road subsurface. Moisture in the subsurface is one of the most damaging situations for the road because it can weaken the base course. Also, a high moisture content subjects the base course to damage from repeated freeze/thaw cycles.

Slope repair involves repairing damage from slides or erosion, including re-vegetation of the repaired slope.

1. Existing System

Maintenance of the drainage facilities and repair of slopes is the direct responsibility of each region/district and is accomplished by station maintenance crews. Some of the work may be required as part of an emergency or natural disaster. When this occurs, immediate attention to the problem must be given and the work is considered a high priority.

The UDOT Station Supervisors Handbook provides for the following drainage and slope repair maintenance activities:

**7S46 – PAVED DITCHES MAINTENANCE.**

This activity involves cleaning and repairing paved ditches to ensure the free flow of water. UDOT’s paved ditches generally consist of V-bottom and rounded cross-sections. There are few paved ditches in inventory resulting in a relatively low maintenance budget for this activity.

When the ditch is accessible, the work is usually accomplished with a Bobcat-type end loader. This work is scheduled on an as-needed basis when a drainage problem arises. The ditches are not cleaned on a regularly scheduled cleaning cycle.

**7S52 – CUT DITCHES, CLEAN & RE SHAPE, REMOVE MINOR SLIDES.**

This activity involves removing deposited material and other debris, cleaning, and reshaping cut ditches to the original slope and grade. Removing up to 30 cubic yards is appropriate for this activity. This activity is similar in work methods to 7S53.

The maintenance stations attempt to clean the ditches twice per year. Resources are not always available to meet this objective, and the work is generally accomplished on an as-needed basis.
7S53 – CANYON CUT DITCH CLEANING.

This activity involves removing deposited rock and other debris from cut ditches steeper than 1:2 and/or higher than 50 feet. Removing more than 30 cubic yards is appropriate for this activity. This activity applies primarily to canyon areas where rock fall has clogged the ditches and disrupted the normal flow of water. The work most often occurs in the spring during periods of high rainfall. The work tends to be accomplished at spot locations as opposed to continuous operations along the roadway shoulder.

Work methods and management practices for this activity is similar to 7S52, and region/district representatives expressed some confusion as to which activity applies in selected situations.

7S56 – OPEN SURFACE DRAINAGE MAINTENANCE.

This activity involves maintaining ditches to the line, grade, depth, and cross-section they were designed or improved to. This activity applies when a defined ditch line exists, as opposed to previous activities where the ditch is not as well defined. In most cases, the ditches run transverse to the road centerline, normally at the inlet and outlet ends of pipes.

Work is generally scheduled on an as-needed basis when blockage occurs.

7S84 – FLOODS AND LANDSLIDES.

This activity responds to catastrophic events such as floods, landslides, or sand drifts. It involves removing and eliminating hazards that are outside the scope of normal maintenance activities. After the immediate hazard is removed, any work to repair excessive road damage is performed under a special activity number. Additional funds may be given to the maintenance stations by Central for major road repairs.

This activity occurs infrequently and consumes a small portion of the maintenance budget and resources. The work is scheduled immediately when needed and is performed at spot locations.

7D58 – DETENTION POND MAINTENANCE.

This activity involves cleaning and repairing all features associated with detention ponds. There are relatively few detention ponds in the maintenance inventory. They normally are present in urban locations, and some maintenance districts have none. The work consumes a small portion of the maintenance budget and resources.

The work is normally scheduled on an as-needed basis. Work is performed when silt in the ponds accumulates to the point that they become nonfunctioning.
7S51 – DRAINAGE PROGRAM MAINTENANCE.

This activity involves cleaning and repairing culverts, drop inlets, and immediate inlet and outlet channels. The work is scheduled on an as-needed basis.

The work under this activity is primarily manual involving a two-person crew and one lease truck. Repairs are of a minor nature.

7D61 – SPECIAL DRAINAGE (VACTOR).

This activity involves the use of vactor equipment for cleaning or washing plugged or restricted culverts. The work is accomplished with specialized equipment that can suction leaves and other debris from the drop inlets. The vactor is equipped with a high pressure hose to flush out clogged drains.

UDOT has allocated one vactor truck per region/district. The vactor is scheduled for the various maintenance stations on a rotating basis. The work needs are determined by the maintenance station supervisor, and a work backlog list is prioritized. When the vactor truck is in his region/district, the station supervisor will accomplish as much of the priority backlog as the schedule allows.

Each maintenance region must supply the operators for the vactor trucks. A district normally has one or two operators trained on the vactor.

7S55 – EROSION REPAIR.

This activity involves repairing and stabilizing damaged slopes, including re-vegetation of the finished slope. The work needs usually occur in the spring during periods of high rainfall. Work consists of re-establishing the slope by importing fill material from other locations.

2. Best Practices

Best practices are categorized into three areas: work methods, management practices, and environmental practices

a. Work Methods

Best work methods incorporate the use of proper equipment and trained personnel to accomplish the activity. Typically, drainage maintenance activities do not require sophisticated work methods or equipment. The exception is the use of vactor trucks for cleaning inlets and culverts. Vactors are specialized equipment and require careful use and maintenance. It is best to have a specific operator assigned to the vactor unit. When the vactor is shared among different operators, care and maintenance of the unit can suffer.
Continuous belt loaders help to make ditch cleaning operations more productive, as opposed to the use of front-end loaders. The belt loader is best assigned when the ditch cleaning operation is continuous along the roadway. Because Utah’s ditch work tends to be accomplished at spot locations, a belt loader might not be applicable.

b. Work Management

Best work management practices address the budgeting, scheduling, and monitoring of drainage activities. Because drainage is so important to the structural integrity of the roadway, it should be treated as a preventive maintenance (PM) activity. Best practices include a PM schedule for the major types of drainage features. A PM approach incorporates the following components:

- An inventory of drainage features showing location, type, and characteristics.
- A PM schedule involving a planned cycle of cleaning and repair for each class of drainage feature.
- Planning and budgeting methods to allocate the funds and resources needed to accomplish the PM objectives.
- Short-term work scheduling to execute the PM schedules on time.
- Continuous monitoring to assess the effectiveness of the PM program.

c. Environmental Practices

Environmental issues and concerns are becoming more prevalent in maintenance activities. Drainage maintenance has a direct impact on water quality in and downstream of road drainage systems.

There are numerous structural and nonstructural best practices that can be installed to reduce the downstream impacts of highway storm water runoff. Many are constructed when the highway facilities are built. It is the responsibility of maintenance to ensure these practices continue to function as intended. In addition, maintenance must perform other traditional activities to drainage facilities that can potentially have environmental impacts. A consistent program of inspection and maintenance is necessary for highway drainage systems to operate effectively.

Environmental considerations are a major concern for maintenance of any drainage facility. Timing of work can be critical to meet the window of opportunity for the protection of water quality and fish life. Following is list of typical best practices that may apply to maintenance of drainage facilities and repair of slope damage.
• Appropriate practices should be used within 300 feet of surface water or potential riparian habitat to ensure that no foreign material or sediments enter the water.

• All drainage facilities should be routinely checked for accumulation of sediment or other pollutants. If specific thresholds are reached, these facilities must be cleaned.

• Maintenance activities should be planned and scheduled in dry conditions to minimize impacts to water quality.

• Vegetative buffers should be provided outside the work zone to provide bio-filtration.

• Ditches should be maintained to the line, grade, and cross section to which they were constructed. Ditches should only be reshaped when their original design no longer functions as intended.

• Disturbed areas should be re-seeded to stabilize slopes and minimize erosion.

• Excavated material should be properly disposed of at an upland site and not in any waterway or wetland.

3. **Strengths and Issues**

   a. **Strengths**

   Local station personnel have the primary responsibility for maintaining all drainage systems. Station personnel build institutional memory of these systems over time. Knowing the area they are maintaining allows the stations to respond quickly when a storm event occurs or a major problem arises. Local maintenance crews are able to respond quickly during emergencies for slides or floods, and are able to address the situation as it happens or shortly thereafter.

   UDOT design personnel can utilize maintenance institutional memory as input for future designs to address identified problems. Someone that has had day to day contact with the problem areas, such as maintenance personnel, can provide the history of a highway.

   The work methods used by the maintenance crews generally conform to best practices.

   b. **Issues**

   Maintenance can address most of the drainage issues that fall within the limits of the highway right-of-way. Maintenance has no control over activities that fall outside the highway right-of-way. Adjacent landowners make property changes that significantly alter the land and changes drainage patterns to and from the highway. Drainage facilities are designed to carry specific volumes when they
are constructed. Once the highway is built, maintenance must address any changes to drainage flowing on or away from the highway.

Drainage maintenance is nearly always accomplished on an as needed basis. Because of the critical impacts of drainage on the roadway, a more systematic PM approach would be cost effective.

Most drainage maintenance involves the movement of water. Water is an environmental resource that has considerable regulatory stipulations attached. Acquisition of necessary permits can be complicated and time consuming.

The descriptions for the ditch maintenance activities tend to be confusing as it is sometimes difficult to distinguish when a specific activity applies. There are two activities that group culverts and enclosed systems (catch basins, pipes, etc.) Cleaning cross culverts can be quite different from maintaining inlets, catch basins and other enclosed systems. More differentiation of activities for these features may be helpful.

Maintenance districts supply operators for the vactor trucks. This may be detrimental to care and maintenance of the truck, which is specialized and costly. An assigned operator to stay with the unit might be warranted.

Drainage maintenance should focus on retaining the technical design requirements of the drainage system. Maintenance must be aware of design capacities and environmental commitments made when facilities are designed. Maintenance may be restricted by available equipment and personnel and unable to provide the intended maintenance requirements.

4. Recommendations

**Recommendation 85. Develop a preventive maintenance program for drainage structures.**

A preventive maintenance approach for drainage structures should be developed. With a drainage PM program, drainage features would be scheduled for maintenance on a regular cycle. This would help to keep the drainage system functioning at it was originally designed to do.

It is likely that a rigorous PM program would require more funding and resources than the current corrective repair approach. However, the overall life-cycle cost of the roadway may be reduced as drainage problems would be corrected before they become detrimental maintenance conditions.
Recommendation 86. Provide adequate lead-time to obtain necessary permits when work in drainage features are required.

Water quality and fish passage issues need to be addressed through necessary permit acquisition. Permits can take considerable time to obtain. Working in a waterway can be time sensitive and adequate lead-time to obtain necessary permits is essential.

Recommendation 87. Reevaluate drainage activity numbers and descriptions to reflect current needs.

The various drainage maintenance activities and numbering system might be improved. There are several reasons for this recommendation. The activity descriptions and numbers for drainage give rise to some confusion as to when a specific activity applies. There is also overlap of some activities. Some activities are relatively minor and consume very few funds and resources. The need for this level of detail should be reconsidered.

Recommendation 88. Assign a designated operator to the vactor trucks.

Because the vactor trucks are specialized and costly units, the Department should assign a designated operator to stay with the unit at all times. This approach could be more efficient as the operator would be fully trained on the unit. It could also provide cost savings in equipment maintenance and repair, as the assigned operator would know the unit very well and be more motivated to keep it in good working order.

Recommendation 89. Develop and document drainage environmental best practices.

There are numerous environmental best practices associated with maintenance of drainage facilities and slope repairs. Current references used by maintenance do not document these practices. In order for these practices to become routine, it will be beneficial to have a readily available reference for drainage maintenance. Adoption of drainage best practices may also facilitate permit acquisition.

H. Traffic Services

Traffic services and operations activities are vitally important to maintaining a safe driving environment. Traffic control assets include items such as pavement striping, pavement reflectors, signs, signals, lighting, and guardrails. They need to be maintained in good operating condition to assure that they convey the proper traffic control messages to motorists.

1. Existing Approach

UDOT’s traffic services maintenance activities address maintenance of the traffic control devices and assets. Utah’s maintenance approach for the major traffic services activities are described below.
a. **Pavement Marking**

The Department uses primarily two types of paint materials and painting pavement guidelines: epoxy and water-based paints. A small amount of thermoplastic pavement markings are also used. Water-based paints have replaced solvent-based paints in recent years for environmental reasons. Generally, epoxy is used on interstate roads, and water-based paints are used on all other routes.

UDOT’s pavement painting season usually occurs between late March and October; however, paint can be applied at any time of year if the pavement is dry and the weather conditions are acceptable. The paint crews are assigned to the regions/districts, as the maintenance stations are not equipped nor staffed to accomplish painting. During the off-season, paint crews perform equipment maintenance and catch up on needed sign repairs. Some painting crew members operate snow plows during the winter.

New paving jobs performed by a contract normally include painting. When included, the contractor must guarantee the paint’s performance for a warranty period of one to four years. There is some concern within the Department that the warranty guarantees are not enforced.

The Department’s general policy is to paint all pavement stripes at least once per year. A second coat of paint is applied to problem areas prior to the winter season.

Activity 7D71 – Painting Guidelines (Water-base) – has very specific quality measures for assessing guideline performance. The quality measures for activity 7D70 – Epoxy Striping – have not been developed.

b. **Sign Maintenance**

Routine sign maintenance is performed by station crews. Routine maintenance generally consists of straightening and replacing damaged or worn signs. The region/district paint and sign crews are responsible for new sign installations.

The Department’s policy is to conduct a thorough sign inspection at least once per year, which should include a night reflectivity survey. The survey is aimed at determining the condition and functionality of each sign. From the survey, sign maintenance needs are determined and prioritized.

The Department has developed a Sign Management System (SMS) which includes the following features:

- A detailed inventory of signs.
- Geographic location data for each sign.
- A digital image of each sign.
• A database of sign type, location, and key characteristics.

The reflectivity of each sign is measured with the use of a retro-reflectometer measuring device. The reflectivity is included in the SMS database so that the system will provide the information needed to determine sign replacement needs and budgets. There is some concern that the resources used to capture data for the system are excessive and have not been cost beneficial.

UDOT uses latest technology materials for sign faces. The high intensity faces provide the reflectivity needed for inclement weather conditions.

c. Pavement Markers and Reflectors

The Department has experimented with several different types of pavement markers and reflectors. None have proven to be satisfactory because of the damage caused from heavy snow plowing and salting.

d. Signals

Signal maintenance is the responsibility of region/district and Central crews. Generally, the Department maintains all of its own signals as well as those of some local municipalities. The work for municipalities is performed under an inter-governmental agreement between the two agencies.

The region/district crew may consist of only one person. This person is a multi-disciplined maintenance worker who performs a variety of routine signal repair and maintenance activities. The Central signal crew is responsible for signal installation, timing changes, and major repair jobs.

The Department is in the process of changing its signal lights to LEDs. The LEDs are brighter, have a longer life expectancy, use less energy, and are more cost-effective.

Signal maintenance problems, such as outages, are reported to the Department from various sources. When a critical problem occurs, the region/district signal repairman is dispatched from his current location. If it cannot be repaired by the region/district person, it is reported to Central who then dispatches a crew based on the criticality of the situation.

e. Guardrail

Maintenance stations have the primary responsibility for guardrail maintenance. Major road renovations may include guardrail installation and replacement by the contractor.
The maintenance stations perform guardrail maintenance on an as-needed basis. The Department’s policy is to repair a damaged guardrail within 48 hours; however, the work is scheduled based on the severity of the damaged site.

The Department has had several contracts in the past to upgrade guardrail end treatments. Because guardrail design is ever-changing, especially end treatments, it is difficult and virtually cost prohibitive to upgrade every time a new design is introduced. A considerable portion of the guardrail in inventory is substandard. The Department has contracts underway to replace and upgrade guardrails to current standards.

2. Best Practices

Many of the best practices deal with traffic engineering policies and standards as opposed to maintenance practices. In many cases, there is a fine distinction between maintenance practices and design standards. The following describes some of the best practices for the major traffic control assets.

a. Pavement Striping

As the average age of the motorist increases, many states are implementing older driver programs. Measures taken to improve the safety for older drivers include such items as the following:

- Widening lane lines from 4 to 6 inches
- Using pavement reflectors on lane divider lines on all major roads

The highway industry continues to research and test new materials for pavement paint. Some states have had very good success with thermoplastic paints because they have proven to be the most durable in high traffic areas. Because of environmental reasons, most agencies have switched to water-based paints on low-volume roads.

Safety is a major concern for pavement striping activities. The accident rate for painting operations is among the highest rate of any maintenance activity. The best practice is to use highly durable paints to avoid having to paint often. When painting is required, the paint train should consist of adequate safety vehicles and traffic control to assure safety for the crews and motorists.

Many agencies contract for pavement striping. Warranty specifications are used by agencies that contract out the bulk of their pavement striping. Under warranty specifications, the contractor must guarantee that the striping will function at specified performance levels for a designated period, often as long as five years.
b. **Sign Maintenance**

Best practices for sign maintenance include the following:

- A policy and program for immediate response to non-functioning “red” series signs – stop, yield, wrong way, do not enter – is warranted because of the critical safety aspects of these signs. The absence of these signs represents a potentially very hazardous condition. Best practice dictates that the program includes continuous inspections, communications with citizens and law enforcement agencies to identify immediate needs, and methods to deploy crews on an emergency response basis when a condition becomes known.

- Regular sign inspections should be completed at least once per year, and include a night inspection to evaluate reflectivity. Some agencies are using retro-reflectivity meters, which can be used during the daylight, to measure reflectivity. The regular inspection process should be aimed at identifying and correcting sign maintenance problems before they become a safety concern.

Sign Maintenance Management Systems are being used by a number of agencies. The systems have the following components:

- Sign inventory by type, size, and location.
- Condition information.
- Maintenance needs.
- Projections for expected life.
- History information.
- GIS supported information system.

Diamond-grade reflective faces are typically used on the red series signs for better reflectivity. The cost is considerably more than the high-intensity faces, but is justified by the safety impacts.

c. **Pavement Markers and Reflectors**

Thermoplastic pavement markings (often referred to by the trade name “Hot Tape”) have been in use for many years. The growing popularity of the thermoplastic is attributed to its superior durability and potential for long-term economy. Although the initial installation cost is high, thermoplastic materials are more durable than commonly used water-based pavement paint. When applied properly, thermoplastic pavement markings can be a cost-effective alternative to conventional paint. While the initial application of thermoplastic pavement markings may be as much as 15 times more costly than conventional paint, their long service life and improved visibility make them an attractive alternative. Based on reported results, the economic break-even point appears to
fall between three to six years. UDOT’s results with thermoplastic pavement markings would depend on the Department’s initial installation cost and the life of the application, which would vary in accordance with differences in the physical environment among the regions/districts.

In recent years, pavement markers have become standard installations on most high-volume roads because of their safety value. Best practice ensures that the markers are present and are highly visible. Typical applications involve the lane dividing lines. Markers are not typically used on edge lines unless there is a specific safety need.

In connection with implementing an older driver program, some agencies have gone to 40-foot spacing as opposed the traditional 80-foot spacing for the markers.

A nighttime inspection of the markers should be made at least once yearly. The inspection should identify and prioritize marker replacement needs.

In snow belt areas, such as Utah, the markers should be recessed to prevent snow plows from destroying them.

d. Guardrail

Maintaining guardrail presents a special challenge for maintenance agencies. Guardrail, especially end treatments, is constantly undergoing research and testing in an effort to develop a safer design. As new designs are adopted, the existing guardrail becomes obsolete. It is not cost-effective to replace the existing guardrail; however, the Department should have a practice of upgrading damaged guardrail to the current standard when repairs are made.

Most guardrail maintenance is reactive in nature. There is little preventive maintenance that can be performed on modern guardrail systems. However, the repair of guardrail should be a high priority. The Department should have a program of continuous inspection to identify repair needs. The repairs may be categorized by the severity of the damage and the location; however, all guardrail repairs should be made within a specified time limit.

e. Signals

From a maintenance perspective, signals represent a special challenge because of the safety aspects. When signals are out, a potentially hazardous condition may be present. To provide the needed level of service, the responsible agency should be properly staffed and equipped to respond to emergencies quickly. Procedures should be in place to notify and deploy maintenance managers and resources rapidly.
Many state DOTs contract with local agencies to perform signal maintenance. In most cases, this practice results in a higher level of service because the local agencies are able to respond more quickly.

3. Strengths and Issues

a. Strengths

The Department’s traffic service maintenance practices are generally in line with industry best practices. The Department is using modern materials such as water-based paints for striping and LED’s for its signals. The Department experiments with different technologies and materials in an attempt to stay current with the latest developments. Region 2 has used thermoplastic pavement markings on new pavement projects. In line with growing trends toward asset management, the Department has developed a Sign Management System.

b. Issues

(1) Pavement Striping Service Levels

The Department may not be achieving a desirable service level for pavement striping. The winter maintenance operations and conditions cause considerable wear of the pavement guidelines, and most guidelines are in need of repainting soon after the winter season. In some cases, the Department does not get to paint all of its roads until late in the summer season. Also, as noted Chapter V Department has had difficulty with the life of its water-based paint.

(2) Sign Management System

The SMS was developed nearly three years ago; however, it has not been successfully implemented. Development of the SMS is a commendable effort, and the Department should determine what future implementation efforts will be required to assure its success.

(3) Signal Maintenance Resources

At least one district indicated that it has only one person to maintain the 100 signals under the district’s responsibility. The person is assigned a scissor truck for access to the signal lights. He is deployed throughout a wide geographic area, and it is often difficult to respond quickly to emergencies.
4. Recommendations

Recommendation 90. Pilot test contracts for pavement striping.

Because of the critical safety aspects of pavement striping, this activity should achieve a high level of service. Because striping requires crews with specialized skills and equipment, special region/district crews are needed. The work can only be accomplished when the pavement is dry and weather conditions are suitable. The activity is limited to summer and on days when environmental conditions permit. The constraints on performing pavement striping create a situation where considerable “down” time is experienced by the paint and striping crews. Although the crew members can be assigned to other duties, the pavement striping activity is delayed and service levels suffer.

The Department should conduct a pilot project to evaluate pavement striping by contract. Many agencies have contracted this activity successfully. Some agencies report that they pay a small premium on the unit cost of the work, but the service levels are considerably higher. If contracting proved to be successful for UDOT, the Department could expect to have pavement striping completed by the early summer months.

Recommendation 91. Move forward with the Sign Management System.

The Department’s development of an SMS represents a progressive step toward implementing an asset management approach within the Department. Much effort has gone into developing the system and collecting data, and the system could provide significant benefits if properly implemented.

The first step in implementing the SMS is to determine the business processes for managing sign maintenance. Once the Department has determined how it wants to manage its business, then the information required to support the business process can be determined. The SMS can be designed and implemented to support the business processes and information needs.

The Department should avoid the trap of implementing the SMS, collecting data, and then determining how to use the data. SMS development and implementation should follow a very organized and systematic approach to achieve a successful result.

Recommendation 92. Evaluate the effectiveness of current signal maintenance resources.

Like other traffic control devices, signals have a high impact on motorist safety. The Department should be organized and have the appropriate resources to assure a high level of service.

It appears that regions/districts with only one signal maintenance person cannot adequately respond to emergency situations. Signal repair crews should be dispatched immediately when the situation warrants.
The use of scissor trucks does not appear to be the best equipment for a signal maintenance crew. Lane closures are required when using scissor trucks to work on lights. The safety concern of having the scissor truck parked in a lane and the time and effort needed to set up proper traffic control make an unsafe and inefficient practice. The Department should provide all signal crews with a bucket truck.

Optionally, the Department should consider contracting with municipalities to maintain signals.

I. Supervision, Training, and Support Maintenance

The activities outlined in this series of the Activity Performance Standards cover a wide variety of work. Many of these activities are used primarily as accounting codes for tracking resources and costs; they are not actual work activities.

Activity 7M92, Station Training, is used to track labor hours and cost for field personnel attending training. The Department has developed a comprehensive training program, a detailed discussion of which is contained in Chapter V of this report.

The following activities are used to allocate and track costs for betterment and construction related activities:

- 7M02 – Federal Construction by Maintenance Crews
- 7M04 – State Betterment
- 7M05 – Block Grants
- 7M06 – Curb and Gutter Connections
- 7M08 – Betterment (other than pavement)

The following three activities are used for building and land maintenance:

- 7M80 – Land & Building
- 7M87 – Station Building Maintenance
- 7M89 – Station Driveways, Lots and Yards Maintenance

Maintenance of land and buildings is the shared responsibility of station and region/district crews. Station crews perform routine building maintenance such as cleaning and minor repairs. Special district crews are responsible for major repairs. Some major repairs, such as re-roofing or garage door replacement, are performed by contract. Station forces support district forces when the requirements of the repair dictate the need.

Activity 7M99, Stockpiling, is used for budgeting and reporting stockpiling activities. Typical materials stockpiled by the maintenance stations include salt, sand, abrasives, and
pre-mixed road base. Materials for chip seal projects are normally delivered to the site by the supplier. Some regions/districts own and operate quarries to produce selected materials.

Equipment maintenance activities are also reported to by a series of 7xxx activity numbers. Stations do not have assigned mechanics. Mechanics are assigned to region/district-wide maintenance stations and operate on a roving basis out to the maintenance stations. Equipment operators are responsible for the first echelon of preventive maintenance such as oil and filter changes. Once each year a certified mechanic performs a detailed safety inspection on each piece of equipment. Each station is responsible for tracking equipment usage and performing preventive maintenance at the appropriate time. The Department has implemented an Equipment Management System to track and analyze equipment cost and history.

The maintenance station and area supervisors report most of their time to Activity 7M86 – Station Administration.

These activity standards involve a wide variety of activities and functions and previous sections have addressed many relevant best practices, including asset management, training, and contract maintenance. In addition, a previous audit addressed issues with the Department’s equipment management system and equipment preventive maintenance.

J. Rest Area Maintenance

Rest areas are provided for the safety and convenience of motorists and thus provide a very important service. Besides providing motorists services, rest areas also present an image for the State. Motorist often form perceptions of the State and the DOT based on the condition and quality of services at the rest areas.

1. Existing Approach

UDOT maintains its rest areas under a statewide contract with a private firm. The contractor is responsible for all work at the rest area site except for the following activities, which are performed by UDOT forces:

- High mast lights
- Pavement maintenance
- Snow and ice
- Pavement striping

The Department performs periodic evaluations of the rest areas. During the MMQA semi-annual road inspections, the rest areas are given a detailed inspection. A check sheet is used to grade each maintenance feature at the site, and a total score is given. Most interviewees from the regions/districts agreed that the private contractor does a good job maintaining rest areas.
2. **Best Practice**

Best practice for rest areas focus on providing a healthy, safe, and convenient environment for motorists who use the facilities. Key components of best practice include the following:

- **Customer Focused Attendants**
  
  Many motorists need assistance at rest areas, such as with travel directions. The motorists expect to be treated courteously and with respect. To a large extent, attendees act as ambassadors for the DOT and the State. With the added focus on customer service by government agencies, best practice dictates that rest area attendants be trained and exhibit good customer relations.

- **Regular Safety Inspections**
  
  Foremost, the facilities should be maintained in a safe and healthy condition. Because conditions can change quickly, the facilities should be constantly monitored and inspected to assure that an unsafe or unhealthy situation does not arise.

- **Quality and Performance Checklists**
  
  Maintenance activities at the rest area should be performed in accordance with detailed prescribed work activity checklists. The checklists should specify each activity and how often it is to be performed – hourly, per shift, daily, weekly, etc. Quality specifications for each maintenance feature and work activity should direct the attendees and rest area maintenance crews on the expected condition levels for each feature.

- **Preventive Maintenance Schedules**
  
  Preventive maintenance schedules should be developed for major facility systems such as lighting, roofs, and water and sewer systems. Often, rest areas are self-contained with no back-up available when building systems fail. As such, an attempt should be made to avoid major maintenance problems through an effective preventive maintenance program rather than be in a corrective repair mode.

- **Customer Feedback**
  
  Because rest areas are for the safety and convenience of motorists, the opinions of the motorists should be heard. Best management practice involves methods to gain feedback from the customers and track customer opinions on the adequacy and quality of the rest area maintenance program.
3. **Strengths and Issues**

   a. **Strengths**

   The Department’s current approach to rest area maintenance is in line with industry best practices. There appear to be no major issues associated with rest area maintenance. The Department’s use of private contractors to maintain the rest areas is consistent with developing trends nationwide. The condition of the areas has apparently improved since the implementation of the private contracts. The contract for the rest areas is quite detailed and appears to have all of the contract language and scope of work requirements adequately defined. The Department performs periodic inspections to assess adherence to the contract and determine if the rest areas are maintained to the specified performance levels. The inspections use detailed checklists to develop a grade of the contractor’s performance.

   b. **Issues**

   Some regions/districts believe that the level of maintenance at rest areas is constrained by the age and baseline condition of the facilities. One operations engineer argued that rest area maintenance could not be improved without replacing most current buildings.

4. **Recommendations**

   None. The Department’s use of private contractors should be continued as long as the program can foster private sector competition. Since this is the second go-round and the Department appointed a new contractor, it appears that the Department’s program is fostering such competition.
Appendix A: Online Survey

Utah Department of Transportation
Maintenance Activities Performance Audit
Region/District Maintenance Units E-mail Survey

Dye Management Group, Inc. is conducting a performance audit on the maintenance function of the Utah Department of Transportation (UDOT). The purpose of the review is to provide an outside assessment of UDOT’s current approach to maintenance and to provide recommendations for improvement.

This survey seeks input from the UDOT Regions on the Central Maintenance Unit. The questionnaire provides you with an opportunity to identify perceptions and insights about the Central Maintenance Unit at UDOT. We want to identify both perceptions about UDOT Maintenance as well as facts as a basis for our analysis. Please be detailed in your responses, and provide examples if possible.

1. What is your name?  
(Your name will not be correlated to your responses to the survey questions. It will only be used to assess who has not completed the survey.)

2. What is your Region (or District)?
   - Region 1
   - Region 2
   - Region 3
   - Price District
   - Richfield District
   - Cedar District

3. What is your position?
   - Region Director
   - Maintenance Engineer
   - Area Supervisor
   - Maintenance Analyst
   - Operations Engineer
   - District Engineer
   - Station Supervisor
   - Training Specialist
   - Other (Specify)
4. **How effective is the Central Maintenance Unit's performance in the following region support activities?**

Please rate on 1-5 scale, 1 is Very Effective, 5 is Very Ineffective.

| Planning for statewide maintenance needs. | 1 2 3 4 5 |
| Comments: | ○ ○ ○ ○ ○ |

| Distribution of statewide maintenance funds. | 1 2 3 4 5 |
| Comments: | ○ ○ ○ ○ ○ |

| Providing timely reports through MMS. | 1 2 3 4 5 |
| Comments: | ○ ○ ○ ○ ○ |

| Managing the statewide feature inventory. | 1 2 3 4 5 |
| Comments: | ○ ○ ○ ○ ○ |

| Providing effective direction for MMQA measurements. | 1 2 3 4 5 |
| Comments: | ○ ○ ○ ○ ○ |

| Developing and improving processes and procedures. | 1 2 3 4 5 |
| Comments: | ○ ○ ○ ○ ○ |

| Researching and implementing new materials. | 1 2 3 4 5 |
| Comments: | ○ ○ ○ ○ ○ |

| Working with the Procurement Division to ensure timely buying and warehousing of maintenance materials. | 1 2 3 4 5 |
| Comments: | ○ ○ ○ ○ ○ |
Providing effective maintenance training.

Comments:

5. What specific issues need to be resolved with the Central Maintenance Unit, and how would you resolve them?

6. What is your view of the distribution of resources between different regions?

(Rate on 1-5 scale, where 1 is very fair and 5 is very unfair. Please add any comments in the space provided.)

- 1 – Very fair
- 2
- 3
- 4
- 5 – Very unfair

7. What is your view of the distribution of resources within your region (or district)?

(Rate on 1-5 scale, where 1 is very fair and 5 is very unfair, please add any comments in the space provided.)

- 1 – Very fair
- 2
- 3
- 4
- 5 – Very unfair

8. MMQA requires certain condition measures. How effective are the condition measures you currently use?

(Rate on 1-5 scale, where 1 is very effective and 5 is very ineffective. Please add any comments in the space provided.)

- 1 – Very effective
- 2
- 3
- 4
- 5 – Very ineffective
8a. Do you have suggestions for more meaningful measures?

9. Rate the effectiveness of regional maintenance management

   (Rate on 1-5 scale, where 1 is very effective and 5 is very ineffective.
   Please add any comments in the space provided.)

   ○ 1 – Very effective
   ○ 2
   ○ 3
   ○ 4
   ○ 5 – Very ineffective

10. How effective are computer systems (e.g., your computer hardware, the connection to Central, and the local area network (LAN) to help you do your job?

    (Rate on 1-5 scale, where 1 is very effective and 5 is very ineffective.
    Please add any comments in the space provided.)

    ○ 1 – Very effective
    ○ 2
    ○ 3
    ○ 4
    ○ 5 – Very ineffective

11. How well do you understand statewide goals for maintenance?

    (Rate on 1-5 scale, where 1 means you understand completely and 5 means you do not understand.
    Please add any comments in the space provided.)

    ○ 1 – Understand completely
    ○ 2
    ○ 3
    ○ 4
    ○ 5 – Do not understand
12. How well do you understand region-wide goals?

(Rate on 1-5 scale, where 1 means you understand completely and 5 means you do not understand. Please add any comments in the space provided.)

- 1 – Understand completely
- 2
- 3
- 4
- 5 – Do not understand

13. How would you rate UDOT as an employer?

(Rate on 1-5 scale, where 1 is very good to work for and 5 is very bad to work for. Please add any comments in the space provided.)

- 1 – Very good to work for
- 2
- 3
- 4
- 5 – Very bad to work for

14. Are there any other issues or comments we should consider in our audit?

15. Are there any other improvements that you would suggest for UDOT maintenance?
## Survey Results

### 2. What is your Region (or District)?

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### 3. What is your position?

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4-1. How effective is the Central Maintenance Unit’s performance in this region support activities: Planning for statewide maintenance needs?

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4-3. How effective is the Central Maintenance Unit’s performance in this region support activities: Providing timely reports through MMS?

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4-4. How effective is the Central Maintenance Unit’s performance in this region support activities: Managing the statewide feature inventory?

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4-5. How effective is the Central Maintenance Unit’s performance in this region support activities: Providing effective direction for MMQA measurements?

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4-6. How effective is the Central Maintenance Unit’s performance in this region support activities: Developing and improving processes and procedures?

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### 4-7. How effective is the Central Maintenance Unit’s performance in this region support activities: Researching and implementing new materials?

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### 4-8. How effective is the Central Maintenance Unit’s performance in this region support activities: Working with Procurement Division to ensure timely buying and warehousing of maintenance materials?

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4-9. How effective is the Central Maintenance Unit’s performance in this region support activities: Providing effective maintenance training?

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6. What is your view of the distribution of resources between different regions?

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7. What is your view of the distribution of resources within your region (or district)?

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8. MMQA requires certain condition measures. How effective are the condition measures you currently use?

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9. Rate the effectiveness of regional maintenance management.

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10. How effective are computer systems (e.g., your computer hardware, the connection to Central, and the local area network (LAN)) to help you do your job?

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11. How well do you understand statewide goals for maintenance?

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12. How well do you understand region-wide goals?

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13. How would you rate UDOT as an employer?

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Verbal Responses to Survey Questions

4. How effective is the Central Maintenance Unit’s performance in the following regional support activities?

Planning for statewide needs.

- Data is so difficult to access analyzing from several possibilities becomes cumbersome and therefore is not accomplished only in traditional ways.
- Most planning of Region needs is accomplished at the Region level.
- Generally good. Some areas such as procurement contracts seem to lag beyond what is needed.
- I am sure that lack of monies means priority is given to Highways with Higher ADTs
- They are good to work with.
- The planning for these needs is okay, but I feel the rural part of the state sometimes gets over looked. I also think we have to many activities into which our money is put. We need to follow the MMQA idea and have eight activities, and let the stations...
- A better understanding of the different needs between the Wasatch front and Southern Utah would be beneficial. We are frequently force fed programs that make sense if you are near SLC and not so much in outlying areas. Trans Tech program is an example...
- It is difficult to plan when all budget issues are up in the air. Personnel change constantly and never stay long enough to understand the process. When the planning is driven by the dollar it just doesn’t work.
- Master plans, without enough on site input to make the decisions.
- Need more method studies to help find the correct materials to use.
- Staff turnover has affected Central Maint. a lot. I think if those who are there now are good people. I hope they stay until they understand the needs of the entire state.
- I think that it ok.
- They are getting better, they are starting to get us involved more in what goes on out on our roads.
- It seems funds are being used in needed areas
- Regions should be by traffic volume and, and also by road miles
- Pavement and structures are on a good plan, but other things like drainage are over looked. A lot of pavement problems are due to poor drainage and when projects are done drainage is one of the first things cut out of the project. There should be more p...
- I feel Central Maintenance is doing a good job.
• I am a special crews supervisor, vegetation and landscape management, where applicable, my answers will be concerning vegetation.
• Could be better.
• I don’t know because I don’t get any information back.
• On my level we never talk to central maintenance.
• No Knowledge
• I feel if there wasn’t so much change in personnel things could be better, every time we get someone that shows interest in our operation it seem they get a better job offer within the dept.
• Statewide being SLC TO Provo?
• They plan for SLC Ogden Provo areas, and think the rural areas needs are about half of the metro needs.
• Don’t really see what’s going on at that level
• Most operations are budget driven vs. needs driven. This may not be the fault of central maintenance, rather the legislature or what is being presented to the legislature.
• We have no real involvement with Central Maintenance, but what we have had has been good.
• The Wasatch front takes first priority.
• Get station supervisor more involved when setting up work on hyws.
• All my knowledge is at a District level so I don’t know much on Central Maintenance’s Performance.
• Would like them to setup asphalt contracts and salt contracts things like that long before we need them
• I understand that maintenance money has to go where the ADT and the largest demand is. The rural areas aren’t greatly overlooked. There is a percentage allocation that I think is pretty good. Maintenance needs are generally approached on a rotational ...
• It’s really hard to answer that when we don’t ever see what central does. We get our direction from the district and that’s all I ever see.
• They seem to do a good job.
• I think that Central Maintenance does almost as well as could be expected with the Budget they receive. Our budget now doesn’t come close to funding our needs, until we get more budget I can’t see that planning makes any sense. It hard to plan for w...
• I am not involved in this process.
• The central funding and technical guidance received from the Roadside Vegetation Manager, Ira Bickford, has been outstanding. The planning efforts in this important environmental specialty have been excellent.

• Better information on maintenance and budgets.

• Need statewide asset management

**Distribution of statewide maintenance funds.**

• Based on present information the funds are distributed adequately.

• I have a problem with the budget distribution. Richfield District is approx. the same in road miles, employees, feature inventory and etc. but we receive substantially less in our budget. I have time answering my people when they ask me why.

• Money for features is the same, weather it be in rural or urban areas. They need to consider ADT volumes

• Inconsistencies in how the budgets are figured, what information is used from Region to Region to determine fixed cost, and feature inventory are two of the biggest problems.

• Region 3 seems to get what’s left over not based on what the needs are. All engineer for maintenance money went to Regions 1 & 2 to cover their snow overruns when they still had money in other code 1 activities that should have been expended first.

• Changing the MMS awards appeared to be a blatant way to make sure Price District would not win it year after year, though they deserve to as they know the system better, ( and use it properly) than the other Region/Districts.

• Need a much better way to distribute funds, feature inventory says very little about need. All inventory could be new and in good shape as compared to inventory that is not so good of shape or as new. Politics seem to be more important than actual need.

• Based on to much History, percentages.

• Need to be realistic no favoritism.

• I only deal with a portion of the Region budget.

• I hope funds are distributed fairly using some common denominator.

• the funds good be distribution better

• Although there are not enough funds to fix everything money are spent where higher traffic demands are.

• I think they do the best they can with the money given. I think MMQAs should be done by one group of people instead of each area doing there own, it would be more fair and a more accurate. Some areas could be in very good shape, but the person doing th...

• I would like to see more funds in our Region.

• Could use more in Region 2.
• haven’t seen any reports
• I think they should analyze our prior years spendings and fund the activities so we can get our work done without overrunning.
• We are always getting shorted on moneys for activities.
• Nothing south of Provo.
• I think they distribute money based on the population of the area. They forget that the population moves out into the rural areas on weekends, etc.
• It seems like Provo north gets all the funds they need.
• HAS BEEN OK – but maybe a little slow to deal with problem areas.
• We are in the southern part of the state there four we are not part of the state of Utah.
• I really don’t have a lot of knowledge on this question, I am assuming they do well.
• I put in my requests to the District Level.
• I am not sure what we get.
• I feel that rural areas will always be last on the priority list of funding. We are at the junction of two major US highways that has more and more truck traffic and actually requires more attention than we are able to give it with the existing finances.
• It seems like the Regions who are closer to the SLC Complex have the ear of Central Maintenance. We in Region 4 feel like our voices are not heard and our needs are not met.
• A good job is done distributing funds, a lot of effort is made in this area, but we need to work on distributing funds on a need basis.
• I wonder how fair the funds are distributed to each of the six Districts or Regions. I believe the Regions that scream the loudest, the ones that can make a good presentation, right or wrong and the areas with the most politics get more than their share.
• I can not rate this. This is an area I do not deal with. I think that we need more funding in training with the new Trans tech positions.
• I am not involved in this process.
• Very good management of 7M12 Roadside Project Funds.
• More information on distributing funds.
• Need statewide asset management

Providing timely reports through MMS.

• Reports unless we ask for them or initiate the process are virtually non-existent. Screens of certain reports are available on the system but it isn’t in a format you want or doesn’t contain all the information needed.
• MMS needs to be updated to be more compatible with Finet.
• Reports seem to be current but we have differences after the material goes thru Finet and we are charged a different price than what was anticipated.

• Could be improved.

• The MMS reports are way to slow. In particular the time it takes to get FINET to post to the MMS report. A Station Supervisor needs to be able to track his budget daily, especially when doing big dollar tasks, and nearing the end of the fiscal year.

• No comment.

• What reports, used by central. Based on Standards not true money spent.

• Have programs that help not catch programs to know if you are using them.

• The reports are always slow and not up to date real hard to manage an accurate budget with the information available to Station Supervisors.

• M.M.S. is slow and does not include all of the things that we use on a project.(like rented equipment or materials that are not on inventory or contract flaggers) Needs to have another costs place to put these other charges and you can put in comments.

• Reports are pretty good, as long as everyone involved does their assignment to keep the information accurate, i.e.; update tables and rates.

• Because it always down.

• It’s only as good as the program. We still have to keep another book for my records to see how much is in our budgets.

• MMS is hard to understand and is slow to get accurate info. Not very user friendly.

• Reports are not always affective.

• This seems to get to us late.

• I feel the reports our coming in on a timely manner.

• Not good. It is always down.

• Haven’t seen any reports.

• Should be able to input into the computer and receive a report back out.

• They only compile info from the district analysts!

• I think our new yearly budget after July 1 could come quicker. We usually don’t know what we have until Sept. or Oct.

• The MMS IS a dinosaur; needs to be updated from dos to windows. It should be compatible with Finet.

• MMS is generally at least a week behind. Many reports are not available to the station. It is better than it used to be, the reports were at least two weeks behind.

• MMS is slow and not up to date with price or inventory.
• Takes too long before the inventory comes off when we input them on T-91’s we should have inventory on mms also

• Quite timely. Again at our rural station we have an inadequate connection with the net that doesn’t allow us timely and efficient reporting.

• We run our own reports so I’m not sure this question pertains.

• Can’t get reports out of MMS mainframe. There is so much data to analyze that a paper report does not make sense. We need to have the ability to down load the information we need and have a years worth of data on a CD instead of in a book.

• This is a very big problem and concern now, all reports now contain errors and are not current, sometimes its hard to determine how current, system seems have to go thru to many hand driven process, if everybody does their job at the right time we may b...

• I do not deal with this.

• I currently do not have access to mms reports

• I don’t use any reports from MMS, I only enter my time.

• Lag between MMS and FINET

• Kept everything remain.

Managing the statewide feature inventory.

• The feature inventory system (software) is so cumbersome and the data is in such a hard to read form it is never up to date. Gathering the data and getting it into the system is very time consuming. It would be better if we could just add the excepti...

• The program is out of date. Currently, there is only one employee who knows the system at Central Maintenance. That employee will soon retire.

• Feature inventory has always been a problem for maintenance because to cost of maintaining a new feature vs. a forty year old feature is not taken in account.

• Region 3 has done a good job of updating their feature inventory.

• It would be nice to have construction update features when changed on projects.

• I only see what we do locally in this regard.

• Do a pretty good job.

• Actually getting better at this.

• Doesn’t seem to be kept up to date.

• I think its ok. I am not involved much. We should use the best software possible like GPS and data collectors that will interact with design software.

• the inventory is getting better

• Feature inventory’s need updated after construction completion
• There are a lot of things that are not on inventory. Drainage is a big one. There are not accurate blueprints of drainage systems, as built plan seem to not get added to the final blueprint of a finished project. Maintenance has little access to blue prints.
• I feel they are doing a great job.
• Feature inventory changes to fast to keep up.
• It is getting better.
• haven’t seen any reports
• Needs to be redone so that the reference posts are correctly placed in the right place
• Our inventory system needs to be updated so when we enter material it can be deducted from our sta. inventory all on the computer and use the computer as our ledger instead of having to wait two weeks to find out our balances.
• Again, info. Gathering from stations and districts, then they look at that info. Basically then make the cuts in the south.
• No Comment
• In put is from the district analyst. Sometimes the inputs are slow. A report of what we have in our areas would help or make it accessible to us in the stations so we could see what is on the computer and submit updates.
• As station supervisor we don’t see what is on the features inventory. We don’t know if the changes have been added or not.
• We all need to do better.
• I know we get monies dependent on our feature inventory but more financing would get better results.
• They do a good job with the resources they have. We need a new computer system.
• Greg does a great job with what he has to work with; but the system is so out of date and not user friendly. When Greg leaves, the department is in a great deal of hurt, because he’s the only one that knows how to work with it. The way the features ...
• It is managed the best it can be, while in Colbalt. Again, it is very difficult to analyze the data.
• All I can say is what a mess, Mile Posting has been changed so much on paper and in the field, locations means nothing, some features were moved to other district at boundaries because of paper Mile Post adjustments but physically in another district. Wh...
• N/A
• I do not do anything with features inventory.
• I am not involved with feature inventory.
• GIS at shed level needs to be utilized more.
• Kept updated.
Providing effective direction for MMQA measurements.

- I believe the MMQA data is not extensive enough. In order to make quality work it needs to drive what we do. This means ownership at the lowest level must be developed.
- At this time the MMQA program is ineffective. It can not be used as a budgeting tool and is to cumbersome to present to the legislature for funding purposes.
- I think we are measuring some wrong activities and we should be measuring condition and not effort.
- Seems to be a lot of confusion about what we are measuring and how to measure it.
- Direction has been good, I hate to see the department do away with budgeting only by MMQA Feature inventory should still play a major role
- Room for improvement.
- We are getting better
- I doubt that any 2 measurements done by separate teams gets measured the same way. It is a good program but the info being gathered is pretty much bogus and of no good use, as the management of it is in the hands of to many folks who understand it dif...
- A very hard process to understand and to communicate. Once again when central has an employee that has been there for a while and begins to understand the processes they seem to move on to greener pastures. It seems the education process has to be red...
- Hopefully the upgrade will let us access the data now.
- Should not use to set budgets until there is more information and all areas are covered.
- To this point MMQA. has been a big waste of money that we could have put out there on the road.
- I feel there is confusion between Regions/District and Central about what MMQA is and how it affects us. I feel it’s the service level portion of our budget process.
- the supervisor good use as a tool
- I would still like to have more training on this for my people
- Every person measures different.
- MMQA reporting guidelines need to be looked at is reporting consistent?
- Not in agreement with the way some items are measured.
- The state is very diverse in its areas, (mountains to desert). One group of people should be doing MMQAs so that a true picture of where good and bad spots can be located. For example one area could be doing delineation on one road every month because ...
- I think now we’ve just started to see some results.
- I feel this is going to be a very good tool to help us do our jobs better.
• The MMQA needs to have more of a standard for better use. There are too many gray areas! The employees need more training for the direction and use of the MMQA.

• We can use it as a tool.

• Haven’t seen any updates but are being told by upper management that we are in line.

• It is different from one end of the state to the other. Also the roads are of a different class and should be measured as such.

• I think we are provided with the necessary direction.

• I don’t believe MMQA measurements are accurate enough to plan the budget on.

• Working a little more to provide more info. As to the directions we need to take but always telling us what we should have done and not so much as to what we should be doing.

• I think every station and region look at this differently. Nothing comes out even. The same people would about need to survey the whole state to make it even reporting on MMQAs.

• No Comment

• feel that we have crossed the line a little with MMQA, when you spent move time on counting than it takes to do the job

• MMQA will only work if it is not tied to budgets are awards. No two people seam to be able to measure many things the same.

• I get my direction from the District level

• need to make sure everyone doing the measurements do it the same way

• With the recent turn-over in Central, there is not much support. We are all out there on our own.

• This program was implemented long before all the bugs were out of it; and long before we all knew what we really wanted to find out from the measurements. Do we want quality, or do we want effort?

• We currently do not have anything that we are comfortable in taking to the legislators, and it is nothing that drives what the stations or regions do. Central has asked the regions what they want to do, and there has been such a wide range of answers.

• I think everybody is interpreting the instructions different, I don’t think all eyes see the same thing. There has been none or very little training, it seams every time go out someone brings up another concern. Same instructions year to year but every...

• I hope this area will get better and we can get some training on MMQA so we are all doing it the same way.

• I do not do anything with MMQA.

• I get direction at the district level.
• Too much room for error
• Moving into right direction.

**Developing and improving processes and procedures.**

• The processes need to be either directed or the group needs to come to consensus so they are accomplished. Some things are not on an equal vote basis and others may be.
• There have been no method studies completed within the last few years that have really helped the Regions. Any processes or procedures that require change are completed by the Regions.
• All the processes need to be improved to many times they seem like road blocks instead of help.
• I feel confident that we are always looking for better ways to improve.
• Lynn Bernhard gets an A+ for his good work, diligence, and follow-through. He asks us what works, and what does not, and why we need changes, then follows through.
• Same comments move on to other challenges to soon
• This could happen faster; seems like we try to change, and then drift back.
• I have had concerns with crack seal material for several years, and the method engineers don’t seem to want to follow up on this.
• Need to try to change some things but some things that are working well we need to leave alone until they are not working anymore. Also learn from other people’s mistakes like talk to other states about what has worked for them.
• I feel they are trying to keep the state maintenance forces progressive. Again staff turnover and credibility has hampered this.
• Better now. McMinimee is involved statewide.
• Region 2 is very proactive in this field
• It is sometimes slow to get a new process going but we seem to try new things to help all the time.
• I feel that we learn more as we go along.
• Doing a good job in this area. It is hard to keep up with new technology.
• don’t know anything about this
• I hate to keep hearing more for less. We need to be realistic and plan for the man power in the future to do our jobs instead of trying to make everyone think that every thing is ok. and sacrificing safety. Do more for less with out sacrificing so...
• By using our measures we have improved our quality and efficiency.
• Headed in the right direction somewhat. They need to be aware that the rest of UDOT has been making great strides as well.

• Central is probably a little better at this. They have people trying new things all the time. The problem is, if something works well, and the state is going to use it, they don’t let the outlying areas know this very fast.

• Seems to be enough changes in the system already.

• I feel that improvements have been made and will continue.

• Little knowledge of improvements since were not on the Wasatch Front

• when we call if we don’t know what is required they will help us through it

• What we have is a complex and confusing system, kind of like the IRS. I wish that for every form that we have to make out that they would delete another obsolete form or that they would hire us secretaries to cope with the paper onslaught so we could ...

• Lynn Bernhard, Methods Engineer, seems interested in helping us in this area. Again, turnover in Central is a problem. I think the focus has been lost in this area.

• It’s really hard to get them to understand and realize that there are problems with certain processes. Know one seems to listen to those of us out in the field working.

• I feel they are stuck doing the same thing the same way. They do not seem to try to find better ways of analyzing data, to help with activity standards for example. The activity standards have needed to be looked at on a regular basis.

• I don’t have any comments.

• The feed back that I get from central is that they are always looking at improving process and procedures.

• I have had plenty of support from central when developing training processes.

• Thumb up.

Researching and implementing new materials.

Working with the Procurement Division to ensure timely buying and warehousing of maintenance materials.

• Sometimes there seems to be little energy or concern that materials are available. I.e., liquid asphalt bids this spring are integral to our work and it is now May and we are just getting them.

• Discussed above.

• Sometimes they buy items for the warehouse on low bid and is cheap stuff which doesn’t last

• The addition of multiple awards has helped to improve to availability of material and equipment rentals. Procurement needs to work more closely with Maintenance in
understanding maintenance needs and the difference between Urban and Rural availability and cost.

- Seems like when a contract is up it takes too long to have a new one in place. Last winter we were out of snow plow blades, good thing we had a mild winter.
- They are good to work with.
- Procurement needs to be timelier in renewing contracts. The renewal dates of some contracts come due during the busiest part of the season. For example, Paint and Beads, I feel the contracts should start or end in the winter months, when we are not...
- Getting better.
- Same comment. It seems when it is time to go to work we are always waiting on contracts to be finalized. They want us to plan and schedule but put up roadblocks.
- Warehousing cost money. Give us an approved list and we’ll get it shipped to us. Let’s quit counting stuff.
- It seems to be a very slow process from the time they decide on a product until it is available to use.
- We have been fighting a paint contract for our striping operation for a month and this time of year we shouldn’t be doing this it should have been settled long before spring broke so we could get paint ordered by the time we needed it. We were fighting...
- I think Central gets along well with procurement. I am not sure everyone understands how delays at the beginning are magnified to the end users. If we are slow to establish resources, we will be delayed or stopped from completing the work in the field.
- When I had work with procurement it came out ok.
- They are getting us involved more on this.
- Good to get bids on non-inventory items.
- Things in stock are easy to get. Special purchases take to long.
- They are changing, but they need to buy quality and not low bids, and need to give prices on everything that is bought
- Procurement is really good about setting up contracts when they are aware we need one. The problem is that they aren’t aware of our needs. Someone in each region should be responsible to find out what materials we use, what materials we may need and if ...
- Getting better.
- Maybe it’s me but it takes a long time to get the stuff to us. Another thing it seems like they no longer stock filters for new equipment. We have to special order it.
- I feel that when we have a piece of equipment, the warehouse should stock the materials needed for that piece of equipment.
- Very good.
• This area could use some improvement in timely.
• It works good.
• have never heard of this happening
• Need to put out bids over a longer period of time so that we do not have to have a higher volume of materials on inventory to do our work. Has any one done a study to see the result of staying with one make or model for parts and repairs?
• Still buying low bid junk. This only costs more in the long run. This relates to stock items…
• The buying part isn’t so bad, but buying the cheapest they can get is a big problem. A lot of things don’t last as long, and I think it probably takes twice as much to do a job right.
• I would like to see contract on asphalt possibly overlap so that maint. is not left without one in certain areas of the state. Sometimes we need mat. And there is not a contract supplier available.
• Don’t have much to do with that.
• We seem to get what we need most of the time.
• Feel that at times cheaper is not the way. In the long run it cost more.
• I believe that more time should be spent with the people using the products before a contract is written.
• All my dealing go through the district Warehouse.
• Haven’t had a problem. They work with us well.
• I try really hard to understand what procurement is up against, but if I need a one dollar item for the office then I have to buy it from Office Depot out of SLC because that is where our contract. We should have at least $750 ceiling instead of $500.
• Procurement seems to wait on Maintenance for specifications.
• I do not deal with them in this area, but I do not here many complaints.
• Warehouse and Supervisors deal more with this than I do, I have heard only a few complaints over the years.
• n/a
• I am not involved in this process.
• Better material out Maint. sheds.
• Specs are not done on time. Contracts not in place in time for procurement of needed items.
• No Comment
Providing effective maintenance training.

- Our region trainer does an outstanding job. Training in the academy has also been very good. Total maintenance training seems to be lacking.
- The training academy has been a very important part of training UDOTs+ maintenance personnel.
- Training is overall good. I think mechanics could use more updated training on computer set up on engines.
- The training academy has helped but we have older employee out there who are being overlooked.
- Training has been provided but just what is required by law. I have seen an improvement in the last few months. Still a need for computer training out in the stations.
- Trans Tech. program still needs some improvement.
- Our training programs are very good. I worry about how technical our new M3 program is becoming. If a person is good on the computers and can handle any schooling does this make them a better employee than someone who has problems with them? Also some...
- We have some good trainers, as far as safety goes, but training on specialized equipment is not too good. The trainers don’t know and we are not hiring anyone to actually come out on the job and work hands on to teach out people. At least not in the o...
- For the most part this being done ok. Most
- We need two career paths for our employees. Management/Equipment-Labor. You don’t need a college degree to perform most maintenance tasks. You do need to operate equipment in a safe and efficient manner, and understand how to maintain highway features.
- Our training is very poor at the station level on equipment. I would like to see our training budget get out to the station level in the areas where it is needed. It doesn’t make sense to me to train everybody at the same level if the majority of employee...
- We have had a strong training program. Training is something that you can always improve on.
- I think we have one of the best.
- The training is getting better.
- Would like more/better computer training.
- Need more applicable career ladder. And Equipment hands on school.
- Yes and no. Sometime crash course isn’t the way.
- The trainer for Region 1 is very effective, but I would like to see more.
- I feel the training is a very good tool to get us all on the right track.
• At the region level, Region One has an excellent trainer, in providing training needs.
• It’s good but it could be better. Need more training on heavy equipment.
• Have not received any training except when told by upper management that this is to be done.
• Over kill
• I think they train us in the things we do, rather than train us in what we might do.
• Current programs are not doing much good. It takes years of hands-on experience to face all the problems involved in highway maintenance.
• This is improving from what it was several years ago. They are going in the right direction.
• Training is a good tool especially with new hires. Training keeps us up to date on equipment, safety, and new programs.
• We don’t get enough good training, especially from our district trainer.
• Academy training should be for new hire. The older ones should have more training at their own region, District and stations.
• It could be better especially for a new employee when it comes to snow removal.
• Many of the trainers in maintenance are people who have little are no real work experience. The Trainers position is not one that many people with experience want. I think that the trainers we have are trying but just do not have the job skills needed to ...
• Living in Rural Utah make’s it hard to take advantage of training opportunities
• it is all right but everything could be better we don’t need to wait until something goes wrong before we train on it.
• I feel we have a very good training program.
• We are changing and revamping training for our employees all the time. The training we do at the Maintenance Academy is very effective for employees and we get a lot of training done with them.
• Central is very responsive to the ever changing maintenance training needs and provides the necessary support to implement changes in our training programs.
• Keeping moving.
• Millard is great

5. **What specific issues need to be resolved with the Central Maintenance Unit, and how would you resolve them?**

• From my view point they do not seem to be a united organization. They are all good people they just don’t seem to have common goals.
• How budget is distributed. Make better use of features and MMQA in budgeting. Refine MMS. Get a better data base. Better information to purchasing.

• The MMS system needs to be updated with Region involvement. More method studies need to be accomplished with results that can be implemented in the Regions.

• Standards – need to work on activity standards.

• Have central support regions and let the regions manage there budget as need be.

• From my prospective there is a big difference between Urban and Rural not saying one is more important than the other. Just different and those differences need to be made clearer to everyone involved.

• It appears to me that some of the staff is overworked and others do not have enough assignments. I also realize that this statement may border discrimination, but I have a real hard time dealing with people that I can not understand when they speak. 2 p

• Central Maintenance in my opinion is doing a good job.

• I have no problem working with central maintenance. You get a good person in central you can work with and knows their job, and then they move on to another position. Don’t know how you fix that.

• Central maintenance needs to get out to the stations and spend time really checking out the needs, the operations, the differences inherent away from the Wasatch front. The whirlwind tours that are the norm though infrequent, do not give a real perspective.

• Most issues are specific to the revolving door. We need to make the positions attractive enough to retain those that seem to be able to do the job.

• Their is always to much turn over with the Methods Engineers, they just start to get to understand their job duties and want we do in Maintenance, then they move on somewhere else. Could maybe look at putting the Methods Engineers positions in the Maintenance.

• Finalizing MMQA issues and implementing the program

• Maintenance needs to have some people that have learned how to keep a road open and functioning in the decision capacity somewhere in management.

• (Budget) Split fairly between Regions\Districts Feature system

• The way it is run now it seems the regions and districts could function better without Central. Central needs to get back in the mode of being support and not control.

• The largest problem with Central Maintenance is that most of those in central if you handed them a shovel they wouldn’t know which end to hold and which end to shovel with. Solve the problem by having our E.I.T.’s spend some time in Maintenance doing real
• Timely resource provision. Complete the process before the need arrives. Effective leadership. Be consistent, have staff available to respond to the field when needed, not just tied to the office.

• It depends on my needs.

• Better tech support and more user friendly MMS System with access to current dollar figures that match with FINET figures. Inventory tied in with MMS system.

• Seems to be an “us and them” attitude. Hard one to solve maybe a better understanding of entire process. Who’s who?

• Getting money divided sooner and both systems need to be merged together than at different time

• I Think They do the best they can

• We all need to be on the same team.

• N/A

• NONE

• I feel that there doing a good job.

• Lesson the amount of reports and paperwork that we have to do in maintenance or get us a secretary. We don’t have the time to do all the reporting and get our work done too.

• Pass on all Information.

• All regions need to be working on the MMQA and performance measures program so that we can show our needs as a maintenance organization and get the funding that we need so that we can better serve our customers.

• None come to mind or stand out.

• Both sides need to be more open minded. They need to come and visit and see what maintenance does to understand our needs.

• One of the biggest issues that always happens is the money problems that we have in early spring, when we are out of money, then all of a sudden they find that magic filing cabinet, with tons of money, and then we scramble like crazy to try and get it spe…

• Communication, maybe develop a website or a newsletter to inform employees of what is happening and the direction that we all need to be headed for. this passing information on to just the upper management is fine but does not get trickled down to the p

• Faster turn around of information.

• Faster and more information.

• Other than equipment management, i.e., Steve McCarthy and the boys, I would clean house and start over!
• They need to come out and see what our needs are, not just based on what the metro areas needs are.
• having more input on products communication
• We need to be trained by people that understand what they are doing. Need to have an idea of how our budget stands day by day and not at the end of the month or the end of the year.
• Don’t have any issues
• I feel unable to comment about this from my level, this would be better addressed at the area supervisor or maintenance engineer level.
• Personally you should make our fiscal year in January, so a person can do his work when the weather changes accordingly. This would help solve the bids for everything.
• We are not involved with them that much so would have to say n/a.
• In our remote area I think that we get overlooked.
• Have more communication at the lower level.
• MMS the way stations connect to the internet it is to slow I would install satellites they are only 200.00 or so and 50.00 a month service. let us do our time offline and when we connect let it send then
• I would resolve that UDOT doesn’t end at the edge of the Central maintenance parking lot. I would have central understand that what works for Central and the Wasatch front is not good for rural Utah. I would have them generate a 10th of the paperwork
• One specific issue is we need a new MMS program. The reports that we get are minimal, and limited as to what kind of information they contain. Those of us who use the system the most, should be the ones who help formulate the new program. We need to el
• Need to provide more direction when implementing a new program. I would resolve the problem by determining the goal and come up with a plan to achieve that goal and make it useful to the stations, since they are usually the key, get the consensus of the
• The Station Supervisors need to be Station Supervisors again—They are asked to do too many reports and information gathering. A MMS system that could glean needed information without input would free up the Supervisors so they can get out of the sheds a
• I do not have any specific issues at this time. Communication with central and the regions would be a good way to resolve any problems. I work with training and if I have a problem I can call and get help from the training coordinator, he is very helpful
• Concerning training: When the central maintenance equipment people invite personnel from the maintenance sheds to attend new equipment training, it should actually be training. The vendors send their sales representatives to these so called training seminars.
• Quality personnel.
• Understanding the timing of the Regions’ needs. The Code 1 and Orange Book funding are 75% of the total responsibility of Central – so they should focus on these items first.

• I do not have a problem from a specific issues perspective. From a policy perspective, however, Central needs to give a clear direction where we need to go as a Department.

6. What is your view of the distribution of resources between different regions?

• Based on information they have they attempt to distribute monies fairly. This money is based on assets not necessarily the condition of the assets.

• It presently is distributed according to feature inventory, it would be better to be distributed according to need.

• I feel that resources are given out to Region One and Two that the other Regions could use.

• They need to come up with a way to calculate ADT in the mix, instead of just surface areas for budget

• I think it would be hard for anyone to say it is very fair because the needs vary to much from Region to Region. There are just to many unfunded needs through out the Department.

• I rate it as average/fair only because what we eventually get is only accomplished when our Analyst fights for what is right. I don’t believe that allocating remaining EFM funds to the Regions/District is fair. Their is no incentive for me to keep my sno

• The Wasatch front seems to get more of the resources than the rural areas. Our roads are getting very old.

• We are treated well by the Equipment division as we have proved to them that we are good managers. We were once rewarded in a fairer manner for our ability to excel at managing our MMS system better than any other district. That has changed to make

• Again the closer you are to central, the more you have their ear, the greater the budget you are allocated. If we were a real team we could determine and prioritize need and make the appropriate budgetary distribution. Just because a region has a lot of i…

• I feel the ADT should be considered in the distribution of resources. Average Daily Traffic Counts.

• Need to request specific needs, not distribute on an established percentage. There are probably not a lot of funds after you cover personal.

• Make sure Districts follow procedure for budget allocations.

• The North Regions get a bigger cut of the Construction money. Their roads are kept replaced more regular than the outlying areas so they don’t really need the larger maintenance percent that they always cry for.

• This could improve by putting the money where the most need is.
• I hope it’s fair. If it becomes political or a single value, we will be less effective and more suspicious of one another.

• Competition?

• I feel like region 2 gets all the money because they are in Salt Lake, granted there are more people and cars but we would like to see more involvement in other regions, like the different pay for being in a rural area.

• Region 2 is very proactive at preventing problems before they escalate. They request funds for these activities and get a lot of them done. There is a greater demand from the public and different levels of service depending on traffic numbers.

• Equipment needs to be looked at where they have heavy usage and traded to area’s with low use.

• Region 2 has higher traffic demands.

• I feel that we can all learn from these resources.

• There seems to be favoritism for some areas.

• Competition.

• I understand that from region to region we all have different needs and different priority’s, but for the most part it comes down to the bottom dollar amount in order to give our customers the level of service that we are trying to provide through estab…

• It seems that certain regions are not really held to staying within budget because they know that they will be bailed out when it comes crunch time, (end of fiscal year).

• We have too many highways in the rural areas of the state that are not up to meeting the traffic involved. The governor wants tourists, so let’s get them where they want to go safely. The secondary roads are the ones that take people to what they want to see.

• I am from the south and the so. regions were asked to give up F.T.E’s to the north and also supply the eq. for them (for snow removal) they have since added trucks with side mounted plows to those areas, providing 1 truck now doing what 2 did. They shoo…

• It seems at times projects are more important in the more populated areas of the state (north) than in the south?

• It seems like the urban areas get all the funds they need leaving out the funds for the rural areas.

• Rumors about who is getting preferential treatment are usually wrong.

• St George is just as important as Salt Lake City, and when it comes down to it just like the Olympics games you called on us because we all do the same things.

• Not sure how this is even done. N/A.
I’m a new station supervisor and I’m not up to speed on everything that takes place in distributing monies to all the regions. But I can see a need to have more money to do litter, a lot of human waste is being left up to us to pickup along the road in pl

Always seems to us Region 2 gets what they want and need and leaves the other regions behind.

UDOT employees I talk to from region 1, 2, and 3, tell me that our equipment would have been traded in years ago. I score this a 3 because I really don’t know.

Region Two has the ear of Central Maintenance. Not only do they have the personnel resources, but the dollars to go with them. It’s hard to hear the voice of Region 4 from 100+ miles away.

They need to decide the method they are going to use for distribution and stick with it for more than one year. One year it’s by feature, that’s out of date, the next year, it’s by MMQA (we never got a straight answer on how that was done), and the next…

I feel central does a good job of distributing money with the information they have but that we need to move more towards good measures to help determine the need.

I work with 5 other trainers, we work well together. If they need information from me or I need information from them we do what we can to help each other.

I can’t honestly say. I always have what I need to get my job done.

Base it on asset management – not the history of budgets.

7. What is your view of the distribution of resources within your region (or district)?

We distribute the monies much the same way as central. However we do move resources to where the needs are to the best of our ability. We have even done this by using station personnel and monies from one station and have them accomplish the work in ano…

We have been placing the resources where the need is the greatest.

Money is always a problem; never enough to go around priority is given to highways with higher ADTs.

Of course I would feel this way; I am partially responsible for this. We do spend a great deal of time and effort to make sure we are doing what is best for the District as a whole. There are very many political pressures to use funding in certain areas.

In some areas it’s unfair but overall not bad.

Again real needs are not addressed. Funds are distributed according to percentages.

Same as previously mentioned.

Better. They are closer to the work.

There always seems to be a little favor given to the areas closest to the Region or District offices.
• Seems to be a popularity contest and doesn’t always make sense.
• I think we do a good job allocating to our crews.
• Push and pull!
• Money goes where it is requested. Plan for every section of road is used to monitor needs in the Region.
• There are maintenance stations that use 10-wheelers and snow plow equipment 5 to 8 times as much as other stations. When comparing equipment between stations you will find identical trucks same year etc with drastic mileage differences. I think that the new…
• Very good.
• Again, the favoritism thing.
• Region One does a very good job.
• Equipment not being utilized in urban areas, but they are still getting new equipment.
• Push and pull!!!
• The resources that we receive to try and give the best level of service for the most part are pretty good. With all of the rental contract’s that are in place for us in region 2 makes our job easier, and more productive to get the job done quicker and cheap
• I really don’t know what resources that we receive from you but, in the budget print outs it seems to be as fair as possible.
• There are other highways besides US-89!!!!!!
• They seem to work things out pretty fair.
• It’s about as fair as two office jockeys can get it.
• There doesn’t seem to be enough to please everyone.
• Left it down a little because feel that improvements can always be made.
• If we need it we usually get it but the snow budget should help to cover us all.
• We use a mix of feature inventory, history, and special needs to distribute our budget. The Management Team works close with one another to insure the crews have the resources they need.
• I wish I could feel good about the way we distribute the budgets in the region. We look at features, we look at urban vs. rural, the number of employees in each station, history, etc. We do pretty well at figuring it out, but there has got to be an easi…
• We are relying too much on history and not on putting the resources where they are needed most.
• Some people are willing to help and some are not.
• I can’t honestly say. I always have what I need to get my job done.
• Need to be able to move $ around more easily based on needs in maintenance activities.

8. **MMQA requires certain condition measures. How effective are the condition measures you currently use?**

• We believe that anything you measure you will do better at. They are effective because of the ownership at the lowest level.

• They are good, but the data is not being used effectively to show the Legislature the true picture.

• They are good with the exception of mowing, noxious weeds, and cut ditch.

• I am also on this coalition. I don’t believe that people put a lot of faith in MMQA because the measurement methods have changed so much in five years. We need to get some firm ways of measuring and stick with it. Too many people have too many different views.

• I feel the MMQA committee, which I am a member of, is doing a good job in refining the way we measure and report.

• Too little understanding by too many people. Too many cooks stirring the soup so to speak. Makes for poor info gathering.

• I think it is important to remember that the condition of the feature is the result of the effort applied by Maintenance. We should be measuring effort not condition.

• We only have one for mowing.

• If we are going to use this for budget purposes it needs to cover the areas that are not up to standard as well as the areas that show signs of damage.

• They are getting more usable, but will always need refining.

• Some of the measures are with MMMS. Pothole, eagerut, crack seal.

• I am not sure what they are used for, but they should not be used solely to base my budget on.

• Guidelines need to be looked at to make the reporting more consistent

• You can’t tell how bad a Drain Box is by looking at the debris on the cover. Also some roads have new sections and old sections so the random does not tell the whole story.

• The state is too diverse to have the stations do there own MMQA measures. I think MMQA would be very valuable if it where done by one group of people that could see all of the state, and compare not only station to station but region to region. Most areas

• Sometimes I feel we are taking to much time on counting and not as much time working to perform our tasks.

• The region one or station measurements, are a better way to drive what needs there are by monthly.
• I feel it is hard to get an accurate measurement because of the seasons of the year, and when we are allowed to do the work and when our budget allows it.

• Some of the measures are not with MMS like pothole, edgerut, crackseal.

• I feel that the MMQA can be effective but between MMQA and the performance measures that we do in region 2 it takes a lot of time to go out and calculate everything and then schedule the activity and try to get it completed.

• We have some questions as to some of the items and how to measure them that we would like to get clarified.

• More standard state wide, also look at different classes of roads, and standards.

• I feel they are working very well.

• Always room to improve…

• For myself I have had no training on MMQA ?????

• No comment.

• We have always done the best job that we could with what we have available.

• When it comes down to it its all money.

• Work on big dollar items, but feel too much time could be wasted counting labor intensive activities.

• No two people seem able to come up with the same numbers. I think the people doing the measuring need a clearer vision of what we are measuring and how it is to be measured.

• every station is not on the same page all measurements are different

• At the time of the year that we check noxious weeds they are dormant since it is early spring or in the fall. It is impossible to be accurate with this topic.

• We measure are entire area so we have a picture of our hole are and the stations use this information to plan what they are going to do each day. We have created much efficiency and upped the morale of our people.

• See MMQA Question #4.

• This program needs to be re-done, so every one is on the same page. At this time I do not fill it is effective the way it is set up at this time.

• I have participated in the gathering of the information, but have not been included in what the measurements actually accomplish.

• Need pavement condition tied to effort.
8a. Do you have suggestions for more meaningful measures?

- We believe that all personnel should be involved in performance measures. We have assigned sections for every employee in most stations. The personal buy off and attitude of individual employees is very high because of it.
- Instead of effort expended make the measure actual condition.
- We need to measure condition not effort.
- Yes. Measure condition and not effort.
- Recent changes have improved the accuracy of MMQA. It is more meaningful now than in the past.
- Somehow they need to measure work construction does on orange book projects, problems with inspectors, problems with road after completion, so maintenance doesn’t have to fix problems that should have been taken care of.
- Return to the original measures for mowing 6 to 14. Noxious weeds needs to be measured with they are easy to identify. (Summer months) Give clearer definitions for what is cut ditch.
- I still like the idea of using our feature inventory to allocate money use the data from both MMQA and feature inventory.
- Yes, but I believe the MMQA coalition can address them, and has heard them. We will never be able to do things the same way throughout the state. If the State was flat and everything was equal, we could measure and expect the same. That is not the case.
- More Training on measures to assure accuracy.
- I feel a District team needs to measure the MMQAs. This will give you a more uniform rating throughout the District.
- The measures are meaningful enough, but they are all screwed up by everyone being on a different page, and not doing the measures equally. It’s one thing to send out pages and pages of instruction, it’s another to get them adhered to properly. The measure…
- Just that it is effort we are measuring. I believe that the measures need to be refined through time and can become more meaningful, at the present time we are on track.
- No.
- Shoulder measures should show a need for any shoulder that the slope does not meet standard. Guardrail and concrete barrier should show a need for any that is to short, wrong end treatment, etc.
- We have not tied it to our budget, and its measures are not affective the way we do it now.
- Pothole , cracksealing , weeds,
- No.
• No.
• Longer sections sampling
• Mowing for example, some areas never need mowed because of desert, other places need to be mowed 2-3 times per year, if the measure is done when it already has been mowed what does that tell you? One station that has to mow 2-3 times a year may rate a s…
• For MMQA we need to measure more than one tenth of a mile.
• No.
• Not at this time.
• I feel that safety is one of the top things we need to take care of in our jobs.
• Let us do the work and less study of it.
• Measurements need to be done more often or by quarterly. This would give a better story on the needs, and what products are working or lasting longer.
• Maybe do more with the MMQA measures.
• None.
• They need to come and do the measures a day or two after we do them.
• Pothole, crackseal, edgerut, weed.
• I feel that on occasions we are trying to cram 15 hours of work in a 10 hour day, I really don’t know what to say.
• In mowing; do we measure what we can actually mow, which is one pass or about 15’ wide, or do we measure to the fence line?
• This is one area where the same person should train the ones to measure the roads state wide.
• Use the same people in doing the measuring each year.
• No but I don’t think the MMQA measures are the way to go.
• Just make sure that we are all on the same page, in the same song book. The starting point is of the most value. Then, as we improve, that becomes standard. Then we change the standard so we can improve. What a bureaucratic cycle!
• ????
• No.
• No.
• No.
• No.
• We are tracking and measuring the doing what should be meaningful (pride, quality, etc., not numbers and percents of).

• Have someone who knows vegetation management with the team who do the measures or inform them what to look for or build a map of problem areas those problems are seasonal.

• Use a more diverse group to come up with the measures. Take the measures in the field have a diverse group use them and see if the numbers match. If they do not find out how the each member came up with the numbers. Keep doing this until the numbers match.

• Think they would be good if all do it the same way.

• Just the one described on #8.

• Evaluate delineators and signs from inside the vehicle, just like the crews do. Edge drop should be more than 1 inch. Vegetation should be done while plants are actively growing.

• Some items need to be measured more often and in some cases a longer distance.

• See MMQA Question NO. 4.

• Re-do the whole program, and what they are trying to accomplish with it.

• No.

• Yes on measurement.

• See #8.

9. Rate the effectiveness of regional maintenance management.

• We need additional measurements and elimination of others that are becoming non-effective. Station and individual ownership seems to be the key.

• My people are doing a good job.

• Need better communications with design personnel when designing projects maintenance needs are not fully being addressed. The process for obtaining cultural clearances needs to be simplified (you can’t get the clearances before a project number has been assigned…

• Regions need to have dedicated funding. Not have to wait until the snow season is over and survive on what’s left. Its either feast or famine.

• I assume District in this case.

• Our management is great. Easy to work with and talk to.

• Not a lot of firm decision-making, or clear direction comes down the chain where problems need repaired. Fairly good decision making on future project needs etc.

• The best is being done on the basis of what they have, but improvement can always be made.
• With the Department changing this year has been a challenge. The Olympics, Trans/tech, funds, etc. I think we will figure it out.

• Doesn’t get out to the Districts enough to really have a feel for what is needed. Region 4 covers too big an area to really be covered effectively from Richfield.

• I think we have the best in the state.

• No comment.

• Very proactive, Plan for every section of road lets you know what is coming up on every road section and when so decisions can be made to get by.

• Region two is very proactive in planning to ascertain funds when needed

• The region can see the diversity it has and plan accordingly.

• I feel that we are doing a great job.

• Region One management has a good working relationship.

• No comment.

• They seem to know what is happening and are on top of things, but we need more information at this lower level so we don’t feel like mushrooms. Kept in the dark and feed full of s@#!.

• Good programs are in place. Everyone is concerned about their duties and assignments. We get good help from our shops, warehousing, and special crews. Annual inspections are a great help. Awareness of certain maintenance problems in the district is another. Good group.

• We don’t need regions. It just made more people with higher paying jobs. They could do the same thing on the district level.

• Region and especially District management do a great job.

• Feel that the regional maintenance management group doesn’t always understand the needs of maintenance.

• Too many conflicts between management stations suffer

• Even with Price district being 300 miles away I think that our maintenance management works quite well.

• We don’t have the monetary resources to be as effective as we need to be. Over the past five years we have not met our pavement preservation strategy even once! We have great plans, but not the budget to make them a reality.

• They have a very heavy work load and sometimes it is hard to go over important items with them. They try to address my needs most of the time.

• I believe that regional management provides maintenance with the resources they require to accomplish the goals at hand.
10. How effective are computer systems (e.g. your computer hardware, the connection to Central, and the local area network (LAN) to help you do your job?

- The maintenance management system is a good system. The software running it is poor and hard to use. The MMQA effort is very good; however, it needs to be accomplished on every construction road segment.
- Needs help.
- Rural connections are slow and access to some data is non existent. MMS is hard to navigate around in and information needs to be in real time.
- Computers need to be updated. Word and Excel.
- Our computer systems are great, but need to be upgraded to keep up with technology. Our technical support is great.
- Being connected at 26,400 bps is slow going. Need a satellite connection out here in boon dock land.
- There’s always something down and not working when you need it.
- The MMS system is very poor for what we need it to do. In this day and age there has to be something better.
- We need to find a better way to link the stations. Internet connections via modems especially in rural areas are often slow and not reliable.
- We need new computers for the paper work we have to do. I think the supervisor could use laptop.
- I would like to see Region 3 have there own computer man to come out to the stations when we have problems, a lot of times you call the people in salt lake to help you and they say it well be 1 or 2 weeks. I have a printer that’s been down for a month.
- I have a very old computer. My memory is at better than 90 percent full. The person who is responsible for technical service does not take ownership of helping me out. His hands are tied on how much he can do because of budget. MMS is down weekly for hours.
- The computers are slow and why can’t we get windows 98 and upgrade and better response on repairs.
- Computer need to be updated.
- we are hooked to the internet with fiber optics, and this saves us time to do our work, other stations still have dial-up connections, at the very least these stations need DSL connections. The computers could be updated more often, they are pretty slow in
- Need to get a different server for the internet
- In the maintenance station everything we do is so slow on the computer.
- The computers we use are out dated and very slow, or else the system itself is slow.
- I feel we need more training on computer hardware.
• This is the biggest problem in my work place! For example; I was disconnected four times in filling this survey out! I can make a cup of coffee why I do the T-91s, and to pick up E-Mail, it can take up to an hour to reply to a message.

• This computer is very ineffective; it is hard to log on to internet, when it is very slow!!!

• Our computer system is very poor. We our always have to wait for the system to run.

• We need a new computer. We also could use a laptop in our truck.

• On a regular basis, my computer is down, and when it does come up, it takes me forever to complete my T-91’s and schedules in a timely manner.

• We have our problems, with the system running and completing the push and pull thing, but other than that it seems to run alright.

• We can to our work and keep up with it. It takes 1 to 2 weeks before it shows up on our budget.

• The reported information needs to have a quicker turn around to be the most useful.

• I think they can be improved, especially the inventory.

• Computers are outdated. No space, hand-me-downs from Salt Lake, piece of junk. Let’s get into the 21st Century, folks. The LAN is very poor and expensive in rural areas. Still have to use dial up to do our MMS reporting because we have no DSL/LAN, only satell…

• They save a lot of time but including an inventory system would help a lot also. We now have to do separate inv. processes in sheds and rely on 2 week past run data from region offices. It would be nice to transfer inv. from warehouse org. to station orgs.

• I have had good service from the Region 4 people involving computers

• Needs to be updated.

• The computer helps save time in making reports. The software is out of date and could be enhanced to make it more user-friendly.

• The computers would be excellent if we could get on line when we wanted. It always fails when you really need to use it, or there changing something or working on it.

• The system we have now is slow (not user friendly).

• We need to upgrade to the 21st century.

• Poor Internet connection due to being in a remote area.

• could be better would rather see laptops in stations getting cheap enough now with a wireless LAN connection could do a lot of work on the job

• I think our equipment is fairly modern but our connection to LAN is poor beyond belief. Central still manages to get out e-mail to tell us that someone in their parking lot hat left their lights on therefore our connection with central must work fine. O…
• The hardware is fairly reliable, but the software needs to be updated.
• My MMSPC connection is down more than it’s up; the station computers are very old, don’t work very well when we try to load new, updated programs.
• We have pretty good computers, but our connection to Central (citrix) and MMSPC could be better. For example I have not been able to get into MMSPC for about a week and know one seems to know why.
• My programs are very poor and do not work 90% of the time and when they do work some how the data is gone. I work with mets and pets.
• This resource lets me research and develop training programs with the latest information available.
• I don’t use them much.
• Have problems in remote areas.

11. How well do you understand statewide goals for maintenance?

• Do not feel I know where we are headed.
• It seems goals in metro regions and rural regions differ.
• There are a lot of inconsistencies in how we do preservation projects from Region to Region. Appears to be to separate goals Urban and Rural.
• I understand the goals, but I am confused with the system in general. Red tape is alive and well. I think Region 4 is too large and it affects the performance of Maintenance and our operation in general.
• Understand adequately.
• Do we have statewide goals? I don’t think I have heard them presented formally.
• Honestly most of my time is spent trying to keep things going.
• Be safe and do the best we can with what we have???? We will never have enough for all needs.
• I know the goal petty good.
• All roads the same. That is the point of MMQA. This is why one group should do MMQAs. We want the same level of service on all roads, and we want it as good as it can be with the resources we have.
• Very well.
• I know it well.
• I somewhat understand what we are trying to accomplish as a department, but on the other hand I see this as an opportunity to stand back, and take a good look at our future, and make some decisions that we can grow from to give our customer’s, the best le…
• I don’t understand and it is hard to understand being that at the last foremen’s conference I overheard some other supervisors talking about this and what a piece of crap it was and just another phase that the state is going through.

• Understand the goals! Don’t understand the budgeting, accommodation of building facilities for unneeded personnel and region programs, and the use of other states’ programs that do not apply to Utah at all, or the use of QI programs that are made up of only…

• No comment.

• With 30 years in the Maintenance dept I feel I know what the goals are. Our biggest problem is the maintenance dept. has not kept up with the amount of traffic.

• Feel that I understand the goals that I know about, but at times, it is not clear what upper management goals are.

• If anybody gives you a one they are very good.

• Could be told better.

• As a station supervisor I’m aware of the stations position in the scheme of things. I don’t have the big picture of an area supervisor, or district engineer’s perspective.

• I feel I know what the department’s goals are, and I think maintenances are the same, but I have never heard exactly what they are and how we are going to meet them. I feel Central tries to appeal to some areas that do not want to do the work and that is

• I work with the Trans Techs and this is a good program but needs work and coordination from every one. It will make are work force a better one.

• I do not completely understand the direction in which the Trans Tech program is headed.

• This question is too broad to answer. Need to be more specific.

• Good understanding of pavement preservation philosophy and what MMQA is trying to do with showing level of service.

12. How well do you understand region-wide goals?

• I set most of them.

• Same as above inconsistencies from District to District

• Again, I understand what the objective is, but have a hard time with the structure of the Region. I would like to see the Environmental Section totally removed and started over again, with some very clear performance measures and goals. I do not believe…

• Adequate

• Same answer.

• There is good communication with me on what needs need to be accomplished.

• Lack of communication
• We measure what we do to create efficiencies. Then reward those who create the efficiencies with credit for completion and a job well done. We have ownership.

• Good today better roads tomorrow.

• Very proactive.

• Very well.

• Good road today. Better road tomorrow.

• Every region has different priorities and conditions that factor in to the equation to complete our goals.

• I believe that this is to drive our needs and our level of service.

• Don’t understand why we even have such a waste of the consumer’s tax payer’s monies. What a joke! No, an embarrassment to transportational goals and functions. Nothing but duplication and rhetoric.

• No comment.

• Support statewide goals.

• Feel that at a district level the goals are talked about and known, but on the regionwide, they are not.

• Too vague.

• With region 4 being split into three districts my perspective is mostly the Price district.

• I know what our Region goals are.

• This question is much too broad to answer. Need to be more specific.

13. How would you rate UDOT as an employer?

• Excellent people to work with and job security, retirement benefits. Inadequate wage increases, neither decent COLA nor consistent merit increases.

• Not employee centered.

• Pay needs to be better to keep quality employees.

• There are many opportunities if you have a college degree and are willing to relocate. People are not recognized so much for performance as they are for credentials. It is a bigger elephant to bite than I ever thought. But, it has provided me a good life.

• I really enjoy my job and the people that I work around.

• I would not trade at this point. The pay is not great, the benefits have always helped make up for that, but I am beginning to wonder as costs go up and benefits are going down. There are very good people and some who need deleted, though getting that d…

• No complaints as to the work environment.
• Maintenance does not seem to get the recognition that some of the other departments in UDOT get. The pay scale is not fair, when you look at a Tech 3 in construction and they make the same as a Station Supervisor, theirs something wrong their, also when…

• Employment to retirement, benefits, work environment.

• They could really follow what they say. EMPLOYEE CENTERED is a real joke in my opinion. Central training makes decisions about employees’ lives without consulting the employees before these decisions are made.

• I have enjoyed my job with. I have held several different positions here and have enjoyed all of them. This is a good job but it sure seems like every time that there is a problem it is our own people fighting against us where if they would understand the…

• Petty good job.

• I like to come to work.

• Morale has dropped and thing have chance without employees help and pay and benefits

• This is a very good job, the money could be better, I do feel we are underpaid, but this is still a good job.

• In some case it a different in some region like differential pay.

• The greatest.

• Get rid of the clicks and it would be a great place to work.

• UDOT has given me good benefits, schooling of the trade, work advancements.

• I like work. Here it is a challenge; you need to test yourself every day.

• UDOT is a good organization to work for, but sometimes political issues arise, which makes it difficult to keep the moral and productive level’s up, without any boiling points, that do happen in any work environment.

• Other than having to be a babysitter for some employees this is still a great job after 23 years.

• UDOT has been a very good job; they need to work on wages especially at the entry level so we can hire people with good experience.

• We need to get back to taking care of the roads, the primary function of our fuel tax. Not meetings, not new regions, not more watchers watching the watchers. This was a good place to work. UDOT station crews are some of the best in the world. Just let them do…

• Need more attention to the services we provide for the public—better products more money and effort to the road maintenance we need to have less meetings and committee groups

• It’s been a good learning experience.
• It takes too long to get up to a living wage where employees can afford to work just one job. Most employees have to work another job to make ends meet.
• Just like to leave room for improvement.
• Treat all the same don’t treat reg 2 better than others traffic doesn’t stop in salt lake valley anymore. Pay us the same as other regions
• This is an economically depressed area. Everybody on the crew is thankful for the job and the benefit package. Nobody likes the winters much due to on-call and no relief drivers. Nobody is happy with the overtime in-excess situation which does not bode…
• I feel pretty good about UDOT. I think organizations within UDOT could work together better. We are very cliquish and seem unwilling to work with and share information. As a result, I think we are duplicating a lot of effort. I think the UDOT managers…
• UDOT invests a lot into each employee. We are treated with dignity and are made to feel like an integral part of the operation. This makes it easy to take ownership in our projects and makes us feel that we are truly valuable to our employer. I love being…
• Kept roads passable and with little budget we have. Kept traveling public happy and safety on visit in our states.

14. Are there any other issues or comments we should consider in our audit?

• I believe both MMS and MMQA are doing the right things. I believe most of the problems with these systems are the software and base structure of what we are accomplishing. If the system was user friendly and data was readily accessible so that analyzation…
• Put more money in the regions hands.
• My concerns were discussed in our personal interview.
• The trans. tech program for maintenance, which was started a few years ago needs a good look at. It is unfair to certain groups of maintenance workers.
• None.
• All of the above.
• How STIP and Preservation projects developed and distributed.
• I believe that more money needs to be put into the purchasing of new equipment; we don’t get enough to even being to keep up with the needs of replacing the equipment.
• Each Region/group should have a representative functioning with Central. So they can develop what we need to function. Instead of building programs to monitor what is going on.
• It would be nice to really accomplish something at the Quality Panel meeting we have twice a year.
• N/A

• Compare actual hours and mileage between station to station and region to region to determine if equipment is getting used equally, and help us to get a plan to make sure that newer safer equipment is in stations that use it daily. There should not be tru…

• We should be able to rate the politicians and have them be accountable.

• No.

• None.

• I feel the employees are not getting the pay for doing a great job they do.

• The fiscal year timing seems to work against us in maintenance. We need funding for the spring months.

• Maybe more comments about our physical inventory, our material costs and our equipment costs, these are important issues that impact our budgets.

• None.

• No.

• These surveys are nice but what would really be nice is to see what has been brought up and is to be done with this information.

• It is real hard to do more for less, with out comprising safety, or the product. Do more work on the government leaders to put more in or cut out the frills. Main Street Enhancements and trees and Etc.

• Cut district personnel and put them in the sheds where the work is being done. One person could do what two are doing now in the district.

• None.

• UDOT employees give a lot of their own lives and personalities in the performance of their duties. At times, they even risk their own safety and lives to provide for those they serve. Nobody knows this but the employees themselves. Floods, snow removal, lands.

• The work we do in maintenance is great, it’s just the management that needs to be adjusted out of their God-like attitude.

• No.

• A comparison of wages vs. responsibilities between Construction techs and Station supervisors.

• Get the other employees involved.

• I would like to see something done about human waste left by the trucking industry, make a logo to cleanup Utah, take care of your waste and not leave it in a bottle or bag for UDOT to pick up to keep our roads clean.
• Maint pay vs. const pay. Station supervisor pay vs. lead pay and so on bottom end is getting better but top end still isn’t right.
• One strenuous last parting comment. Rural southeastern Utah is not the Wasatch front. We have different problems, solutions, and have not the resources of Region 1, 2, or 3.
• As I said in the number one box I feel that I can’t give you any information at all where I deal with the district in all that areas that you are questioning. So from my point of view I really don’t see anything at all that central does at least at the st…
• New MMS software. Need to integrate the feature inventory and MMQA into MMS.
• The sooner we get a new MMS program, the better off we all are going to be.
• MMSPC needs to be updated and built to our own needs. If there is a program already written that will fit our needs, that is fine. If not, we need to build our own. The system needs the ability to do asset management. The feature inv. system needs to be…
• Who is rowing the canoe when everyone in it is in charge?
• No.
• Performance measures for Region and Central Maintenance

15. Are there any other improvements that you would suggest for UDOT maintenance?

• Inventory systems need to be improved. From a physical inventory point of view using coordinates and exceptions rather than re-inventorying every time. The warehouse system also needs to be updated with bar code capability so that commodity data could be…
• Have one annual visit, instead of two semiannual visits.
• Systems and process improvement in multiple.
• I would like to see procurement be more active in getting contracts we need. for instance I-15 was rebuilt last year we have miles of sound walls, when they get hit we have to repair them. Stuff like that should be on contract.
• I feel that UDOT is doing a great job.
• Stream line the problem resolution situations that drag on for years.
• We as a state department need to all be a team that has trust in one another. As it is there seems to be competition for everything. At this time no one trusts anyone. It would be nice to know that tax payer’s money was always being spent in the most ef…
• Get people who are doing the work in the decision-making process.
• I don’t think it gives the public a good impression of us to have Region or District employee picnics on state time. If some one thinks we need a party invite the employees to come on there own time or not to bother.
• To change the mms system, so that it tracks each stations budget day to day and by task. also may fix the warehouse ordering more user freindly, maybe see if we can get it on line to order material and see the prices, (for example we can order online from
• N/A
• Equipment training, operators.
• New Station to handle our new equipment. Sheds are too small for the ten wheelers
• More special crews. There should be a broom and vactor crew in region 2, there is only one vactor truck in region 2 and it is assigned to a maintenance station. This station needs to supply an operator every day to help the other stations. we should have…
• Hire more help for station maintenance workers.
• Increase in pay to match other job related activities.
• I feel that I get very little time to get ready to get ready for going from one type of operation to another.
• No.
• Need more help in stations.
• I feel UDOT is doing one very good job.
• They need to do away with the urban pay, the way it is right now it’s not right, Dist. 2 gets it and not the other two Dist.
• Get the pay administered fairly. The nicet and new pay plan really hurt some of us long time supervisors. It’s not right that someone with less time and less time in grade make more than some others.
• Never give anybody benefits to just one area, any monies given out should be to ALL EMPLOYEE’S. Same people doing the same job should have the same monies!!!!!!!!!!!!!!!
• Not at this time
• I am very satisfied with the support I receive from central maint.
• Just try and keep us informed.
• More training on equipment and less class room work.
• Keep the supervisors up to date on issues before they are outdated.
• More training on equipment and less in the classroom.
• The department really needs to get involved with training the public about highway maintenance, repairs, construction, reconstruction, and emergency situation. This could best be done by starting out with the state’s driver education program. Teach the upcoming generation…
Why does management need to be so secretive about their way of doing things. Why does management have their favorites to move up the ladder, and then lie about doing so?

Improvements are controlled at the legislature level as far as funds go so it’s tough to change many things. You do the best with what you have to work with.

More money for our employees.

More money.

Trade the equipment we use more often.

Listen more to employees’ ideas and suggestions.

I would like to see them put all Station Supervisor’s on M86 all the time.

I would like to keep my techs at my shed I believe we are going to see a slump in moral, being taken away from the crews in the summer to do engineering work. I can see the point of the whole thing, but I can’t see me hiring summer hires to do what we’ve…

Keep moving in the direction we are going it is getting better.

As I alluded to—we are at the jct of 191/666, two major truck routes that have heavily fatigued the asphalt and is going to need some major attention soon. SR666 is scheduled for an overlay in FY 05 so we are not forgotten and we are on a preventive main…

Regular updates of Performance Standards. Keeping them updated insures our budgets are meaningful.

I think that the MMS software needs to be improved. I think that the current software doesn’t do everything that we need.

No.

Keep the training coming. Revisit TQM and continuous improvement philosophy-do re-training of this from time to time.

Central needs to get out to Regions more often – especially sheds. Listen to inputs from Regions. Don’t base budgets on history.
Appendix B: Survey of State Agency Highway Maintenance Best Practices

Date __________________________________________
State __________________________________________
Contact Person __________________________________________
Title __________________________________________
Telephone __________________________________________

A. Planning & Budgeting

1. Do you set long term (more than two years) targets or goals for maintenance? If the answer is yes, describe how the targets or goals are identified or measured?

2. Are the target goals used to determine maintenance needs for the short term (1-2 year) budget process? If so, who sets the goals?

3. Do you use lifecycle cost analysis for any maintenance planning or budget strategies?

4. Do you use maintenance priorities for any maintenance planning or budget strategies?

5. Briefly describe your budget process. Who identifies the initial budget, and who has the authority to establish the final budget. Is the budget based on historical expenditures, inventory, performance goals, life cycle cost analysis, other criteria, or a combination? If a combination is used, please identify each criteria.

B. Asset Management

Feature Inventory

1. Does your department currently have an inventory of maintainable features that is accurate?
2. Who is responsible for maintaining the inventory? Who is responsible updating the inventory? How frequently is it updated? What system of referencing is used to locate features?

3. Is the inventory used as a basis for planning and/or budgeting? If so, how?

Maintenance Performance Measurement
(Maintenance Management Quality Assurance)

1. Do you have a system to measure performance or outcomes of the maintenance program?

2. If yes, briefly describe the process. How many measures are used? How are measurements made? How often are measurements made?

3. How is the performance data used?

4. Is a presentation made to the legislature relating performance data to funding levels? If so, how effective has the presentation been? (Have they resulted in increased funding?)

Customer Surveys

1. Do you perform public surveys specifically related to maintenance?

2. How are the surveys conducted? How frequently are surveys conducted?

3. Is the data used to set maintenance program goals or performance targets?

C. Maintenance Training

1. Do you have a formal training program for maintenance employees?

2. If yes, briefly describe it in general. Is it mandatory? Who pays for it? What is the focus?

3. How effective has training been? How is training effectiveness measured?

D. Methods Engineering

1. Do you have in-house staff devoted to developing and improving maintenance processes, procedures, and materials?

2. If yes, describe how the staff identifies issues for research (e.g. concerns from field staff, periodic review of costliest process and materials, etc.)
E. Maintenance Methods Technology Transfer

1. Do you have a formal process for maintenance technology transfer?

2. If yes, briefly describe it in general. How is information transferred? How is it requested?

F. Other Maintenance Issues

1. Is vegetation maintenance handled in house or contracted out? If in house, is vegetation maintenance centralized or decentralized? If decentralized, does each district have a special vegetation crew, or is the work done by maintenance technicians?

2. What are the three or four major statewide issues related to vegetation maintenance?

3. Is the management of maintenance facilities (buildings) centralized or decentralized?

4. Is the budget for building maintenance separate from highway maintenance? How are budgets for building apportioned, by identified needs, historical percent to each district, condition assessment, other?
Survey of State Agency Highway Maintenance Best Practices

Date May 21, 2002
State ARIZONA
Contact Person Jim Dorre
Title State Maintenance Engineer
Telephone 602-712-7949

A. Planning & Budgeting

1. Do you set long term (more than two years) targets or goals for maintenance? If the answer is yes, describe how the targets or goals are identified or measured? We have a list of needs that we use for budget requests. The list is developed by the Districts.

2. Are the target goals used to determine maintenance needs for the short term (1-2 year) budget process? If so, who sets the goals? Yes. If funding is received for a request, the funding is used to accomplish the need.

3. Do you use lifecycle cost analysis for any maintenance planning or budget strategies? Not at this time. It is one of our long-term goals.

4. Do you use maintenance priorities for any maintenance planning or budget strategies? Maintenance priorities are what drive our planning and budget strategies.

5. Briefly describe your budget process. Who identifies the initial budget, and who has the authority to establish the final budget. Is the budget based on historical expenditures, inventory, performance goals, life cycle cost analysis, other criteria, or a combination? If a combination is used, please identify each criteria. Although needs are developed by the Districts, grouped and prioritized by a statewide maintenance engineering group, the Governor sets a maximum of how much of the Highway fund can be used for non-construction processes.
B. Asset Management

Feature Inventory

1. Does your department currently have an inventory of maintainable features that is accurate? We have an inventory of maintainable features. I do not believe any agency has an accurate inventory. We are in the process of revising our inventory database.

2. Who is responsible for maintaining the inventory? Who is responsible updating the inventory? How frequently is it updated? What system of referencing is used to locate features? The owner of the inventory item is responsible for maintaining the inventory. We currently use route and mile post to reference our features to comply with agency mapping requirements. The new inventory database will have the ability to include GPS/GIS.

3. Is the inventory used as a basis for planning and/or budgeting? If so, how? The inventory is critical to planning and budgeting.

Maintenance Performance Measurement (Maintenance Management Quality Assurance)

1. Do you have a system to measure performance or outcomes of the maintenance program? Our maintenance management system captures performance.

2. If yes, briefly describe the process. How many measures are used? How are measurements made? How often are measurements made? Each production maintenance activity captures labor, equipment and materials that can be compared to statewide and maintenance unit averages. Actuals are compared to planning values throughout the year.

3. How is the performance data used? We look for innovations, changes in technology to help be more efficient, we have an incentive program that returns savings to employee paychecks for improvements in performance.

4. Is a presentation made to the legislature relating performance data to funding levels? If so, how effective has the presentation been? (Have they resulted in increased funding?) We are required to make an annual report to the legislature on our condition measurements. If the legislature has given us funding to improve the condition of the highway system, we give target conditions and allocated funding at the start and report the results of the funding the following year.
Customer Surveys

1. Do you perform public surveys specifically related to maintenance? Yes

2. How are the surveys conducted? How frequently are surveys conducted? As part of our maintenance incentive program, each maintenance unit is required to survey their customers on a monthly basis. Positive ratings increase the employee incentive pay. Every three years we conduct a statewide performance survey on the condition of the highway system. We report this information to the legislature and use the public and our annual condition ratings to establish target areas for maintenance.

3. Is the data used to set maintenance program goals or performance targets? Yes

C. Maintenance Training

1. Do you have a formal training program for maintenance employees? We do not have a separate maintenance training program.

2. If yes, briefly describe it in general. Is it mandatory? Who pays for it? What is the focus? We have some classes for equipment operator training and classes for the maintenance management system components. We are initiating a new safety program. They are not mandatory. Training is by train the trainer personnel from maintenance.

3. How effective has training been? How is training effectiveness measured? We have not measured the effectiveness.

D. Methods Engineering

1. Do you have in-house staff devoted to developing and improving maintenance processes, procedures, and materials? Yes

2. If yes, describe how the staff identifies issues for research (e.g. concerns from field staff, periodic review of costliest process and materials, etc.) We have several approaches. The SPR, federal funding for research is utilized by maintenance for some projects. The Central Maintenance Group has a planning section that works to improve the technology of the maintenance management systems. The District Maintenance Engineers and Superintendents have formed a group called the MSLT (Maintenance Servant Leadership Team) to assist the maintenance personnel in performing their duties. The MSLT meets every other month and tackles issues from pay and training to the type of materials used and the equipment necessary to perform the work.
E. Maintenance Methods Technology Transfer

1. Do you have a formal process for maintenance technology transfer? Yes

2. If yes, briefly describe it in general. How is information transferred? How is it requested? Attendance at AASHTO and WASHTO maintenance committee meetings. Annual meetings with adjacent state maintenance personnel. Semi-annual state maintenance conference. MSLT meetings. Central maintenance training and site visits.

F. Other Maintenance Issues

1. Is vegetation maintenance handled in house or contracted out? If in house, is vegetation maintenance centralized or decentralized? If decentralized, does each district have a special vegetation crew, or is the work done by maintenance technicians? In house. Decentralized into four regions reporting to a headquarters office. All regional managers and 50% of the vegetation techs are college graduates with degrees in vegetation related subjects.

2. What are the three or four major statewide issues related to vegetation maintenance? Budget, noxious weeds, encroachment of vegetation, chemically sensitive public.

3. Is the management of maintenance facilities (buildings) centralized or decentralized? This is not a maintenance function. There is a separate facilities management section in the department.

4. Is the budget for building maintenance separate from highway maintenance? How are budgets for building apportioned, by identified needs, historical percent to each district, condition assessment, other? Separate.
Survey of State Agency Highway Maintenance
Best Practices

Date       Frank Day
State      Florida
Contact Person       Frank Day
Title       Bridge Engineer
Telephone       850.488-8815

A. Planning & Budgeting

1. Do you set long term (more than 2 years) targets or goals for maintenance? If the answer is yes, describe how the targets or goals are identified or measured? Yes, Goals are established and measured using a Maintenance Rating Program (MRP).

2. Are the target goals used to determine maintenance needs for the short term (1-2 year) budget process? If so, who sets the goals? Yes. Recommended by the State Maintenance Office and approved by the Executive committee.

3. Do you use lifecycle cost analysis for any maintenance planning or budget strategies? No

4. Do you use maintenance priorities for any maintenance planning or budget strategies? Yes, Activities that relate to safety have higher priority

5. Briefly describe your budget process. Who identifies the initial budget, and who has the authority to establish the final budget. Is the budget based on historical expenditures, inventory, performance goals, life cycle cost analysis, other criteria, or a combination? If a combination is used, please identify each criteria. The initial budget is prepared by the State Maintenance Offices and is approved by the Executive Committee. The budget is based on historical expenditures, inventory and performance goals.

B. Asset Management

Feature Inventory

1. Does your department currently have an inventory of maintainable features that is accurate? yes
2. Who is responsible for maintaining the inventory? Who is responsible updating the inventory? How frequently is it updated? What system of referencing is used to locate features? Districts maintain and update the inventory. It is updated as needed. Mileposts are used to locate features.

3. Is the inventory used as a basis for planning and/or budgeting? If so, how? Maintenance has a zero base budget. Inventories are multiplied by unit costs for activities.

**Maintenance Performance Measurement**

(Maintenance Management Quality Assurance)

1. Do you have a system to measure performance or outcomes of the maintenance program? Yes

2. If yes, briefly describe the process. How many measures are used? How are measurements made? How often are measurements made? The MRP is used to measure the actual maintenance condition of numerous highway features. This is a complex process, call for more details.

3. How is the performance data used? Budgeting and field operational decisions

4. Is a presentation made to the legislature relating performance data to funding levels? If so, how effective has the presentation been? (Have they resulted in increased funding?) Yes. Very effective, funding levels have increased dramatically.

C. Customer Surveys

1. Do you perform public surveys specifically related to maintenance? Yes, A broad range of questions are asked and some of these are specific to maintenance.

2. How are the surveys conducted? How frequently are surveys conducted? Conducted by consultants each year.

3. Is the data used to set maintenance program goals or performance targets? Somewhat, we are only in our second year.

D. Maintenance Training

1. Do you have a formal training program for maintenance employees? All training is formal, but there is no formal program specifically for maintenance.

2. If yes, briefly describe it in general. Is it mandatory? Who pays for it? What is the focus? Some training is mandatory, the majority is on an as needed basis.

3. How effective has training been? How is training effectiveness measured? Difficult to measure. Effectiveness is not measured.
E. Methods Engineering

1. Do you have in-house staff devoted to developing and improving maintenance processes, procedures, and materials? This defines the responsibilities of the Central Maintenance Office.

2. If yes, describe how the staff identifies issues for research (e.g. concerns from field staff, periodic review of costliest process and materials, etc.) Detailed field reviews are performed annually in each District(8). Findings determine future actions.

F. Maintenance Methods Technology Transfer

1. Do you have a formal process for maintenance technology transfer? yes

2. If yes, briefly describe it in general. How is information transferred? How is it requested? An annual meeting is held and innovative methods/processes are presented to all maintenance managers.

G. Other Maintenance Issues

1. Is vegetation maintenance handled in house or contracted out? If in house, is vegetation maintenance centralized or decentralized? If decentralized, does each district have a special vegetation crew, or is the work done by maintenance technicians? 20 percent in-house, 80 percent contracted out, All in-house is performed by maintenance technicians.

2. What are the three or four major statewide issues related to vegetation maintenance? Is the management of maintenance facilities (buildings) centralized or decentralized? Major vegetation management issues are; 1. control of invasive species, 2. herbicide reduction, 3. tree rimming in urban areas. Management of buildings is a de-centralized function.

3. Is the budget for building maintenance separate from highway maintenance? How are budgets for building apportioned, by identified needs, historical percent to each district, condition assessment, other? Major repairs are separate from the maintenance budget and budget is generated base on actual need. Minor repairs are based on historical needs.
Survey of State Agency Highway Maintenance Best Practices

Date __May 24, 2002______________________________

State __Kansas______________________________

Contact Person __Dean Testa__ __Jaci Vogel______________________________

Title __Bureau Chief of Construction/Maintenance______________________________

Telephone __(785) 296-3576______________________________

A. Planning & Budgeting

1. Do you set long-term (more than two years) targets or goals for maintenance? If the answer is yes, describe how the targets or goals are identified or measured?

In our pavement management system, goals are set for desired pavement conditions of our highway system. These are measured annually through the PMS condition assessment surveys.

In our Maintenance Quality Assurance Program, goals are set for desired levels of service for various highway elements. These are measured bi-annually through the Maintenance Quality Assurance inspections. (see section 2.)

2. Are the target goals used to determine maintenance needs for the short-term (1-2 year) budget process? If so, who sets the goals?

The PMS goals assist in determining pavement preservation needs in the short term, however, they do not contribute to the budget process. The PMS goals are set by executive management.

3. Do you use lifecycle cost analysis for any maintenance planning or budget strategies?

No.

4. Do you use maintenance priorities for any maintenance planning or budget strategies?

Yes. As part of our highway maintenance management system, maintenance activity priorities are identified and are used in work planning.

5. Briefly describe your budget process. Who identifies the initial budget, and who has the authority to establish the final budget. Is the budget based on historical
expenditures, inventory, performance goals, life cycle cost analysis, other criteria, or a combination? If a combination is used, please identify each criteria.

Our budget is based on historical expenditures. The initial budget is identified by each bureau/department and the final authority is the Secretary of the Department of Transportation.

B. Asset Management

Feature Inventory

1. Does your department currently have an inventory of maintainable features that is accurate?

KDOT has a highway features inventory that is only current for lane miles.

2. Who is responsible for maintaining the inventory? Who is responsible updating the inventory? How frequently is it updated? What system of referencing is used to locate features?

The features inventory is maintained by a management systems analyst out of the headquarters maintenance department. The features inventory is updated by each district office. The lane miles are updated most frequently. This occurs whenever there is a change in the lane miles. The referencing system to locate the features is route-county-reference post.

3. Is the inventory used as a basis for planning and/or budgeting? If so, how?

The lane miles from the features inventory are used as a basis for planning the number of dump trucks and maintenance personnel necessary at each maintenance garage.

Maintenance Performance Measurement
(Maintenance Management Quality Assurance)

1. Do you have a system to measure performance or outcomes of the maintenance program?

Yes.

2. If yes, briefly describe the process. How many measures are used? How are measurements made? How often are measurements made?

Thirty randomly selected 0.1 mile segments are selected for each of our 112 subareas. Thirty one highway elements, grouped into five categories, are inspected as to whether they meet or fail a prescribed conditions. Based on the inspection results, a level of service is calculated for each element as well as each category. The calculated level of
service is summarized at the subarea, area, district and statewide level. Inspection is performed bi-annually – spring and fall.

3. How is the performance data used?

The performance data is used informally by all levels of maintenance personnel to assist in the planning, scheduling, and decision making.

4. Is a presentation made to the legislature relating performance data to funding levels? If so, how effective has the presentation been? (Have they resulted in increased funding?)

No.

Customer Surveys

1. Do you perform public surveys specifically related to maintenance?

The KDOT’s public surveys include questions specifically related to maintenance.

2. How are the surveys conducted? How frequently are surveys conducted?

A consultant performs the survey through telephone interviews. The surveys are conducted every two-years.

3. Is the data used to set maintenance program goals or performance targets?

To date, the data has only reconfirmed the agency has set the correct program goals and priorities.

C. Maintenance Training

1. Do you have a formal training program for maintenance employees?

Yes, a formal training program for the equipment operators.

2. If yes, briefly describe it in general. Is it mandatory? Who pays for it? What is the focus?

It is on the job training in various areas of highway maintenance and includes a written test as well as demonstration of skills. Satisfactory completion of both the test and the skills are necessary before promotion from an equipment operator trainee to an equipment operator classification. The training is all done in-house at their assigned job location.

3. How effective has training been? How is training effectiveness measured?
It has been effective to date and is measured through skill assessment. The program is currently under development for expansion to experienced equipment operators. This will allow a career path into eventual lead worker and supervisory positions.

D. Methods Engineering

1. Do you have in-house staff devoted to developing and improving maintenance processes, procedures, and materials?

No staff is devoted, but continual development and improvement of maintenance processes, procedures, and materials are incorporated by maintenance staff as part of their position.

2. If yes, describe how the staff identifies issues for research (e.g. concerns from field staff, periodic review of costliest process and materials, etc.)

By keeping abreast of what other DOT maintenance departments are doing, what new items are available by vendors, feedback from field staff, and periodic self assessment of the maintenance department.

E. Maintenance Methods Technology Transfer

1. Do you have a formal process for maintenance technology transfer?

No

2. If yes, briefly describe it in general. How is information transferred? How is it requested?

F. Other Maintenance Issues

1. Is vegetation maintenance handled in house or contracted out? If in house, is vegetation maintenance centralized or decentralized? If decentralized, does each district have a special vegetation crew, or is the work done by maintenance technicians?

Vegetation maintenance is decentralized and is handled both in house and contracted out, depending upon the location. The predominant vegetation maintenance contracted out is the noxious weed spraying although there is locations of contracted mowing as well.

2. What are the three or four major statewide issues related to vegetation maintenance?

One issue is the coordination between the DOT mowing policy and the Audubon Society preferences in protecting wildlife habitat. As well, an issue of the coordination between the DOT mowing policy and the highway beautification of planting wildflowers in the right of way.
3. Is the management of maintenance facilities (buildings) centralized or decentralized?

Management of maintenance facilities is centralized, however, each district manages the small repair and maintenance necessary for the facilities.

4. Is the budget for building maintenance separate from highway maintenance? How are budgets for building apportioned, by identified needs, historical percent to each district, condition assessment, other?

Yes, both the building maintenance and the building capital improvement funding are separate from highway funding. Budget apportionment for building capital improvements is a combination of identified desires from the field, a facility assessment, and preservation needs.

Additionally, the building maintenance apportionment is a percentage to each district based on the number of buildings in their district.
Survey of State Agency Highway Maintenance Best Practices

Date: May 23, 2002
State: Minnesota
Contact Person: James A. Lilly
Title: Assistant State Maintenance Engineer
Telephone: 651/296-3513

A. Planning & Budgeting

1. Do you set long term (more than two years) targets or goals for maintenance? If the answer is yes, describe how the targets or goals are identified or measured?

Yes, We have a set of Business Indicator Performance measures and targets, which include Snow and Ice event recovery times and signing and striping replacement schedules. We are currently working on measures and targets for issuing access permits and short distance road smoothness.

Measures and targets are set with an iterative process of customer focus groups and surveys. This started in 1994 with a determination of customer identifiable outcomes. It progressed to developing measures to assess our performance against those outcomes and then customer surveys to determine appropriate targets.

We have now progressed to setting multiyear targets for Snow and Ice regain times and are attempting to connect that with our funding requests.

2. Are the target goals used to determine maintenance needs for the short term (1-2 year) budget process? If so, who sets the goals?

Yes, We are beginning to tie our work planning to our budget by using Activity Based Budgeting (ABB). We have done a historic evaluation using ABB and are attempting to construct an actual ABB for the next fiscal years budget and to prepare a biennium budget request for legislature next year. This is all very new.

The targets are approved by our executive management team, but assembled by the district maintenance engineers with Central Office Staff support. We have an active group of Maintenance Engineers on the Maintenance Business Management Team.
(MBMT) that represent each of the districts and Central Office, which oversees these activities.

3. Do you use lifecycle cost analysis for any maintenance planning or budget strategies?
   
   No, not formally

4. Do you use maintenance priorities for any maintenance planning or budget strategies?
   
   Yes, Maintenance Planning is done based on District priorities and budgets. Via the ABB process, we expect to be able to roll these up to a department budget proposal and to distribute appropriate monies in return.

5. Briefly describe your budget process. Who identifies the initial budget, and who has the authority to establish the final budget. Is the budget based on historical expenditures, inventory, performance goals, life cycle cost analysis, other criteria, or a combination? If a combination is used, please identify each criteria.

   The budget process is undergoing a significant modification from a traditional process to ABB. However, in both processes proposed budgets will roll up to higher level. The Department’s executive and financial teams issue basic guidelines to districts and specialty offices, which use them to work from the last “historical” base budget to generate a requested budget for the next year or biennium. The Department’s executive and financial teams establish the department’s budget proposal which they take to the Governor’s office. The Governor’s staff working with the different commissioners sets the final budget request to go to the legislature.

B. Asset Management

Feature Inventory

1. Does your department currently have an inventory of maintainable features that is accurate?

   It has a GASB-34 compliant inventory of all parts of the infrastructure. An inventory of other features such as signs, striping, small diameter culverts exists to various degrees in each district. Accuracy of the miscellaneous inventories varies by locations.

2. Who is responsible for maintaining the inventory? Who is responsible updating the inventory? How frequently is it updated? What system of referencing is used to locate features?

   The GASB-34 inventory is the responsibility of the Office of Finance. Minor inventory items are the discretionary responsibilities of the districts and maintenance areas.

3. Is the inventory used as a basis for planning and/or budgeting? If so, how?
Maintenance Performance Measurement  
(Maintenance Management Quality Assurance)

1. Do you have a system to measure performance or outcomes of the maintenance program? Yes

2. If yes, briefly describe the process. How many measures are used? How are measurements made? How often are measurements made?

The process begins with the Maintenance Business Management Team (MBMT) which consists of one Maintenance Engineer from each district, the State Maintenance and Assistant State Maintenance Engineers. The MBMT meets three to six times a year to establish measures and targets, to review performance and to recommend improvements.

Within the last two years the department has added a small staff of technical experts to develop and implement measures and targets in all areas of the Department. This staff works with us to make sure the Maintenance Measures meet Department requirements.

We have a fairly well refined set of measures for snow and ice removal, sign replacement and striping replacement (3 total). We are still in the process of developing measures for issuance of access permits and roadway maintenance (2 total).

Data is collected for our Maintenance Performance Business Indicators every two weeks. Monthly reports are made on our Snow and Ice Performance Measure. Annual reports are made on this, the sign replacement and striping replacement measures to Department executive management.

3. How is the performance data used?

District Engineers are held accountable for their performance against these three annual measures by our Senior Management Team (SMT) which consists of the Chief Engineer and his immediate staff.

The monthly measures are used at the Group, Division and district levels.

4. Is a presentation made to the legislature relating performance data to funding levels? If so, how effective has the presentation been? (Have they resulted in increased funding?)

Not to date.
Customer Surveys

1. Do you perform public surveys specifically related to maintenance?

   Yes, we have performed biennial maintenance market research surveys since 1996. Starting in 2001, we will be conducting these annually as part of the Transportation Omnibus Survey.

2. How are the surveys conducted? How frequently are surveys conducted?

   We have two in-house market researchers who direct the selection of market research consulting firms, organize the preparation of the research and assist in the revaluation of the results. These surveys are now performed annually.

3. Is the data used to set maintenance program goals or performance targets?

   Our early market research surveys were used to determine customer perceived outcomes. The following surveys were used to refine and verify our measures and most recently our targets.

   Some of the first surveys were used to alter both our winter and summer maintenance operations. In particular we changed our mowing procedures and our start times for snow plow operations based on market research.

C. Maintenance Training

1. Do you have a formal training program for maintenance employees?

   Several Districts and our Metro Division have formal training programs for Maintenance workers. The Department is in the process of unifying these and developing a statewide program. Our target date is September 2002 for the first Winter Maintenance Training Program.

2. If yes, briefly describe it in general. Is it mandatory? Who pays for it? What is the focus?

   Individual districts have made it mandatory. Each District currently pays for their own training. The focus has been on Snow Plow operations. Our Metro Division has a summer maintenance training program as well.

   The Unified Department’s training will have the same prioritization, Snow Plow Operation first, then Summer Maintenance. Currently we have a lot of mobility into the Plow Operations and have the greatest need there.

3. How effective has training been? How is training effectiveness measured?

   The current pilot programs have been very successful and effective. Measurement is by a competency evaluation of new operators and the number of new drivers trained.
D. Methods Engineering

1. Do you have in-house staff devoted to developing and improving maintenance processes, procedures, and materials?

   Yes, we have one staff member whose job is focused on improving business processes. We have three additional positions dedicated to researching, testing and implementing improvements in processes, procedures and materials.

2. If yes, describe how the staff identifies issues for research (e.g. concerns from field staff, periodic review of costliest process and materials, etc.)

   We have set aside $360,000 annually to fund three positions and projects. Candidate projects are proposed by field and office maintenance personnel to a Maintenance Operations Research Engineer (MORE). The request is for funding for local testing or field implementation. The MORE approves or rejects smaller projects (up to $12,000). Larger projects are screened and brought before a New Technologies Research Evaluation Committee (NTREC), which meets, reviews and decides on funding proposals two or three times per year.

   The three staff members follow these projects, assist in writing evaluation reports and then disseminate the results.

E. Maintenance Methods Technology Transfer

1. Do you have a formal process for maintenance technology transfer? Yes

2. If yes, briefly describe it in general. How is information transferred? How is it requested?

   Our formal process is integrative with our Methods Engineering and has been described in that section (D.)

F. Other Maintenance Issues

1. Is vegetation maintenance handled in house or contracted out? If in house, is vegetation maintenance centralized or decentralized? If decentralized, does each district have a special vegetation crew, or is the work done by maintenance technicians?

   It is Decentralized, each district handles their own program. All have special vegetation crews. Some contract part of the work out.

2. What are the three or four major statewide issues related to vegetation maintenance?

   Estimating the amount of noxious weeds to be removed.
Handling budget restrictions

Chemical selection by evaluating environmental and health concerns.

3. Is the management of maintenance facilities (buildings) centralized or decentralized?

Actual maintenance of facilities is decentralized, but there are technical areas that have centralized support, such as maintenance management systems, which includes standards development, audit and inspections, building and project design, plans, specifications and regulatory requirements.

4. Is the budget for building maintenance separate from highway maintenance? How are budgets for building apportioned, by identified needs, historical percent to each district, condition assessment, other?

Yes, facilities maintenance dollars for all MnDOT facilities are separate from highway maintenance funds.

Facilities maintenance dollars are appropriated annually from the Trunk Highway Fund based on State Statute requiring a minimum of 2% of the Agency facility replacement cost be available for facility maintenance. These funds are then apportioned by square foot based on a Building Complexity Factor, (the actual difficulty of the facility maintained. ie. Headquarters Buildings, office space is weighted at 1, vehicle maintenance bays are weighted at 2, Weight Scales at 5, etc. Multiply the Actual Square Footage X the Building Complexity Factor = Adjusted Square Footage).

These funds cover all facility maintenance except the following:

- Funds retained at the Central Office for contingency purposes, other requirements not District responsibilities, and for shared expenses. (Re-Roofing 75% Central Office, 25% District funds, HVAC 80%-20%, Sanitary Sewer 75%-25%).

- Items needed for day to day routine building maintenance. Funds for these functions are from the District Operating Budget.

- Furniture, Carpeting items, from the District Operating Budget.

- Maintenance items with a unit cost of less than $3000 should not be purchased from this program unless they are included in a once-a-year annual contract, or lumped as multiples to exceed the $3000 minimum.

A Facilities Assessment has been recently implemented which helps determine major maintenance requirements and capital replacement priorities.
Virginia DOT’s Response to
Survey of State Agency Highway Maintenance Best Practices

Date: June 24, 2002

State: Virginia DOT

Contact Person: Bob Kardian

Title: Special Studies Engineer

Telephone: 804-786-2849

A. Planning & Budgeting

1. Do you set long term (more than 2 years) targets or goals for maintenance? If the answer is yes, describe how the targets or goals are identified or measured?

   Yes. Our maintenance rest area program is budgeted on a six year cycle. A list of priorities consider the following goals to meet increasing customer expectations: federal guidelines for parking, utility availability, AASHTO guidelines that facilities be located within a one-hour drive, and land availability to provide all designated, approved services. Actual rest area maintenance is outsourced with six 10-year contracts covering the entire state. The contracts specify performance criteria re minimum standards governing mowing, rest area cleaning, garbage removal, litter pick up, and so forth.

2. Are the target goals used to determine maintenance needs for the short term (1-2 year) budget process? If so, who sets the goals? Yes, but short-term maintenance involves a different set of goals based on preventive, restorative, and operational maintenance. Field units informally use a “Levels-of-Service for Maintenance Conditions” document that identifies criteria thresholds for current maintenance conditions (e.g., cracking, raveling or rutting in more than 10% of the pavement area), which is generally used for budgeting. VDOT has successfully completed a formal process for three counties in which inventory is obtained and maintenance condition assessments are calculated. Full implementation of this formal process (Inventory and Condition Assessment System) is expected for FY2004.

3. Do you use lifecycle cost analysis for any maintenance planning or budget strategies? Yes. LCCA procedures are used for pavements. Average service life is 10 years with the inclusion of Superpave™, the discount rate is 4%, and the salvage
value on 30-year analysis periods was determined by assigning a percentage to the original construction cost.

4. Do you use maintenance priorities for any maintenance planning or budget strategies? Yes. Pavement priorities are based on IRI ratings and bridge priorities are based on VDOT’s deficiency ratings and FHWA’s general condition ratings and sufficiency ratings. Other maintenance assets such as traffic services, roadside, drainage, etc. have maintenance level of service thresholds, which are embedded in our Inventory & Condition Assessment System (ICAS), which will be fully implemented in FY 2004.

5. Briefly describe your budget process. Who identifies the initial budget, and who has the authority to establish the final budget. Is the budget based on historical expenditures, inventory, performance goals, life cycle cost analysis, other criteria, or a combination? If a combination is used, please identify each criteria. Budget appropriations are approved by the legislature, which are subdivided into a Maintenance and Operations allocation. All District Maintenance Engineers and Central Office Program Managers identify maintenance needs. Central Office’s Maintenance Division then lists preliminary annual and biennial maintenance budgets for each district for discussion and approval by the Maintenance Program Leadership Group (MPLG). The MPLG, a statewide committee, makes final approval of district maintenance allocation based on established maintenance needs and approved allocations. Supplemental funding requests are ranked according to specific program criteria (mandates, impact on foundation budget, strategic direction, life cycle costs, and consistent levels-of-service). See additional information in the attached three documents “Budget Development Process” and “Biennium Budget Flowcharts” [2].

B. Asset Management

Feature Inventory

1. Does your department currently have an inventory of maintainable features that is accurate? Not at the present time. Full implementation of ICAS (see above) is expected for FY 2004.

2. Who is responsible for maintaining the inventory? Who is responsible updating the inventory? What system of referencing is used to locate features? The Central Office, Districts and Residencies are responsible for maintaining inventory based on asset type. For example, Central Office maintains inventories for rest areas, Districts for bridges and Interstate signs, and Residencies most other assets. Updates vary based on asset type. Referencing systems also vary from computer-based Access databases to local managed systems by field units. One of the overall purposes of the Department’s ICAS is to standardize reference systems.
4. **Is the inventory used as a basis for planning and/or budgeting? If so, how?** Some inventory is used for budgeting purpose such as highway signs, which have replacement cycles based on types of sheeting (one example is every 15 years). Most repairs and replacements of inventory is performed based on established maintenance levels-of-service, as explained in answers to questions #2 and #4.

**Maintenance Performance Measurement (Maintenance Management Quality Assurance)**

5. **Do you have a system to measure performance or outcomes of the maintenance program?** Yes, pavements and bridges are based on performance measures. Eventually, ICAS will join PMS and BMS to unify the state’s inventory and assessment systems. VDOT’s maintenance asset performances and outcomes are under the auspices of our Asset Management Program.

6. **If yes, briefly describe the process.** How many measures are used? How are measurements made? How often are measurements made? For example, 70% of statewide bridges should have a general condition rating of 6 or better. Please contact Mr. Jim Keck, Asset Management Director, at 804-371-2978 for further information.

7. **How is the performance data used?** Please contact Mr. Jim Keck, Asset Management Director, at 804-371-2978 for further information.

8. **Is a presentation made to the legislature relating performance data to funding levels? If so, how effective has the presentation been?** (Have they resulted in increased funding?) Although not at this time, it is expected that presentations will be made to the legislature once all of the projects under our Asset Management Program are in full implementation. VDOT’s Asset Management is working towards a program whereby different funding levels for various condition levels can be readily shown and appropriate decisions made for various assets. For example, x dollars will maintain assets at 80%; x + y will maintain assets at 85%; x – z will maintain assets at 75%. Our original condition assessment system was based on a legislative mandate in 1988. This system has evolved into our current ICAS, which is expected to be operational in FY 2004.

**C. Customer Surveys**

1. **Do you perform public surveys specifically related to maintenance?** Yes.

2. **How are the surveys conducted? How frequently are surveys conducted?** Focus groups, telephone surveys, mail surveys, web/Internet surveys. Two to 5 years.

3. **Is the data used to set maintenance program goals or performance targets?** Survey data will be an integral part of the total package whereby performance targets and outcomes will be approved, measured, monitored, and reported.
D. Maintenance Training

1. Do you have a formal training program for maintenance employees? Yes. Two avenues: VDOT’s Maintenance Division Training Academy and VDOT’s Human Resources Division.

2. If yes, briefly describe it in general. Is it mandatory? Who pays for it? What is the focus? VDOT instituted a formal Maintenance Training Academy about 10 years ago, which develops a learning system to help the field meet its needs. Primarily, this system helps the field achieve a multi-skilled workforce by empowering field personnel to create and implement some of their own training and development needs. The Academy has also developed a series of training manuals on a number of topics for use in the field. In addition, they are developing training for field personnel on what the new Asset Management Program is and how it will work.

The HR Division is responsible for conducting development, safety and technical courses for all of VDOT’s employees, including specific courses directed to maintenance personnel. Examples of HR maintenance courses include bridge tunnel fire training, cold weather indoctrination, and ferry boat seamanship, steering, and onboard emergencies.

Some courses are mandatory. Generally, funding for the Training Academy is budgeted from the Maintenance Program and funding for HR courses is paid by HR division.

3. How effective has training been? How is training effectiveness measured? As always, effectiveness is only as good as the participant’s attitude. Generally, effectiveness is good based on employee’s subsequent job performance and increased understanding of processes. Mandatory courses such as ferry boat operations are very effective because employment depends upon effective deliverance of job skills and abilities.

E. Methods Engineering

1. Do you have in-house staff devoted to developing and improving maintenance processes, procedures, and materials? VDOT has two in-house programs that are geared to continuous improvements in not only maintenance areas, but in all areas: the Ideas at Work Program, administered by the HR Division, and the Maintenance Operations Research Program, administered by the Maintenance Training Academy.

2. If yes, describe how the staff identifies issues for research (e.g. concerns from field staff, periodic review of costliest process and materials, etc.)

   - Ideas at Work Program. Ideas generated independently from employees that will increase productivity, reduce costs, promote safer working conditions,
conserve resources, or improve public services. Ideas are submitted to the Human Resources Division who forwards ideas to respective divisions for comments and recommendations. HR will process the ideas and, if implemented, the employee could receive an award. Awards vary from days of leave, cash, and certificates of recognition.

- Maintenance Operations Research (MOR) Program. This program provides funding and assistance for innovations relating to the field operations. MOR covers winter maintenance, road and bridge maintenance, operations maintenance, general maintenance, and work zone safety. Funding based on formulas.

F. Maintenance Methods Technology Transfer

1. Do you have a formal process for maintenance technology transfer? Yes. VDOT has an established Virginia Transportation Research Council, located in Charlottesville, Virginia, who is a recognized national leader in T². Two of its Research Scientists are primarily assigned to maintenance.

2. If yes, briefly describe it in general. How is information transferred? How is it requested? The mission objectives of the VTRC are to:

- Promote excellence in transportation through objective research and superior technical services.
- Respond to the needs of our clients and sponsors in a timely, cost-effective manner by focusing on:
  - Improving transportation safety
  - Building and maintaining a better transportation infrastructure
  - Making the transportation system operate more efficiently and effectively
  - Introducing new technologies into practice
  - Advancing the state-of-the-art in transportation
  - Assessing the social and environmental impacts of transportation
  - Providing a high return on the investment in the Research Council.
- Develop and maintain a highly skilled and nationally recognized staff.
- Contribute to the development of current and future transportation professionals through education and training programs.

Results of research studies are formally published in TRB, NCHRP, or AASHTO reports as well as in internal VDOT publications, which are distributed widely throughout the Department. Most research studies are based on formal planning (PL) or highway planning and research (HPR) projects, and funded accordingly. Individual VDOT divisions, districts, or residencies through informal processes such as e-mail or memoranda can also request special, ad hoc studies.
G. Other Maintenance Issues

1. Is vegetation maintenance handled in house or contracted out? If in house, is vegetation maintenance centralized or decentralized? If decentralized, does each district have a special vegetation crew, or is the work done by maintenance technicians? Vegetation maintenance is handled both in-house and outsourced. In-house operations are generally decentralized and managed by Residency maintenance crews or District Environment Managers and their crews depending on the actual maintenance activity. For example, mowing is handled by local maintenance crews or outsourced while herbicide spraying is performed by district environmental crews or outsourced. Maintenance and Environmental Divisions centrally approve policies. Each of VDOT’s nine districts has a special environmental crew who handles environmental issues governing maintenance. In addition, each of VDOT’s 45 local residencies has several maintenance area headquarters that perform routine maintenance on vegetation control. Contracts are generally decentralized with assistance from Central Office Divisions.

2. What are the 3 or 4 major statewide issues related to vegetation maintenance?
   - Erosion control and sedimentation
   - Beaver damage
   - Sight distance (vegetation covering signs or hiding intersections)
   - Environmental factors governing herbicide spraying

3. Is the management of maintenance facilities (buildings) centralized or decentralized? Both centralized or decentralized depending on type of maintenance. New construction of buildings or major building repairs (> $10,000) is handled centrally through VDOT’s Capital Outlay Program. Routine maintenance and minor building repairs (< $10,000) are handled locally by VDOT’s area headquarters’ Physical Plant budgets (maintenance funding).

4. Is the budget for building maintenance separate from highway maintenance? How are budgets for building apportioned, by identified needs, historical percent to each district, condition assessment, other? Depends on whether building repairs > <$10,000. Physical plant (PP) budgets are based on total square footage in building inventory: $1.15/SF. Based on a consultant report, physical plant needs should be in the area of $1.65/SF. VDOT District Maintenance Engineers are trying to increase the PP budgets.
VDOT’s Maintenance Program

(a) Budget Development Process

March, odd year Each District Maintenance Engineer (DME) and Program Managers in the Maintenance Division identifies needs for the next biennium above their current level of funding. Requests are forwarded to the Central Office where the Decision Support and Policy Analysis Section compiles all requests and calculates the dollar amount. Central Office Program Managers can also make requests for maintenance related activities that they are responsible for. This includes the Bridge Safety Inspection and Underwater Bridge Inspection Programs managed by the Bridge Division, the Wetland Mitigation Program managed by the Environmental Division, and possibly some Traffic Engineering studies or initiatives that are directly maintenance related. All of these items would be funded by the Highway Maintenance Program (6040000).

April Maintenance staff compiles the biennial additional needs list and combines similar requests to simplify the review process for MPLG members. The MPLG begins to prioritize needs via a criteria rating system. The status of the additional needs list is discussed at the April meeting where the group begins to prioritize and (probably) reduce the list.

May The Decision Support and Program Analysis staff develops a tentative lump sum Biennial Budget request based on input and feed-back provided by the MPLG. Requested research is done by Maintenance staff, and if necessary, Program Managers are invited to the monthly meeting for further discussion of centralized items on the additional needs list.

June Maintenance staff presents the final version of the MPLG Additional Needs list, or discussion continues with DMEs and/or program managers regarding specifics of the requests. Often, alternative funding schemes are suggested for discussion and possible approval by the group.

July-August Further discussion may be needed to respond to issues or concerns raised by the MPLG, Maintenance Staff or Program Managers. Once all concerns are addressed, the MPLG approves a list of initiatives with a dollar value associated with each initiative. The proposal then goes on the agenda for the next Executive Committee Meeting for approval.

Late Sept.-Mid Oct. The approved list of Maintenance Program initiatives becomes a part of the Biennial Budget proposal that VDOT submits to the Department of Planning and Budget. Financial Planning and Debt Management assembles the agency package, and assigns the priority number for the program. This, along with other initiatives submitted for the department becomes a part of the state’s Biennial Budget proposal after Planning and Budget approval.
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<td>December</td>
<td>The governor presents his Biennial Budget to the Commonwealth.</td>
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<td>January</td>
<td>General Assembly Session begins.</td>
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<tr>
<td>April</td>
<td>General Assembly Session ends. If the budget is approved as submitted, the request for additional funds becomes a part of the Maintenance Program for the upcoming biennium. It is identified as supplemental funding on the MPLG report. It is added to the current biennial budget amount and this is the district’s new lump sum to be distributed.</td>
</tr>
<tr>
<td>May</td>
<td>Prior to the start of the biennium, budget allocations are loaded into the FMSII system. District funds are assigned to account codes as well as asset categories.</td>
</tr>
<tr>
<td>July 1, even year</td>
<td>This marks the start of a new biennium and fiscal year.</td>
</tr>
</tbody>
</table>
VDOT’s MAINTENANCE PROGRAM
FY 2002 – 2004 BIENNIUM BUDGET

November 2000
- Develop Decision Package for Maintenance Program
  - Base Appropriation: $847,939,000
  - Identify Stakeholders: Structure & Bridge, Environmental, Traffic Engineering, ITS, MPLG, Others?
  - Previously Funded Requirements Documented
  - New Requirements Submitted
  - Priorities Determined

April 2001
- Virginia Dept of Planning and Budget Issues Instructions
- Maintenance Decision Package Formatted According to Instructions
- Approvals Obtained: MPLG, Assistant Commissioner, Executive Team
  - Revisions?

September 2001
- Decision Package Due – Virginia Dept of Planning and Budget
- Included in Governor’s Budget

January – March 2002
- General Assembly Session to Consider FY 2002 – 2004 Biennium Budget
VDOT
FY 2002-2004 Biennium Additional Needs Request Flowchart

Maintenance Program Leadership Group (MPLG)

Structure & Bridge

Traffic Engineering

Environmental

ITS

Nine Districts

Central Office Programs

Maintenance Division's Decision Support & Policy Analysis (DS&PA) Section:
compilation of data

MPLG: review and approval

DS&PA: final preparation

Financial Planning & Debt Management Division

Virginia Department of Planning & Budget

Note: For additional information on VDOT's budgetary processes, please contact Mr. Dan Hinderliter, Decision Support & Policy Analysis Manager, at 804-786-3070.
Survey of State Agency Highway Maintenance Best Practices

Date  June 6, 2002
State  Washington
Contact Person  Rico Baroga
Title  Maintenance Accountability Process Manager
Telephone  (360)705-4448

A. Planning & Budgeting

1. Do you set long term (more than 2 years) targets or goals for maintenance? If the answer is yes, describe how the targets or goals are identified or measured? No. Level of Service (LOS) targets or goals are set every two years when our biennial budget is provided by the state legislature.

2. Are the target goals used to determine maintenance needs for the short term (1-2 year) budget process? If so, who sets the goals? Yes. Goals are established through a collaborative process involving maintenance managers, agency executive management, and the transportation committee of the state legislature.

3. Do you use lifecycle cost analysis for any maintenance planning or budget strategies? We use this approach on a limited basis. For example, we recently replaced incandescent light bulbs with LED units in our traffic signals. While the purchase price of LED units is greater than incandescent bulbs, a lifecycle cost analysis shows the LED units to be preferable.

4. Do you use maintenance priorities for any maintenance planning or budget strategies? Yes. All major maintenance activities are prioritized based on their contribution to meeting program goals (i.e. provide safety, operate system reliably). When there are budget reduction or budget increases, the priority ranking is used to help determine which activity funding level (and resultant LOS) should be changed.

5. Briefly describe your budget process. Who identifies the initial budget, and who has the authority to establish the final budget. Is the budget based on historical expenditures, inventory, performance goals, life cycle cost analysis, other criteria, or
a combination? If a combination is used, please identify each criteria. A total
Maintenance program funding level is established by an agency executive
management group. This dollar amount is based on revenue projections. Maintenance
managers then identify the LOS that can be delivered with this budget. There is some
“give and take” amongst various program budgets and executive management
eventually settles on program budget amounts which are provided as
recommendations to the Transportation Commission (a group of citizen representatives appointed by the Governor to oversee WSDOT). The Commission
adopts a budget and provides it to the state legislature. The legislature then develops a
transportation budget which is provided to the governor for final approval. A
combination of historical expenditures, LOS goals, inventory (in the form of system
additions) and available revenue is used in this process.

B. Asset Management

Feature Inventory

1. Does your department currently have an inventory of maintainable features that is
accurate? Our feature inventory varies considerably. For example, we have a very
precise inventory of all WSDOT bridges. Some WSDOT regions have a good
inventory of all their culverts. We do not have any kind of inventory of existing
guardrail. Some features are kept track of in a statewide inventory. Others are kept
track of in a regional or maintenance area office if an individual maintenance
manager took the initiative to develop and maintain the inventory.

2. Who is responsible for maintaining the inventory? Who is responsible updating the
inventory? How frequently is it updated? What system of referencing is used to locate
features? It varies widely – see response to question #1.

3. Is the inventory used as a basis for planning and/or budgeting? If so, how? Not on a
large scale. Additions (from construction projects or route jurisdiction transfers) to
the highway system are accounted for in the budget.

Maintenance Performance Measurement
(Maintenance Management Quality Assurance)

1. Do you have a system to measure performance or outcomes of the maintenance
program? yes

2. If yes, briefly describe the process. How many measures are used? How are
measurements made? How often are measurements made? We have outcome-based
performance measures and LOS ratings for 34 maintenance activities. Each spring and
fall, the condition of all highway features is assessed via field surveys at randomly-
selected locations. The field condition data is used to calculate LOS ratings for each
activity.
3. How is the performance data used? Performance data is reported to maintenance managers for budgeting and planning purposes. It is used to communicate to executive managers and legislators the results of maintenance program activities.

4. Is a presentation made to the legislature relating performance data to funding levels? If so, how effective has the presentation been? (Have they resulted in increased funding?) A presentation of the LOS data is provided to the legislature every two years as they work on budgets. The presentation of this information has been very effective resulting in generally improved credibility of the maintenance program and increased program funding in some biennia.

Customer Surveys

1. Do you perform public surveys specifically related to maintenance? Yes. We conducted a survey in 1995 and another one in 2000.

2. How are the surveys conducted? How frequently are surveys conducted? We contracted with a public relations firm and they conducted a telephone survey of randomly-selected Washington State residents. The 1995 survey also included two focus group discussions.

3. Is the data used to set maintenance program goals or performance targets? Customer survey data has not been used to set goals. We have used this data to verify and/or calibrate LOS ratings in the context of a “balanced scorecard”.

C. Maintenance Training

1. Do you have a formal training program for maintenance employees? Yes

2. If yes, briefly describe it in general. Is it mandatory? Who pays for it? What is the focus?

   Each maintenance class has a training matrix. The supervisor will add or delete courses from that matrix for each employee to match their duties or their focus.

   Some of the classes will be mandatory and others won’t.

   The employee’s organization pays for their time and travel. Headquarters pays for the development and instructor’s time as well as the facility the training is held in.

3. How effective has training been? How is training effectiveness measured?

   We feel our training is effective but have not developed a method of measuring it.

D. Methods Engineering

1. Do you have in-house staff devoted to developing and improving maintenance processes, procedures, and materials? Yes.
2. If yes, describe how the staff identifies issues for research (e.g. concerns from field staff, periodic review of costliest process and materials, etc.)

Our specialists meet periodically with other states, Canadian provinces and the federal government to discuss new technology and materials. We also have a research branch that our specialists work with to develop research ideas.

E. Maintenance Methods Technology Transfer

1. Do you have a formal process for maintenance technology transfer? Yes.

2. If yes, briefly describe it in general. How is information transferred? How is it requested?

Our specialists travel statewide meeting with crews, holding training and transferring technology. As new materials or technologies come along, the specialists will request these crews to try the product or technology and report back. This information is then used to determine whether we transfer or drop the new idea.

F. Other Maintenance Issues

1. Is vegetation maintenance handled in-house or contracted out? If in-house, is vegetation maintenance centralized or decentralized? If decentralized, does each district have a special vegetation crew, or is the work done by maintenance technicians? Vegetation Maintenance is handled in-house on a decentralized basis. Each Maintenance Area has a specialized (spray) crew.

2. What are the three or four major statewide issues related to vegetation maintenance? Pressure from special interest groups to reduce herbicide use. Conversion of the Vegetation Management Program from a calendar-based spray/mow program to an Integrated Vegetation Management Program. Balancing the interests of adjoining property owners (i.e. agricultural landowners) with operational, safety, and budget issues.

3. Is the management of maintenance facilities (buildings) centralized or decentralized? It is decentralized.

4. Is the budget for building maintenance separate from highway maintenance? Yes.

5. How are budgets for building apportioned, by identified needs, historical percent to each district, condition assessment, other? Currently apportioned based on building square footage. Efforts are currently underway to revise procedures so budget apportionment will be made on documented building maintenance needs.
Appendix C: Asset Management Best Practices

These best practices are drawn from the management framework described in the report for Phase I of NCHRP Project 20-24(11), “Asset Management Guidance for Transportation Agencies,” Fall 2001, posted on the NCHRP publications website (accessible through the TRB home page).

Best practices are not prescriptive. Each agency may determine the scope of its asset management effort, priorities for implementation, and details of customization. These best practices are offered as guidelines. All guidelines may not be applicable to all agencies for statutory or other reasons.

A. Policy Guidance and Objectives

Policy guidance in the context of asset management comprises statutory and non-statutory policy goals that are set for a transportation program. These goals may arise, for example, from statewide policy set by the executive or legislative branches, federal policy requirements, policy statements set by the Transportation Board, and policy directives issued by the DOT. Objectives are specific targets associated with policy goals. They may be quantitative (e.g., “at least 70 percent of state highway pavements will be in good to fair condition within the next five years”) or qualitative (e.g., “Interstate-highway accident rates will be significantly reduced in the next three years”).

- Principles of good asset management are articulated in the agency’s business plan and are clearly recognized throughout the agency’s organizational units as the driving force for resource allocation and utilization.
- Policy goals and objectives embody a life-cycle perspective of asset performance and cost, and encourage preservation and maintenance strategies that result in long-term benefits.
- Policy goals and objectives are supported by quantitative and measurable performance measures or criteria.
- Measured system performance is compared to established goals; reliable information on asset condition and public perceptions thereof are accounted for in updating policy goals and objectives.
- Resource allocation decisions for the maintenance program are based on expected performance rather than on historical splits or formulas that do not correlate with an objective measure of system condition.
- The agency actively engages with political leaders and other policy makers to define expectations of system performance, frame alternative approaches to maintaining
desired performance, and outline the consequences of decisions and courses of action addressing these expectations.

- The agency’s asset management systems are designed and applied to yield meaningful information on policy choices and consequences.

**B. Maintenance Program Development**

- Funding allocation criteria and maintenance priorities are consistent with and support the state’s and the agency’s policy goals and objectives.
- Updates and revisions to the maintenance programming process are performed regularly to reflect changes in policy, technology, and emerging issues.
- Recommended programs and budgets are tied to performance budgeting concepts entailing structuring of costs by activity and relationship of costs to levels of service or performance measures.
- Transportation system monitoring ensures that levels of service are regularly applied to quantify the impacts of program decisions and to provide feedback for future program priorities.
- Progress toward system performance targets is measured and reported regularly.
- Tradeoffs between maintenance program areas, or between maintenance and capital preservation, are based upon analyses of life-cycle benefits and costs, rather than arbitrary formulas or historical splits.
- The implications of more or less resources allocated to each program are clearly communicated in terms of selected performance measures.

**C. Program Delivery**

- The agency knows its full costs for delivering its program activities and services.
- Measures are defined and tracked to gauge successful program delivery. The agency has the ability to easily track service delivery against the program plan so that adjustments can be made.
- Agency senior managers and program managers are regularly informed of progress; a well-understood mechanism exists to make needed adjustments.
- Policy-makers and key stakeholders are kept informed of program status and adjustments.
- The agency has a process to review and revise delivery approaches if improvement is needed.
The agency periodically evaluates its options for delivering programs and services, such as use of state employees, inter-governmental agreements, partnering, outsourcing, and managed competition.

D. Information and Analysis

- The agency maintains an inventory of assets that is complete, accurate, and current.
- Asset condition data are updated periodically to provide timely and accurate information on status and performance.
- The agency applies the appropriate mix of data collection technology (e.g., visual, automated, remote sensing) to provide the cost-effective coverage needed for a quality basis of information.
- Information on customer perceptions is updated regularly through surveys, focus groups, complaint tracking, or other means to gauge public opinion on asset condition and agency performance and to respond thereto.
- Information on actual costs and accomplishments by asset, activity, and location is maintained to track actual cost and performance and improve cost estimation techniques.
- A sampling methodology, if used, is demonstrated to be appropriate in terms of network coverage, sample size, and frequency. Assignments and training of survey teams ensure objectivity, consistency, and repeatability.
- The agency’s single-asset management systems and databases (e.g., MMS, PMS, BMS, Feature Inventory) are updated and integrated to enable consistent information on all asset categories to be accessible to multiple applications, and to provide managers at various organizational levels the information they need for effective asset management.
- Information requirements and standards are in place to ensure that future system- and database-development efforts will integrate with existing systems and provide improved asset management capabilities.
- Systems and information are based upon a common geographic referencing system and a common map-based interface for analysis, display, and reporting.
- The agency has decision-support tools that facilitate exploration of capital-maintenance tradeoffs for different assets.
- The agency has tools that support analysis of maintenance strategies and technologies using a life-cycle cost perspective.
- The agency has tools that provide an understanding of performance/level-of-service impacts of different proposed maintenance budgets.
- The agency includes maintenance expenditures in financial reports conforming to GASB Statement 34.
• Information on asset condition and the level of expenditure needed to meet target condition is available from the agency’s MMS (if needed for GASB 34).
Appendix D: Technical Appendix to MMQA

A. Statistical Analysis of Sample Size

UDOT performed a statistical analysis of sample requirements during MMQA development. While this analysis is not documented in the material on MMQA obtained for this audit, background information has been obtained in interviews with UDOT staff. The formula that was used by UDOT to investigate sample size is taken from NCHRP Report 422:\(^{48}\)

\[
 n = \frac{(z^2 s^2)}{d^2} \tag{1}
\]

where:

- \( n \) is the required sample size;
- \( z \) is a statistic based upon the specified confidence interval (for an estimate at a 90 percent confidence interval, \( z = 1.645 \));
- \( s \) is the standard deviation of the sample data (assumed in this analysis to be equal to the mean); and
- \( d \) is the required precision or allowable error, which is taken in this analysis to be 10 percent of the mean.

The number of required sample sections per station that was originally computed by UDOT using eq. [1] was felt to be too great a data collection effort for the stations. Therefore, UDOT adopted a recommendation from NCHRP Report 422 that a minimum of 25 sections be sampled.\(^{49}\) UDOT translated this recommendation into semi-annual surveys of 12 and 13 sample sections, respectively. These sample sections, each 0.1-mile long, are selected from a list of 20 randomly identified road segments each year, a process that may bias the sample somewhat. Survey data are collected at the station level and rolled up to the region level; aggregation at the statewide level is not yet available.

The discussion below analyzes the statistical validity of UDOT’s decision to go with a minimum sample size at the station level. Statistical validity is analyzed for highway networks at a statewide, region level, and station level. The form of Eq. [1] assumes that the population of 0.1-mile highway sections to be sampled is very large. This assumption is definitely true when analyzing the network at a statewide level; is reasonable at a region level; but is not likely true at a station level. This fact does not invalidate the analysis, but it does mean that the computed sample size is conservative when applied to stations (and to a lesser degree to regions) – i.e., it is somewhat larger than what a more precise estimate

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\(^{49}\) NCHRP Report 422, p. 36.
would call for. An adjustment for a “finite population size” is applied below at the station and the region levels, based upon the sampling model used by Colorado DOT, to adjust the sample size downward.

A preliminary value of the standard deviation is proposed above to be able to estimate the required sample size. This is not an unusual strategy, and the resulting approximation of the sample size does not detract from the analysis since it is considering broad differences at a station, region, and statewide level. As additional data on road condition are collected each fiscal year, updated estimates of the standard deviation can be incorporated in applying eq. [1].

UDOT inspects its 0.1-mile sample sections in the following way:

- On undivided roads it inspects all lanes in both directions.
- On divided highways it inspects all lanes in one direction only.

In developing the relationship between the total population of 0.1-mile highway segments and the number of sample sections, UDOT’s inspection procedures thus fall between a relationship based purely on centerline miles and one based purely on lane-miles. Therefore, statistics are analyzed below using both measures to establish the bounds of the desired result.

The parameter values proposed in association with eq. [1] call for a confidence interval of 90 percent and an allowable error of 10 percent. These parameters will be referred to as “90-10” as a shorthand. When eq. [1] is applied at a 90-10 estimate, it yields a required sample size of 271 highway sections 0.1-mile long. The question then is how this required sample size compares to the samples that are actually available at a station level, region level, and statewide.

1. **Station Level**

   Station-level results are shown in Exhibit D-1 and Exhibit D-2 for lane-miles and centerline miles, respectively. Average mileages for each station in a region have been used to simplify the calculations.

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50 A more precise estimate for samples from a “finite” population (i.e., one of limited size) is obtained by applying a “finite population adjustment” that is discussed in many statistics texts. The need for a finite population adjustment and how to estimate it are not discussed in NCHRP Report 422.
Exhibit D-1: Sample-Size Calculations Based on Lane-Miles at the Station Level

<table>
<thead>
<tr>
<th>Region</th>
<th>Lane Miles</th>
<th>Stations</th>
<th>Lane miles/Station</th>
<th>Segments/Station</th>
<th>Required Sample Size</th>
<th>Current Sample Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region 1</td>
<td>2,660</td>
<td>15</td>
<td>177</td>
<td>1,774</td>
<td>235</td>
<td>25</td>
</tr>
<tr>
<td>Region 2</td>
<td>3,492</td>
<td>16</td>
<td>218</td>
<td>2,182</td>
<td>241</td>
<td>25</td>
</tr>
<tr>
<td>Region 3</td>
<td>2,709</td>
<td>14</td>
<td>193</td>
<td>1,935</td>
<td>237</td>
<td>25</td>
</tr>
<tr>
<td>Richfield District</td>
<td>2,340</td>
<td>11</td>
<td>213</td>
<td>2,127</td>
<td>240</td>
<td>25</td>
</tr>
<tr>
<td>Price District</td>
<td>2,549</td>
<td>10</td>
<td>255</td>
<td>2,549</td>
<td>245</td>
<td>25</td>
</tr>
<tr>
<td>Cedar City District</td>
<td>2,424</td>
<td>12</td>
<td>202</td>
<td>2,020</td>
<td>239</td>
<td>25</td>
</tr>
</tbody>
</table>

A finite population adjustment based on one used for Colorado DOT has been applied to the sample size calculation, which reduces the required sample size from 271 to a smaller number as shown in the “Required Sample Size” column in both tables.

The results for both lane-miles and centerline miles indicate that a sample size of 25 random road sections does not provide statistically valid results at a 90-10 level. The estimated error exceeds 30 percent in both calculations.

2. Region Level

Results at the region level are summarized in Exhibit D-3 and Exhibit D-4 for lane-miles and centerline miles respectively.

Exhibit D-3: Sample Size Calculations Based on Lane-Miles at the Region Level

<table>
<thead>
<tr>
<th>Region</th>
<th>Lane Miles</th>
<th>Segments</th>
<th>Required Sample Size</th>
<th>Current Sample Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region 1</td>
<td>2,660</td>
<td>26,603</td>
<td>268</td>
<td>375</td>
</tr>
<tr>
<td>Region 2</td>
<td>3,492</td>
<td>34,916</td>
<td>269</td>
<td>400</td>
</tr>
<tr>
<td>Region 3</td>
<td>2,709</td>
<td>27,088</td>
<td>268</td>
<td>350</td>
</tr>
<tr>
<td>Richfield District</td>
<td>2,340</td>
<td>23,399</td>
<td>268</td>
<td>275</td>
</tr>
<tr>
<td>Price District</td>
<td>2,549</td>
<td>25,493</td>
<td>268</td>
<td>250</td>
</tr>
<tr>
<td>Cedar City District</td>
<td>2,424</td>
<td>24,241</td>
<td>268</td>
<td>300</td>
</tr>
</tbody>
</table>
Exhibit D-4: Size Calculations Based on Centerline Miles at the Region Level

<table>
<thead>
<tr>
<th>Region</th>
<th>Lane Miles</th>
<th>Segments</th>
<th>Required Sample Size</th>
<th>Current Sample Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region 1</td>
<td>942</td>
<td>9,423</td>
<td>263</td>
<td>375</td>
</tr>
<tr>
<td>Region 2</td>
<td>858</td>
<td>8,580</td>
<td>262</td>
<td>400</td>
</tr>
<tr>
<td>Region 3</td>
<td>1,049</td>
<td>10,485</td>
<td>264</td>
<td>350</td>
</tr>
<tr>
<td>Richfield District</td>
<td>1,026</td>
<td>10,256</td>
<td>264</td>
<td>275</td>
</tr>
<tr>
<td>Price District</td>
<td>1,044</td>
<td>10,440</td>
<td>264</td>
<td>250</td>
</tr>
<tr>
<td>Cedar City District</td>
<td>955</td>
<td>9,546</td>
<td>263</td>
<td>300</td>
</tr>
</tbody>
</table>

Both calculations indicate that sample sizes are sufficient for estimates at a 90-10 level of confidence. (The Price District substantially meets this target, although a small increase in the number of samples will provide an additional factor of safety.) Estimated errors are in the range of 8 to 10 percent in both calculations. Since the required (i.e., computed) and the current sample sizes are relatively close in several regions, however, the validity of the region sampling should be checked periodically with respect to the assumed values of the parameters in eq. [1], particularly the standard deviation that is observed in data collection in the sample sections.

3. Statewide

At a statewide level there are 1,950 samples available annually, compared to 271 required for a statistically valid sample at a 90-10 confidence level. With the available samples exceeding the number required by a substantial margin, the estimated error in sample estimates is less than four percent.

B. Audit Analysis of LOS-Cost Models

UDOT has estimated cost models by regressing data on annual expenditures versus measured LOS. Separate models have been developed for individual activities and regions. An example for asphalt patching and repair is shown in Exhibit D-5. The ordinate represents annual maintenance cost for that activity in a region; the abscissa represents LOS values, where 1 denotes LOS A, 2 = LOS B, and so forth through 6 = LOS F. (LOS E, which would correspond to 5 on the scale, is not used.) UDOT has undertaken a unique approach in attempting to develop its initial set of models directly from observed data, rather than based upon managerial judgment as has been done in other states.

51 Ideally the model would be developed for costs experienced through an entire fiscal year, July 1-June 30. In practice, models must sometimes be developed as soon as possible, and might represent a period slightly shorter: e.g., July 1 through June 1.
The models build upon existing patterns of expenditure among regions, as is evident from Exhibit D-5, particularly in the much higher cost in the urbanized Region 2. This modeling premise is not unusual, and is a feature of such models in several other states. To assess the underlying characteristics of the models, however, it is useful to plot them in a “normalized” form. A normalized form is one in which the models represent relative rather than absolute dollar values. The cost corresponding to LOS C is arbitrarily chosen to represent a relative cost of unity.\textsuperscript{52} Costs of other LOS values are then expressed relative to this baseline cost. The example for asphalt patching and repair is shown in Exhibit D-6.

\textsuperscript{52} Other points could have been chosen to represent relative costs of unity without affecting the result. LOS C is useful because it is in the midrange of the model’s domain, and it is easy to see the cost implications of LOS values higher or lower than LOS=C.
The slopes of the linear models all fall within an envelope, but are not the same. This aspect of UDOT’s models differentiates it from other DOTs, which seek to apply a single relative model for a given activity to all regions. That is, the slope of the relative model for a given activity is the same for all regions, even though the baseline expenditure that each region experiences at LOS C may be different. (The slopes of models that apply to different activities may differ from one another, however.) Other key activities were analyzed in a similar way – crack sealing and chip seal, pavement striping, and repair and replacement of signs – and these showed similar differences among slopes across regions. The greatest agreement in these models across regions occurs with snow and ice control, as shown in absolute and relative terms in Exhibit D-7 and Exhibit D-8. Discussions with UDOT indicate that the regions preferred these individually tailored models when they were developed.
Exhibit D-7: LOS-Maintenance Cost Models by Region for Snow and Ice Control

Exhibit D-8: LOS-Cost Models by Region for Snow and Ice Control

One implication of developing models in this way, however, is that it is not clear whether the different slopes represent true variations in the incremental costs of achieving different levels of service in different regions, or whether they are an artifact of different data collection norms and procedures. A second implication is that differences among the models may represent different maintenance standards, practices and techniques. While it
may be appropriate to have such differences and associated variations in costs among regions, these should be discussed explicitly on the basis of standards and practices to ensure that maintenance is being practiced efficiently and appropriately across regions. This comment is not meant to discourage different practices where they are justified, but only to ensure that the differences are recognized and their implications understood. A third implication is that individual models take additional time to develop and manage, with potentially no gain in the quality of the models, since separate pools of data must be analyzed for each combination of activity and region. A statewide pool of data, with contributions by all regions for each activity, could provide a better estimate of a single model with a larger number of data points.
Appendix E: Utah Laws on Maintenance

72-1-201. Creation of Department of Transportation – Functions, powers, duties, rights, and responsibilities.

There is created a Department of Transportation which shall:
(1) have the general responsibility for planning, research, design, construction, maintenance, security, and safety of state transportation systems;
(4) plan, develop, construct, and maintain state transportation systems that are safe, reliable, environmentally sensitive, and serve the needs of the traveling public, commerce, and industry;
(8) in accordance with Title 63, Chapter 46a, Utah Administrative Rulemaking Act, make policy and rules for the administration of the department, state transportation systems, and programs.

72-1-203. Deputy Director – Appointment – Qualifications – Other assistants and advisers – Salaries.

(2) The deputy director is the chief engineer of the department. The deputy director shall assist the executive director and is responsible for:

(b) operation and maintenance of the state transportation system.

72-1-204. Divisions enumerated – Duties.

The divisions of the department are:
(7) the Operations Division responsible for:

(a) maintaining the state transportation systems;


(4) The executive director may also establish district offices within a region to implement maintenance, encroachment, safety, community involvement, and loss management functions of the region.

72-1-208. Cooperation with counties, cities, towns, the federal government, and all state departments.

(1) The department shall cooperate with the counties, cities, and towns in the construction, maintenance, and use of the highways and in all related matters, and may provide services to the counties, cities, and towns on terms mutually agreed upon.

72-6-101. Title.

This chapter is known as the “Construction, Maintenance, and Operations Act.”
72-6-102. Uniform plans and specifications for construction and maintenance.

The department shall:
(1) prepare and adopt uniform standard plans and specifications for the construction and maintenance of state highways; and
(2) issue a manual containing plans and specifications for the information and guidance of officials having supervisions of the construction and maintenance of state highways.

72-6-105. Contracts for construction and maintenance – Agreements with county or municipality.

The department may enter into written agreements on behalf of the state with any county or municipality for rights-of-way and the construction or maintenance of any part of a state highway.

72-6-106. Use of recycled asphalt.

(1) In making plans, specifications, and estimates, and in advertising for bids under this chapter, the department shall allow up to 25% but may allow up to 60% reclaimed asphalt pavement to be incorporated into hot asphaltic concrete used for road construction and maintenance.
(2) The department shall ensure that hot asphaltic concrete incorporating reclaimed asphalt pavement meets or exceeds the department quality standards for roads constructed or maintained with hot asphaltic concrete not containing reclaimed asphalt pavement.


(1) As used in this section and Section 72-6-108:
   (d) “Maintenance” means the keeping of a road facility in safe and usable condition to which it was constructed or improved, and includes:
      (i) the reworking of an existing surface by the application of up to and including two inches of bituminous pavement;
      (ii) the installation or replacement of guardrails, seal coats, and culverts;
      (iii) the grading or widening of an existing unpaved road or flattening of shoulders or side slopes to meet current width and safety standards; and
      (iv) horizontal or vertical alignment changes necessary to bring an existing road in compliance with current safety standards.
   (e) “Project” means the performance of a clearly identifiable group of associated road construction activities or the same type of maintenance process, where the construction or maintenance is performed on any one class B or C road, within a half-mile proximity and occurs within the same calendar year.
(2) The following types of maintenance work are not subject to the contract or bid limit requirements of this section:
   (a) the repair of less than the entire surface by crack sealing or patching; and
   (b) road repairs incidental to the installation, replacement, or repair of water mains, sewers, drainage pipes, culverts, or curbs and gutters.
72-6-111. Construction and maintenance of appurtenances – Noise abatement measures.

(1) The department is authorized to construct and maintain appurtenances along the state highway system necessary for public safety, welfare, and information. Appurtenances include highway illumination, sidewalks, curbs, gutters, steps, driveways, retaining walls, fire hydrants, guard rails, noise abatement measures, storm sewers, and rest areas.

72-7-514. Landscape control program.

(1) As used in this section, “landscape control” means trimming or removal of seedlings, saplings, trees and vegetation along the interstate, federal aid primary highway existing as of June 1, 1991, and national highway system right-of-way to provide clear visibility of outdoor advertising.

(2) (a) The department shall establish a landscape control program as provided under this section.

   (b) Except as provided in this section, a person, including an outdoor advertising sign owner or business owner may not perform or cause landscape control to be performed.

(3) (a) An outdoor advertising sign owner or business owner may submit a request for landscape control to the department.

   (b) Within 60 days of the request under Subsection (3)(a), the department shall:

      (i) conduct a field review of the request with a representative of the sign or business owner, the department, and the Federal Highway Administration to consider the following issues listed in their order of priority:

          (A) safety;

          (B) protection of highway features, including right-of-way and landscaping;

          (C) aesthetics; and

          (D) motorists' view of the sign or business; and

      (ii) notify the sign or business owner what, if any, trimming, removal, restoration, banking, or other landscape control shall be allowed as decided by the department, after consultation with the Federal Highway Administration.

   (c) If the sign or business owner elects to proceed, in accordance with the decision issued under this subsection, the department shall issue a permit that describes what landscape control may be allowed, assigns responsibility for costs, describes the safety measures to be observed, and attaches any explanatory plans or other information.

(4) The department shall establish an appeals process within the department for landscape control decisions made under Subsection (3).

(5) (a) A person who performs landscape control in violation of this section is guilty of a class C misdemeanor, and is liable to the owner for treble the amount of damages sustained to the landscape.

   (b) Each permit issued under this section shall notify the permit holder of the penalties under Subsection (5)(a).
## Appendix F: Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>AADT</td>
<td>Average Annual Daily Traffic</td>
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<tr>
<td>AASHTO</td>
<td>American Association of State Highway Officials</td>
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<tr>
<td>ABB</td>
<td>Activity Based Budget</td>
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<tr>
<td>BMS</td>
<td>Bridge Maintenance System</td>
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<tr>
<td>CEU</td>
<td>College of Eastern Utah</td>
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<tr>
<td>CPRM</td>
<td>Certified Professional Roadside Manager</td>
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<tr>
<td>CRM</td>
<td>Customer Relationship Management</td>
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<tr>
<td>DOT</td>
<td>Department of Transportation</td>
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<tr>
<td>DWR</td>
<td>Department of Wildlife Resource</td>
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<tr>
<td>FHWA</td>
<td>Federal Highway Administration</td>
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<tr>
<td>FTE</td>
<td>Full-Time Equivalent</td>
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<tr>
<td>FWD</td>
<td>Falling Weight Deflectometer</td>
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<tr>
<td>GASB</td>
<td>Government Accounting Standards Board</td>
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<tr>
<td>GIS</td>
<td>Geographical Information Systems</td>
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<tr>
<td>IAM</td>
<td>I-15 Asset Manager</td>
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<tr>
<td>IMMP</td>
<td>Integrated Maintenance Management Program</td>
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<tr>
<td>IPM</td>
<td>Integrated Pest Management</td>
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<tr>
<td>IRVM</td>
<td>Integrated Roadside Vegetation Management</td>
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<tr>
<td>ISS</td>
<td>Information System Support</td>
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<tr>
<td>IT</td>
<td>Information Technology</td>
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<tr>
<td>IVM</td>
<td>Integrated Vegetation Management</td>
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<tr>
<td>LAN</td>
<td>Local Area Network</td>
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<tr>
<td>LOS</td>
<td>Level of Service</td>
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</table>
MAP       Maintenance Accountability Process
MMQA      Maintenance Management Quality Assurance
MMQC      Maintenance Management Quality Control
MMS       Maintenance Management System
MRP       Maintenance Rating Program

NCHRP     National Cooperative Highway Research Program
NHS       National Highway System
NICET     National Institute of Certification in Engineering Technologies
NRVMA     National Roadside Vegetation Management Association

PB        Parsons Brinckerhoff Report
PCC       Portland Cement Concrete
PDBS      Project Development Business System
PMS       Pavement Management System

QIC       Quality Improvement Council

UDOT      Utah Department of Transportation
URRWP     Utah Rural Roadsides for Wildlife Program
WSDOT     Washington State Department of Transportation
Appendix G: Region/District Organization Charts
Exhibit G-1: Region 1 Maintenance Organization

Operations Engineer

- Maintenance Operations Analyst
  - Traffic Engineer
  - Safety Risk Management Officer
  - Permits Officer
  - Assistants
    - Maintenance Engineer
    - North Area Supervisor
      - Special Crew & Shop Area Supervisor
    - Maintenance Trainer
    - Sub Station
      - Station 1423
      - Station 1421
    - Sub Station
      - Station 1423
      - Station 1423
    - Station 1431
    - Station 1433
    - Station 1435
    - Station 1436
    - Station 1437
    - Station 1441
    - Station 1443
    - Station 1445
    - Station 1448
    - Station 1449
  - South Area Supervisor
  - Station 1424
  - Station 1425
  - Station 1426
Exhibit G-2: Region 2 Maintenance Organization
Exhibit G-3: Region 3 Maintenance Organization

Operations Engineer

Assistant Operations Engineer/Maintenance Engineer

Permits Officer
Maintenance Area Supervisor/South
Maintenance Area Supervisor/North
Maintenance Area Supervisor/East

Maintenance Analyst

Traffic Engineer

Safety/Loss Control

Supervisor 341 Shop

Maintenance Training Specialist

Traffic Data Specialist

Rotational Engineers

Stations

Stations

Stations
Exhibit G-4: Price Maintenance Organization

District Engineer

- Warehouse Supervisor
- Office Tech III
- Maintenance Analyst
- Maintenance Training Specialist
- Safety/Loss Center Specialist
- Region R/W Control Coordinator

- Maintenance Area Supervisor
  - Station
  - Station
  - Station
  - Station
  - Station

- Maintenance Area Supervisor
  - Station
  - Station
  - Station

- Maintenance Area Supervisor
  - Station
  - Shop

- Maintenance Area Supervisor
  - Station
  - Station

- Maintenance Area Supervisor
  - Station
  - Station

- Maintenance Area Supervisor
  - Station
  - Station
Exhibit G-5: Cedar Maintenance Organization

- District Engineer
  - Office Technician
  - Office Technician
  - Warehouse/Radio
  - Safety/Loss Control Manager
  - Warehouse/Radio
  - Encroachment/Permits Officer
  - District Trainer
  - Maintenance Analyst
  - Shop

- Maintenance Supervisor North
  - Station 527 Beaver
  - Station 532 Cove Fort
  - Station 534 Meadow
  - Station 536 Scipio

- Maintenance Supervisor South
  - Station 531 Milford
  - Station 533 Garrison
  - Station 535 Delta
  - Station 531 St. George
  - Station 523 Beryl
  - Station 526 Parowan
  - Transport Driver
  - Station 522 Hurricane
  - Station 524 Cedar City
  - Station 526 Parowan
  - Station 540 Cedar City
  - Station 543 Point Crew
Exhibit G-6: Richfield District Maintenance Organization

District Engineer

District Maintenance Trainer

Maintenance Operations Analyst

Maintenance South Area Supervisor

Maintenance Central Area Supervisor

Maintenance North Area Supervisor

Station

Station

Station

Station

Station

Station

Station

Specialty Crew

Paint Crew
Appendix H: Condensed Report

This summary presents the results of a performance audit of the Utah Department of Transportation (UDOT) Maintenance function.

A. Approach

To meet the objectives of this audit, Dye Management Group, Inc. conducted interviews and focus groups, administered an e-mail survey, performed a best practices and benchmarking review, and analyzed Department documents. The audit was overseen by a steering committee of UDOT officials from both headquarters and the regions/districts.

B. Description and Analysis

The following summarizes each area analyzed, best practice in the field, and strengths and issues with the current approach.

1. Organization and Strategic Direction of UDOT Maintenance

Responsibility for maintenance in UDOT is primarily shared between two levels: the Central Maintenance Unit (“Central”) located in the Salt Lake City headquarters complex and six geographically located region/district field operations around the State. The Engineer for Maintenance reports to the Director of the Operations Group, who in turn reports to the Deputy Director. Central provides leadership and support to the regions/districts in a variety of technical areas, such as budgeting, methods, and asset preservation. The region/district operations offices are highly decentralized due to the geographic distribution of the work, and day-to-day decisions for field operations are made at the field level by the region/district maintenance managers. UDOT has developed a strategic plan that identifies values, goals, and strategies for the Department as a whole, including maintenance.

Best practice in organization and strategic planning displayed by other states includes involving managers at different levels in the organization in planning and linking the strategic plan to implementation through budgets, operational plans, individual management performance plans, and evaluations. Elements in good strategic plans address customers, goals, strategies, and preservation of infrastructure assets. Good strategic plans also deal with organizational and employee performance. Departments ensure that goals and strategies are understood throughout the organization by communicating them through staff meetings, newsletters, and other means.
Strengths of the maintenance process include the fact that UDOT has developed a strategic direction that includes maintenance elements and is posted on the UDOT website. Strategic elements are also included in manager performance plans. UDOT has also attempted to implement Maintenance Management Quality Assurance (MMQA) and is developing an asset management process, which can provide a measurement and policy basis for maintenance.

Issues to be addressed include the fact that region/district maintenance personnel do not clearly understand UDOT statewide strategic goals and the strategic direction is not yet linked to implementation. The strategic direction has not yet been operationalized for maintenance by including elements in the budget, MMQA, and other processes. Managers at lower levels in UDOT have not been involved in plan development.

Recommendations include:

**Recommendation 1.** Develop a strategic approach to maintenance.

**Recommendation 2.** Operationalize the strategic approach.

**Recommendation 3.** Involve managers at all levels in the planning and implementation process.

2. **Communication**

A decentralized organization has advantages for a large, diverse state; however, it creates additional problems of coordination among different regional areas. Coordination requires good communication, such as committee meetings, official visits, and informal phone conversations.

Successful organizations maintain a balance in communication between individuals (informal and formal), to include vertical (within division), horizontal (across the enterprise) and public relations (outside the enterprise). Such a balance reflects a realistic picture of the communication behavior required for success.

Communication between the regions/districts and some staff in Central is strong. Established communication channels, including the monthly Operations Engineers meetings and the Annual Maintenance Conference, provide opportunities to share solutions among those in the organization.

Communication between the regions/districts and other staff in Central is poor. Regions/districts perceive a lack of leadership on issues such as MMQA and methods engineering. Meetings have lacked structure and have not focused on outcomes.
Recommendations include:

**Recommendation 4.** Strengthen the decision-making and issue resolution structure for maintenance.

**Recommendation 5.** Develop a Central customer relationship management (CRM) process.

**Recommendation 6.** Increase the expertise of Central.

### 3. Asset Management

Asset management is a comprehensive approach involving asset inventory, condition, and future investment scenarios. While UDOT is committed to asset management, the Executive Director has not yet determined how quickly and how extensively it will be implemented.

Best practice in asset management includes an integrated approach that focuses on results. The approach should apply quality information throughout the process. Departments that have been successful in applying asset management consider asset management as a “way of doing business,” rather than a separate initiative.

The agency’s current strategic business plan identifies several priority areas relevant to asset management. Specifically, UDOT’s maintenance management system (MMS) philosophy enables this system to track program expenditures, resource usage, and accomplishments much more closely than other state DOTs. However, leadership is needed to define asset management, communicate it internally and externally to key stakeholders, coordinate the efforts of the several organizational units involved, and demonstrate long-term commitment by example.

Recommendations include:

**Recommendation 7.** Develop an asset management plan for Maintenance consistent with the broader statewide framework now being considered by UDOT.

**Recommendation 8.** Strengthen the policy framework for maintenance management as a performance-based process.

**Recommendation 9.** Renew the MMQA as the basis for performance-based resource allocation in maintenance.

**Recommendation 10.** Develop a department-wide data collection approach that all regions/districts subscribe to and conduct regularly and consistently.

**Recommendation 11.** Engage the Legislature and the Transportation Commission in the concept of a policy-driven, performance-based budgeting approach, and discuss with them their roles in this process and their willingness to apply it.
Recommendation 12. Develop a program of training, communication, and review for Central and field managers to increase management capabilities and staff familiarity with asset management, to identify problems and resolve them, and to recommend updates and enhancements of the asset management plan.

Recommendation 13. Review current business processes and legacy system applications to update them, bring them into alignment, and promote integration and data sharing where useful.

4. **Feature Inventory**

UDOT maintains a Feature Inventory to keep track of its infrastructure. This inventory has grown in importance due to its use for budgeting, scheduling, and managing work at maintenance stations.

The best feature inventories have a clear purpose and store adequate information to satisfy the specified purpose. A single custodian has been appointed in charge of the inventory and a flexible schedule exists for updating the inventory year round. In addition, good feature inventories use reliable software.

While both Central and region/district staff recognize the importance of maintaining the Feature Inventory, there are several concerns about the current system: information is inaccurate and is not kept up-to-date; regions/districts do not have adequate reports; the system is not user friendly and is too slow, especially for remote operation in the regions/districts; and field staff lack training on data collection and inspection.

Recommendations include:

Recommendation 14. Coordinate the Feature Inventory with the overall framework for asset management.

Recommendation 15. Prepare a complete development and implementation plan for any changes to the Feature Inventory.

Recommendation 16. Allocate additional resources for the collection of inventory data.

5. **Pavement Preservation**

UDOT Preservation Contracts cover projects that are less than $2 million and are limited to pavement and bridge decks. The contracts include thin overlays, chip sealing, slurry sealing, slab jacking, slab replacement, and minor corrective work. They also include service projects such as flagging, traffic control, painting, and striping. The program totaled approximately $45 million in fiscal year 2002.

Best practice in pavement preservation includes an acceptance of the philosophy of preservation throughout the agency. This philosophy provides for preservation treatments
to be applied to roads in good condition as part of a comprehensive management plan. Agencies with successful pavement preservation programs also provide focused training for their employees, in addition to educating the legislature and the public about the benefits of such a program.

While regions/districts reported receiving good customer service from Central, they were concerned about the unpredictable funding for the program. They were additionally concerned about the inadequate training for pavement preservation and the inconsistent approaches to pavement preservation among regions/districts.

Recommendations include:

**Recommendation 17.** Adopt a funding approach that stabilizes annual Orange Book funding commitments as much as possible to ensure continuity in meeting preservation objectives.

**Recommendation 18.** Promote greater consistency in region/district approaches to project identification and selection.

**Recommendation 19.** Develop a course outline for preservation work, including plan development and training material for the course.

**Recommendation 20.** Develop an external relations program.

### 6. Lands and Buildings

Lands and Buildings is a Central function that ensures the timely maintenance and replacement of UDOT maintenance buildings and facilities. Lands and Buildings has a budget of approximately $1.8 million annually.

Best practice in Lands and Buildings provides that the program be managed according to a master plan. A master plan has six key components: goals, strategies, standards, inventory condition information, needs assessment, and description of funding levels.

Most of those interviewed in the regions/districts believed that the distribution of funding among regions/districts is fair. Interviewees also thought that the contract for rest area maintenance, which is managed by Central Lands and Buildings, is working well.

However, Lands and Buildings has not established a master plan. It has neither articulated goals or strategies for Lands and Buildings nor used consistent standards for maintenance facilities. Condition surveys have not been performed on most maintenance stations. Further, Central does not have a management tracking system for identifying building needs, although a sizeable backlog of needs exists.

Recommendations include:

**Recommendation 21.** Establish a master plan for Lands and Buildings.
Recommendation 22. Perform condition surveys on all maintenance facilities.

Recommendation 23. Establish a building management system.

Recommendation 24. Prepare a case for allocating additional funding for Lands and Buildings.

7. Maintenance Management Quality Assurance (MMQA)

MMQA was designed to provide a clear link between maintenance objectives, maintenance activities, maintenance levels of service, the budget, and actual performance. MMQA provides levels of service (LOS) that define an existing or proposed quality of maintenance. Central uses MMQA to test the budget implications of targeted LOS, and to support budget requests.

Best practice in MMQA defines measures of LOS for all maintenance that relates to both agency standards and customer perceptions. Customer perceptions are collected through periodic surveys. In addition, analytic procedures have been developed to support the maintenance condition survey to determine current LOS.

UDOT has successfully begun implementation of most of the tangible elements of MMQA. Among those components implemented are LOS, condition surveys, analytic tools, and documentation. Problems with the program include lack of identified need and rationale and a failure to engage internal and external stakeholders. MMQA has also been implemented at a much more decentralized level at UDOT than it has been at other DOTs.

Recommendations include:

Recommendation 25. Appoint an action team to guide MMQA revision and implementation.

Recommendation 26. Update condition measures and LOS definitions and thresholds.

Recommendation 27. Develop a department-wide data collection approach to which all regions subscribe and which is conducted regularly and consistently.

Recommendation 28. Match condition sampling strategy and level of management to which data are applied.

Recommendation 29. Update the method of expressing LOS-based cost models.

Recommendation 30. Develop a stronger statewide management capability for MMQA.

Recommendation 31. Ensure MMQA is understood and accepted at all levels of the organization.
Recommendation 32. Conduct ongoing customer surveys and focus groups and incorporate the results into the MMQA process.

Recommendation 33. Promote the understanding of MMQA, LOS, and performance-based budgeting by the Transportation Commission and the Legislature, and assess their willingness to support a budgeting process using this performance-based approach.

8. Budgeting and Accounting

Central shares responsibility for program development, budgeting, and accounting with the regions/districts. Program development is done by very high level staff at Central and by region/district directors only. Region/district managers solicit input from senior staff indirectly, and lower-level field staff are not involved. Central establishes initial budget estimates based on the Feature Inventory and historical fixed costs of maintaining the highway system in a steady-state condition. Once funds are allocated by the Legislature, Central monitors and tracks monthly expenditures, comparing planned against actual costs.

Best practice in the area includes using a single performance-based budgeting method, surveying customers to determine focus and expectations, and integrating information systems. Statewide performance targets are identifiable by field personnel. Costs and productivity are tracked in real time.

One strength of the budgeting process is that it is flexible enough to be shifted among different groups at the region/district level. The existing system encourages accountability for and adherence to the budget.

The budget does not account for inventory condition or customer viewpoints, and does not fully integrate MMQA. There are numerous problems with the management and financial systems.

Recommendations include:

Recommendation 34. Apply a single, performance-based budgeting approach.

Recommendation 35. Involve all managers and the public in the budget allocation process.

Recommendation 36. Resolve fiscal year end conflicts.

Recommendation 37. Provide integrated real time information.

Recommendation 38. Base the budget upon customer expectations.
9. Maintenance Management System

The MMS was developed to help region/district maintenance units plan, manage, and track the costs of maintenance activities. The four major functions of the MMS are planning, organizing, directing, and controlling. MMS is supported by three technical components: the MMS/PC, which provides the access and summary reporting for the regions/districts and stations; the MMS/Mainframe, which provides a central database for detailed MMS data; and the “tank,” which provides integration between MMS/Mainframe, MMS/PC, and the FiNet and payroll systems.

The best MMSs have many functions in common. They support planning using a performance-based approach, such as MMQA. They improve the scheduling of labor, equipment, and materials to accomplish the proposed work to the level of service indicated. They provide management reports that document costs, work accomplishments, resource usage, level of service provided, and impacts or benefits to the Department and to highway users. The MMS is integrated with other transportation asset management systems, including pavement management, bridge management, asset inventory, and sign inventory.

The current MMS has several strengths. It provides for single entry of labor, materials, and equipment usage, reducing errors that may result from multiple input processes. It collects data near the source, reducing the opportunity for error. It also computes costs for resources as they are utilized rather than waiting for payroll and financial system cycles to provide the cost for an activity.

However, the system is difficult to use, support, and modify. Users experience poor performance and cannot rely on the data. Further, there are reconciliation issues between the MMS and other statewide systems. In addition, there is little integration between MMS and other UDOT systems.

Four basic alternatives were analyzed: maintain the current system, extend the current system, redevelop the system, or implement a commercial system. We recommend implementing a commercial system. Implementing a proven system reduces the development risk. It also addresses the immediate maintenance management requirements while providing the option to add other integrated modules. It provides a firm, long-range strategy for implementing effective systems at a competitive cost. Based on our high-level review of UDOT’s requirements, the commercial offerings can meet most of the organization’s needs and provide cost effective flexibility to meet new requirements in an ever-changing business environment.

Recommendation includes:

**Recommendation 39.** Implement a commercial MMS package.
10. **Methods Engineering**

Methods engineering is a Central function that provides investigation, experimentation, and technology transfer for the region/district maintenance units.

Best practice in methods engineering includes a focus on solutions and clear performance measures for identifying success and failure. A formal process is used to solicit ideas for research from the field and a defined set of criteria establishes priorities. Customer-representative steering committees guide the research. The impact of the research is well documented.

Regions/districts support the need for methods engineering from Central. The methods engineering group provides an established network of support with the University of Utah, vendors, and lab testing facilities. In addition, the current group has experience in measuring outcomes and evaluating technologies.

Issues in methods engineering include the fact that the methods engineers lack familiarity with UDOT’s strategic direction, and methods engineering also lacks a formal business process, formal reporting standards, and processes to institutionalize implementation of research findings.

Recommendations include:

**Recommendation 40.** Evaluate the classification of the Methods Engineer position.

**Recommendation 41.** Establish a system to allow region/district staff to influence the prioritization of methods engineering.

**Recommendation 42.** The Methods Engineer should visit each region/district frequently.

**Recommendation 43.** The Methods Engineer should formalize reporting procedures.

11. **Training**

Central provides for the training needs of maintenance staff. It does so through a combination of formal, required training and informal, elective training. Training also is provided by region/district personnel.

Best practice in training includes clearly articulating the training objectives to a well defined audience. Knowledgeable, accessible instructors and a low student-to-instructor ratio are important. Successful training programs also maintain flexibility to modify the program based on evaluations and technology updates.

The majority of interviewees in the regions/districts endorsed Central’s training program. The Training Academy and the M3 program have clearly defined audiences, specific objectives for learning, accessible trainers, and reasonable student-to-teacher
ratios. The Training Committee has also responded to suggestions from the trainees, resulting in great program flexibility. Region/district interviewees identified several areas where training could be improved, particularly in equipment operations, communications, and management skills. Interviewees also mentioned the need for more instruction on site at the station level.

Issues regarding training include the need for more equipment training, more supervisor training, and more evaluation and documentation of training results.

Recommendations include:

**Recommendation 44.** Conduct rigorous evaluations of training.

**Recommendation 45.** Reassess the approach towards equipment training.

**Recommendation 46.** Include additional topics in Station Supervisor and Area Supervisor training.

**Recommendation 47.** Provide training on the Maintenance Management System.

12. **Procurement**

The UDOT Procurement Division (Procurement) advertises and awards statewide contracts for materials used by Maintenance, such as asphalt, paint, and salt. Procurement’s warehouses stock everything from roadway signs and delineators to rakes and shovels.

The best-run procurement departments acquire, store, and distribute quality materials in a timely manner. In addition, they provide quality customer service and set high standards for business practices.

Procurement has established the Buy Right Committee to improve customer service. Procurement has also recently shifted its focus from detection of procurement violation to prevention, which has reduced variances while improving customer relations.

Station supervisors reported problems in obtaining prices for certain items from the Central Warehouse. Many region/district field staff reported that they do not understand the procurement process and regulations. There have been delays in awarding statewide contracts for asphalt and paint.

Recommendations include:

**Recommendation 48.** Procurement should include information on accessing current inventory item pricing in its training seminars.

**Recommendation 49.** The Central Engineer for Maintenance should work with Methods Engineers to meet deadlines with Procurement.
**Recommendation 50.** Procurement should investigate new technology for data collection of warehouse and inventory information.

### 13. Vegetation

Central supports vegetation maintenance through training and providing technical assistance to the regions/districts on effective erosion control, noxious weed control, and vegetation establishment and control.

Best practice in vegetation maintenance requires continuing education to stay current with the latest techniques. Many successful states are also implementing integrated pest management to vegetation on roadsides.

UDOT’s roadside planting and management practices set the standard followed by most counties. Interviewees from the regions/districts almost universally praised the Roadside Vegetation Manager for providing effective leadership, useful training, and prompt answers to concerns. In addition, recent reductions in chemical applications have reduced the environmental impact of UDOT’s vegetation maintenance program.

Differences in the organization of the regions/districts have reduced Central’s confidence in the ability of the local crews to successfully accomplish major vegetation objectives. Some regions/districts do not understand the significance of the program. In addition, some interviewees in the regions/districts indicated that they do not agree with the MMQA performance measures for vegetation condition.

Recommendations include:

**Recommendation 51.** Determine the effectiveness of dedicated vegetation crews in each region/district. If the approach is proven to result in better outcomes, UDOT should establish a special crew in every region/district.

**Recommendation 52.** Obtain maintenance input early in project design, before projects are constructed.

**Recommendation 53.** Increase knowledge and training on vegetation objectives and the methods used by maintenance managers to improve understanding of the vegetation maintenance program.

**Recommendation 54.** Obtain input from maintenance personnel on all levels before developing MMQA performance measures.

### 14. Region/District Organization

Region/district maintenance units are involved in all stages of the maintenance work, from planning and budgeting to field work. Responsibility for region/district maintenance is divided among an operation engineer/district engineer, a maintenance
analyst, area supervisors, station supervisors, and a maintenance trainer. All the regions and the Cedar City district also have a maintenance engineer. In addition to region/district maintenance crews, some maintenance activities are performed by private contractors or other public agencies by contract. Regions/districts vary in their level of contract maintenance.

Best practices include succession planning, which helps to address increasing rates of attrition. Performance management is being used in some states to motivate employees and hold them accountable for results. A few DOTs have developed a systematic process to determine whether maintenance activities remain in-house or are contracted out.

UDOT has a decentralized organizational structure that encourages regions/districts to be innovative and creative in finding solutions to common problems. Some form of performance management is used in each of the regions/districts.

UDOT has not developed a formal succession plan. MMQA targets and the Department’s Strategic Direction have not been tied to some region/district performance management plans. No region/district reported having a systematic approach for evaluating whether maintenance activities should remain in-house or should be contracted out.

Recommendations include:

**Recommendation 55.** Develop a departmental succession plan.

**Recommendation 56.** Provide leadership to the regions/districts in developing effective performance management plans.

**Recommendation 57.** Ensure that performance is rewarded.

**Recommendation 58.** Develop guidance for the regions/districts for evaluating whether or not maintenance activities should be contracted out.

15. **Transportation Technician Program**

UDOT’s Transportation Technician Program seeks to cross-train construction and maintenance personnel to enable maintenance staff to serve as construction inspectors and to enable construction staff to assist maintenance in winter activities. The program entails a four-year curriculum for training and education, after which employees choose the unit (maintenance or construction) to which they will be permanently assigned. The Program is now in its third year.

Best practice would suggest that information about the Program be communicated to potential candidates and employees have the opportunity to avail themselves of the Program’s benefits. The Program’s progress toward achieving desired benefits should be tracked statewide. Information should be available on the rates of participation.
across the organization. The Department should be aware of the full costs and benefits of the program.

The Program allows Transportation Technicians to become more well-rounded employees, as Technicians from construction understand better the implications of construction quality for road performance and Technicians from maintenance understand better how quality is managed in the construction process. However, the Program results in loss of maintenance manpower at a time when peak work demands occur through the summer. While internal analyses of the benefits to construction have been completed, the impacts to maintenance have not been studied, and the cost of the education and training component of the Program has not been included in the analysis.

Recommendations include:

**Recommendation 59.** Ensure that ongoing analyses of the impacts of the Transportation Technician Program reflect the full range of its benefits and costs in both maintenance and construction.

**Recommendation 60.** Review implications for staffing levels once the more complete analyses in Recommendation 59 are performed.

**Recommendation 61.** Provide clearer statewide information on Transportation Technician Program operation and impacts.

### 16. Region/District Resource Allocation

The work program allocation is developed initially in Central, using both the approved legislative budget and the Maintenance Management Quality Assurance (MMQA) breakdown of budget by labor, equipment usage, and materials for each activity. A trial breakdown is then submitted to the regions/districts for review and adjustment.

Best practices in resource allocation entail consistent guidelines; acknowledgement of the factors affecting allocation decisions and adjustments; realistic funding to complete the planned work program; and a balance in the mix of labor, equipment usage, and materials that are funded to complete the work program.

The analyses of MMS data support the basic premises and methods of the current budgeting approach and allocation of approved budgets to the region/district-level work programs. Maintenance expenditures are strongly correlated with both labor force FTEs and inventory lane-miles. At a high level, these results support the position that maintenance allocations to regions/districts are “fair.”

One issue is that the current MMQA approach is not able to roll-up budget estimates to a statewide level. MMQA lacks buy-in and credibility among UDOT managers, which inhibits its acceptance and greater use in resource allocation. Procedural steps
do not always take advantage of the data available to balance among labor, equipment, and materials resources.

Recommendations include:

**Recommendation 62.** Move to MMQA as the basis of resource allocation.

**Recommendation 63.** Improve the accuracy of wage rates now used.

### 17. Station Location

UDOT has a 25-year plan for replacing and rehabilitating all maintenance stations. Four factors are used to determine if rehabilitation or replacement is necessary; many existing stations currently meet three of these factors. UDOT relies on the region/district to propose particular sites for replacement stations. Central may encourage the region/district to consider factors in the site selection, but the final decision is made by the region/district.

Best practice in facility management includes operating under a master plan. Anticipating building needs and buying right of way before it is needed is another best practice. Equivalent value exchanges allow a DOT to swap an existing maintenance station and yard for a parcel and buildings of equivalent value. To avoid the costs related to building new stations and make more efficient crew size decisions, one DOT allows its districts to swap service areas or buy labor, equipment, and materials from another district.

Utah has adopted a law that allows UDOT the flexibility to trade properties with interested developers.

UDOT currently does not operate under a master plan. Also, the Legislature has not allowed UDOT to purchase land in advance.

Recommendations include:

**Recommendation 64.** Establish a master plan for Lands and Buildings, as recommended in Chapter III.

**Recommendation 65.** Require maintenance stations to periodically review service areas as part of a master planning process.

**Recommendation 66.** Encourage inter-region/district service purchases or swapping in order to maximize efficiency.

**Recommendation 67.** Revise policies and procedures to reflect actual practice.
18. Snow and Ice Control

Because of their unpredictability, snow and ice activities are among the most difficult activities to manage. UDOT has established Level of Service (LOS) standards for snow and ice, which are outlined in the activity standards. In general, the LOS for a given road segment depends on the road classification and traffic volume. Exceptions are provided for special conditions. The region/district managers are responsible for implementing the policies. In practice, the LOS standards seem to be loosely implemented.

Snow and ice control best practices involve citizen input in the policy-making process and budgeting procedures that correlate budgets to various service levels. Additionally, well-thought out pre-season route planning and preparation, post-storm, and post-season operations are important to a well-managed snow and ice program. Other best practices include continuous research, cutting-edge technology, and proper use of chemicals. Many departments of transportation have successfully used contract maintenance for snow and ice control.

UDOT currently is experimenting with state-of-the-art technologies such as Road Weather Information Systems (RWIS) and anti-icing chemicals. The Department has implemented a comprehensive operator training and certification program, and frequent maintenance seminars and meetings provide an excellent forum for internal and external knowledge transfer. Some planned post-season operations should improve the lifespan of State bridges. However, variations in field implementation of snow and ice policy results in considerable variation of service levels between regions/districts and maintenance stations. Route planning and preparation, while an important management function, is practiced very loosely in the field. The Department may not be taking full advantage of cost-effective technologies available for storm tracking and weather information. The lack of covered storage for salt and abrasives may be environmentally detrimental and could be causing material waste. The Department may not be utilizing the advantages of private sector contractors for a portion of the peak snow removal work load.

Recommendations include:

**Recommendation 68.** Re-confirm UDOT’s practice of varying levels of service by geographic areas.

**Recommendation 69.** Provide more training to section managers on the benefits and cost-effectiveness of route planning.

**Recommendation 70.** Develop and conduct annual refresher training.

**Recommendation 71.** Continue upgrading to covered storage facilities for chemicals and abrasives.
19. **Hard Surface Maintenance**

Pavement maintenance is performed by crews operating from the maintenance stations. The type of work that these crews carry out is highly seasonal. Between May and early October, the work includes fog seals, surface rejuvenation, chip seals, grader placed hot-mix asphalt, thin overlays on flexible pavement surfaces, and patching on Portland cement concrete pavement surfaces. Occasionally, maintenance crews will rent an asphalt laydown machine and operator and place their own hot-mix asphalt overlays. Pothole repair is carried out in the winter months when such distresses tend to appear; potholes are typically repaired when it is not snowing. Crack sealing is also performed during the colder months, when cracks are at their widest.

Best practice includes performing Quality Assurance, using maintenance management systems (MMS) that allow remote access from portable devices, judiciously contracting out maintenance, preserving pavement, and integrating data between MMS and pavement management systems (PMS).

UDOT’s maintenance program includes a full range of maintenance treatments and emphasizes pavement preservation. Project selection is conducted at both the region/district and Central level, depending on the type of treatment needed. UDOT has expanded its pavement management activities to include pavement management engineers in each region.

At the present time, UDOT does not have a method of tracking all of its maintenance applications in a manner that is consistent with the pavement management system. The goal for the preventive maintenance program is not well known among maintenance personnel. UDOT has developed a maintenance manual to help provide some consistency in the application of maintenance techniques, but the FHWA’s National Highway Institute (NHI) training course should be provided to all maintenance personnel. An effective preventive maintenance program requires a dedicated funding source. While a certain amount of region/district autonomy is important, UDOT currently cannot be assured that there is consistency in the way projects are selected and treatments are applied.

Recommendations include:

**Recommendation 72.** Formalize the State’s preventive maintenance program.

**Recommendation 73.** Provide training on treatment applications.

**Recommendation 74.** Strengthen the integration of pavement maintenance and pavement management information.

**Recommendation 75.** Develop and implement QA procedures.
20. Non-Hard Surface Maintenance

Non-Hard Surface Maintenance covers activities on two maintenance features – unpaved roads and unpaved shoulders. Unpaved road maintenance is performed mostly in the spring and fall months when moisture is present and conditions are most suitable for this type of work. UDOT attempts to grade unpaved roads twice per year. The work is scheduled on an as-needed basis when the condition of the road surface warrants. UDOT does not have a regularly scheduled maintenance cycle on shoulders. Work needs are identified either during road inspections, from observations made by the crews, or by call-ins from external sources.

Best practices for maintaining unpaved roads include establishing/re-establishing proper crown and road cross-section, grading the edge of the traveled way to channel water to a defined ditch or slope, adding properly graduated aggregate to assure road surface strength and stability, and compacting the road surface for stability and to prevent premature rutting and surface deterioration. A dust palliative or liquid asphalt may be applied to the road surface to help prevent dust, retain fines in the road surface, and slow absorption of water into the base. The best practices for maintaining shoulders are similar to those for unpaved roads. They include reshaping the shoulders for proper slope and drainage, adding properly graduated aggregate to restore strength and stability, and compacting the shoulders after they have been worked to ensure stability. Some agencies apply a liquid asphalt or chip seal to the shoulder surface to help preserve the shoulder structure.

In general, UDOT’s work methods appear to be in line with industry norms. However, UDOT does not have a defined cycle of shoulder maintenance. UDOT uses native materials from either the roadway or shoulders and bank run from available gravel pits. Depending on the volume of traffic on the unpaved roads or shoulders, this material may not have the proper gradation for strength and compaction. Currently, UDOT uses either dump trucks or end loaders to compact surfaces. This may be adequate for low traffic volumes, but might not be sufficient where good compaction is needed.

Recommendations include:

**Recommendation 76.** Develop a regular cycle of shoulder maintenance.

**Recommendation 77.** Review the applicability of gradated materials.

**Recommendation 78.** Add a wheel compactor as part of the standard crew.

21. Roadside Maintenance

Maintenance of the roadside is the direct responsibility of each region/district and is accomplished by station maintenance crews. Removing rocks, animal carcasses, and other large debris from the roadway is the highest priority of UDOT’s Roadside Maintenance program, as it is considered safety related. Litter control is generally
considered a low priority and is primarily done when higher priority work cannot be scheduled. Fence repair is an essential activity to prevent UDOT liability.

Many states are utilizing an Adopt-A-Highway program to control litter on the roadside. Some transportation agencies are able to utilize inexpensive labor provided by local and state department of corrections inmates to remove litter. Some departments have found that outsourcing dead animal pickup is a cost-effective solution.

UDOT does employ an Adopt-A-Highway program. Also, regions/districts with prisons within their borders have used prison crews for litter removal. Several regions/districts reported outsourcing carcass removal. However, UDOT’s grouping of maintenance activities for roadside maintenance is unusual. Roadside maintenance in other states often includes maintenance activities that UDOT identifies in Group 5, Vegetation Control and Drainage and Slope Repair. In contrast, rock and carcass removal from the roadway is often not included in roadside maintenance. Although UDOT has an Adopt-A-Highway litter control program, there is no MMS charge number to track the associated expenses.

Recommendations include:

Recommendation 79. Regroup maintenance activities that occur on the roadside.

Recommendation 80. Provide a charge number for Adopt-A-Highway activities.

22. Vegetation Control

The vegetation control personnel are organized at the region/district level. Some regions/districts have a crew designated to handle all vegetation maintenance activities within the region/district. In others, vegetation maintenance is accomplished by maintenance crews as part of their regular work program. UDOT is in the process of implementing an Integrated Roadside Vegetation Management (IRVM) approach to roadside maintenance. While some regions/districts have implemented this approach, others have not.

Vegetation maintenance is a specialized area of highway maintenance that requires unique expertise not required in other aspects of highway maintenance. In order to keep current on the innovative approaches to vegetation management, ongoing training and education is essential. Some maintenance effort is dedicated to year-round vegetation management. This affords personnel the opportunity to properly train, spend time strategically planning for future needs, and build institutional memory of past problems.

UDOT’s IRVM program is a sound application. However, region/district personnel can be assigned vegetation control duties that they are not adequately trained to accomplish. Also, most of the MMS vegetation control activity numbers do not directly connect to MMQA outcome measurements.
Recommendations include:

**Recommendation 81.** Increase specialized training for all personnel involved in vegetation control activities.

**Recommendation 82.** Target regions/districts that have not fully implemented IRVM for additional education and training.

**Recommendation 83.** Make a better connection between MMS and MMQA.

### 23. Major Structure Maintenance

UDOT maintenance stations have limited capacity and resources to perform major structure repairs. The majority of structure maintenance is performed by contract. However, maintenance stations do perform minor structure repairs, such as deck patching, crack sealing, deck washing, and minor slope repairs.

Best practices for routine bridge maintenance include periodic inspections, regular sweeping and cleaning, and crack and joint sealing. Also, painting schedules for steel bridges should be developed to preserve the life of the span.

The Department’s bridge maintenance program appears to be in line with industry norms. UDOT performs both regular and biannual bridge inspections. Maintenance crews perform several of the routine treatments that extend the structures’ life spans. However, there appears to be no defined preventive maintenance approach for bridges.

Recommendation includes:

**Recommendation 84.** Establish a preventive maintenance program for bridges.

### 24. Drainage and Slope Repair

Drainage maintenance involves removing water from the roadway and conveying natural waterways from one side of the highway to the other. Slope repair involves repairing damage from slides or erosion, including re-vegetation of the repaired slope. Such maintenance has important safety implications and prevents damage to the highway, associated structures, and adjacent property. Maintenance of the drainage facilities and repair of slopes is the responsibility of each region/district and is accomplished by station maintenance crews.

Best practice for drainage and slope repair includes using appropriate specialized equipment, such as vactor trucks and continuous belt loaders. Because drainage is so important to the structural integrity of the roadway, it should be treated as a preventive maintenance activity. A consistent program of inspection and maintenance is necessary for highway drainage systems to operate effectively. Timing of work can
also be critical to meet the window of opportunity for the protection of water quality and fish life.

UDOT’s work methods for drainage and slope repair crews generally conform to best practices. In addition, UDOT design personnel utilize maintenance institutional memory as input for future designs to address identified problems.

Drainage maintenance is usually accomplished on an as-needed basis, rather than as preventive maintenance. Restrictions on specialized equipment may prevent UDOT station crews from provide the intended level of drainage maintenance.

Recommendations include:

**Recommendation 85.** Develop a preventive maintenance program for drainage structures.

**Recommendation 86.** Provide adequate lead-time to obtain necessary permits when work in drainage features are required.

**Recommendation 87.** Reevaluate drainage activity numbers and descriptions to reflect current needs.

**Recommendation 88.** Assign a designated operator to the vactor trucks.

**Recommendation 89.** Develop and document drainage environmental best practices.

### 25. Traffic Services

UDOT’s traffic services maintenance activities address maintenance of the traffic control devices and assets. Some of the major traffic control devices serviced by UDOT Maintenance include pavement markings, signs, pavement markers and reflectors, signals, and guardrail.

The highway industry continues to research and test new materials for pavement paint. Safety is a major concern for pavement striping activities, thus a best practice is to use highly durable paints to avoid having to paint often. Many agencies contract for pavement striping. Sign Maintenance Management Systems are being used by a number of agencies. Many state DOTs contract with local agencies to perform signal maintenance.

The Department’s traffic service maintenance practices are generally in line with industry best practices. The Department has also developed a Sign Management System (SMS). However, the Department may not be achieving a desirable service level for pavement striping. Most pavement guidelines are in need of repainting soon after the winter season. In some cases, the Department does not get to paint all of its roads until late in the summer season. Also, the Department has had difficulty with the
life of its water-based paint. UDOT’s SMS was developed nearly three years ago, but it has not been successfully implemented.

Recommendations include:

**Recommendation 90.** Pilot test contracts for pavement striping.

**Recommendation 91.** Move forward with the Sign Management System.

**Recommendation 92.** Evaluate the effectiveness of current signal maintenance resources.

26. **Supervision, Training, and Support Maintenance**

Activity standards for this category involve a wide variety of activities and functions and previous chapters have addressed many relevant best practices, including asset management, training, and contract maintenance. In addition, a previous audit addressed issues with the Department’s equipment management system and equipment preventive maintenance.

27. **Rest Area Maintenance**

UDOT maintains its rest areas under a statewide contract with a private firm. The contractor is responsible for all work at the rest area site except for a few activities performed by UDOT forces. The Department performs periodic evaluations of the rest areas. During the MMQA semi-annual road inspections, the rest areas are given a detailed inspection. A check sheet is used to grade each maintenance feature at the site, and a total score is given. Most interviewees from the regions/districts agreed that the private contractor does a good job maintaining rest areas.

Best practice for rest areas focus on providing a healthy, safe and convenient environment for motorists who use the facilities. Key components of best practice include customer focused attendants, regular safety inspections, quality and performance checklists, preventive maintenance schedules, and solicitation of customer feedback.

The Department’s current approach to rest area maintenance is in line with industry best practices. The condition of the areas has apparently improved since the implementation of a new private contractor. However, some region/district employees believe that outdated rest areas need to be replaced in order to provide an acceptable level of maintenance.

We have no recommendations for improving rest area maintenance.