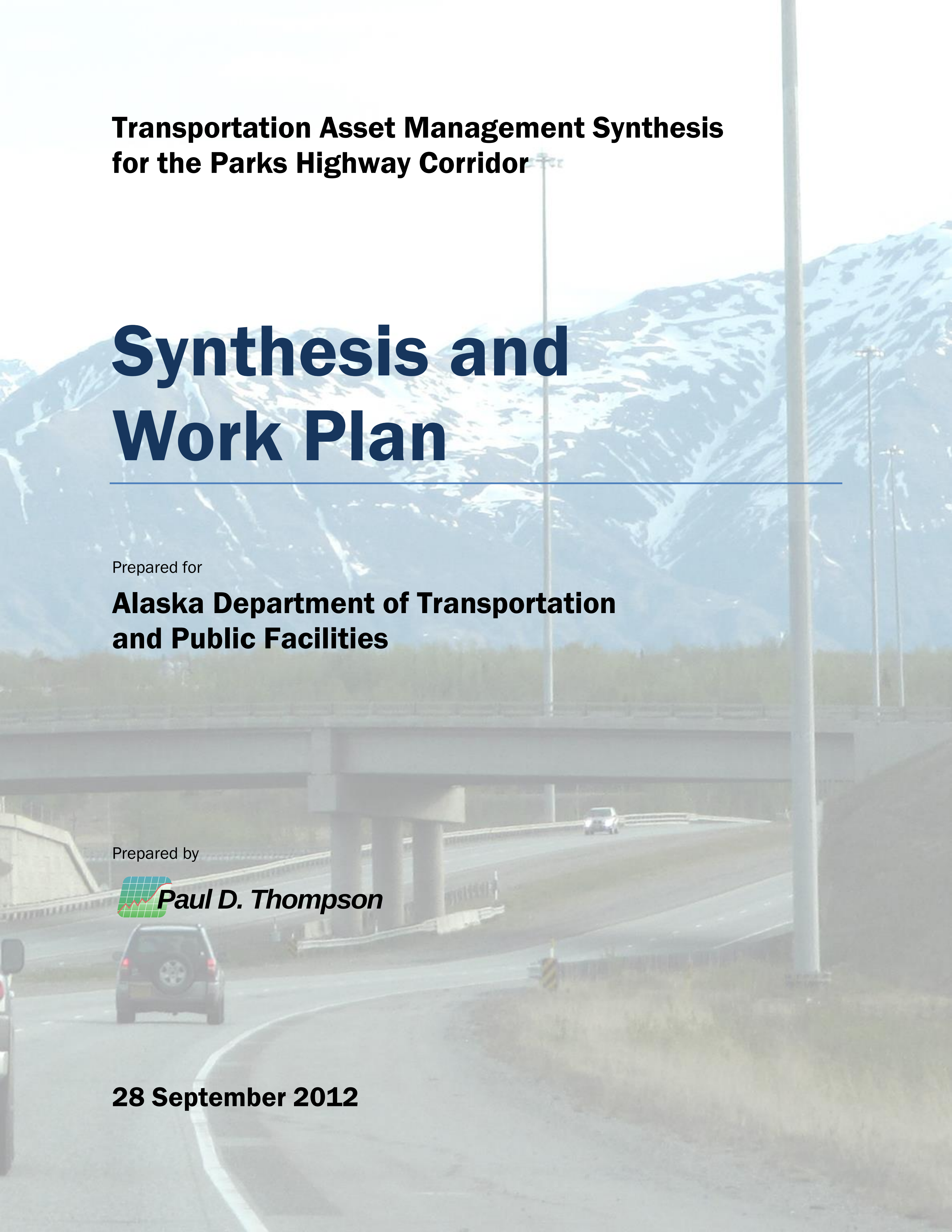

Transportation Asset Management Synthesis for the Parks Highway Corridor

Synthesis and Work Plan

Prepared for

Alaska Department of Transportation and Public Facilities

Prepared by

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28 September 2012

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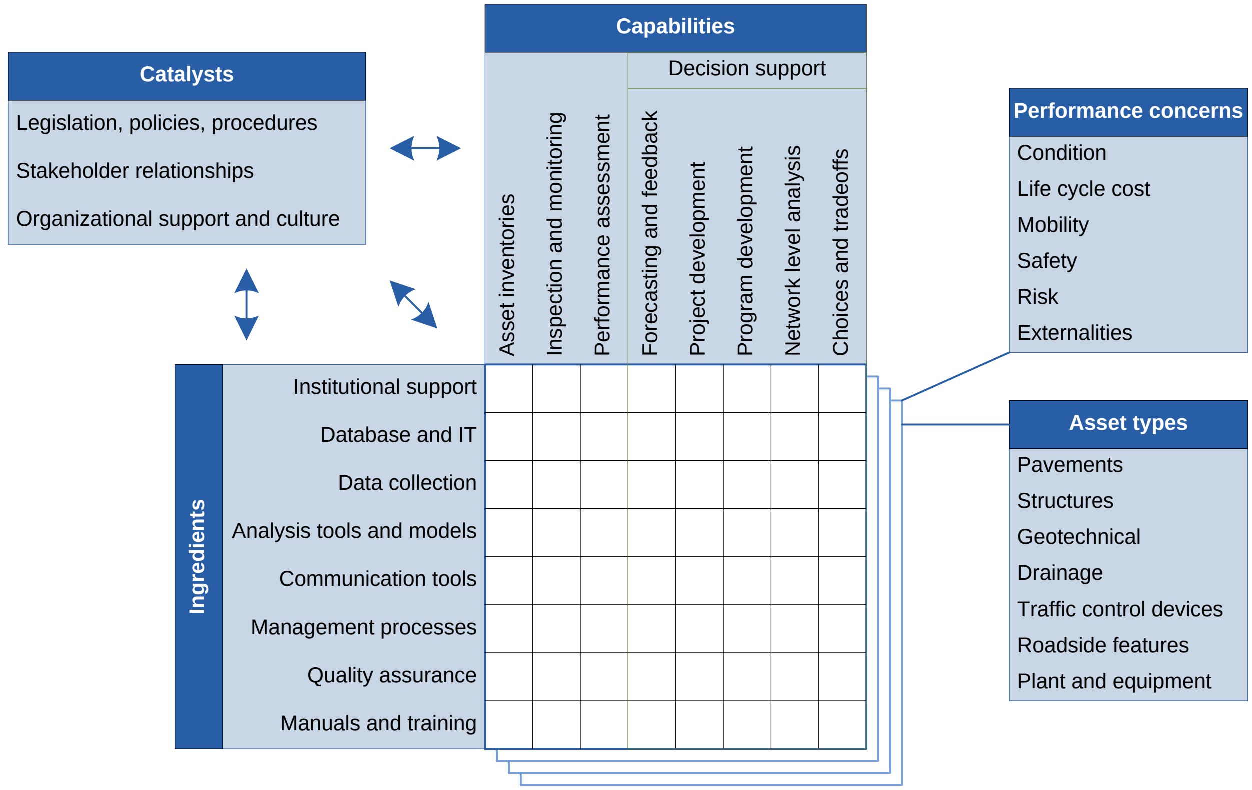
Executive summary

Transportation Asset Management (TAM) is a strategic and systematic process of maintaining and managing infrastructure assets throughout their life cycle, focusing on business and engineering practices for resource allocation and utilization. It uses data and analysis to improve decision making, with the objective of providing the required level of service in the most cost effective manner.

The Alaska Department of Transportation and Public Facilities (DOT&PF) desires to improve its asset management practices, as a means to improve the life cycle cost effectiveness and performance of its physical infrastructure. The Department may be characterized as being in the Awakening stage of asset management maturity, where a basic set of capabilities are in place for a few types of assets, but these are not yet integrated into Department-level decision making. There is considerable room for enhancement through a variety of initiatives involving data, research, procedures, tools, and culture.

This document provides a comprehensive synthesis and gap analysis, using the general framework shown below to describe the state of the practice and the Department's position within it. In most cases there is wide variation in best practices across the industry, so the focus is on levels of maturity that the Department can reasonably attain over the next few years.



Currently the Department has a considerable amount of data on certain assets and certain performance concerns, particularly pavement roughness and rutting, bridge condition and geometrics, geotechnical material sites, and unstable slopes. These data sources have been linked in a Parks Highway Data Integration Page, providing a user-friendly geographic perspective on corridor conditions and performance.

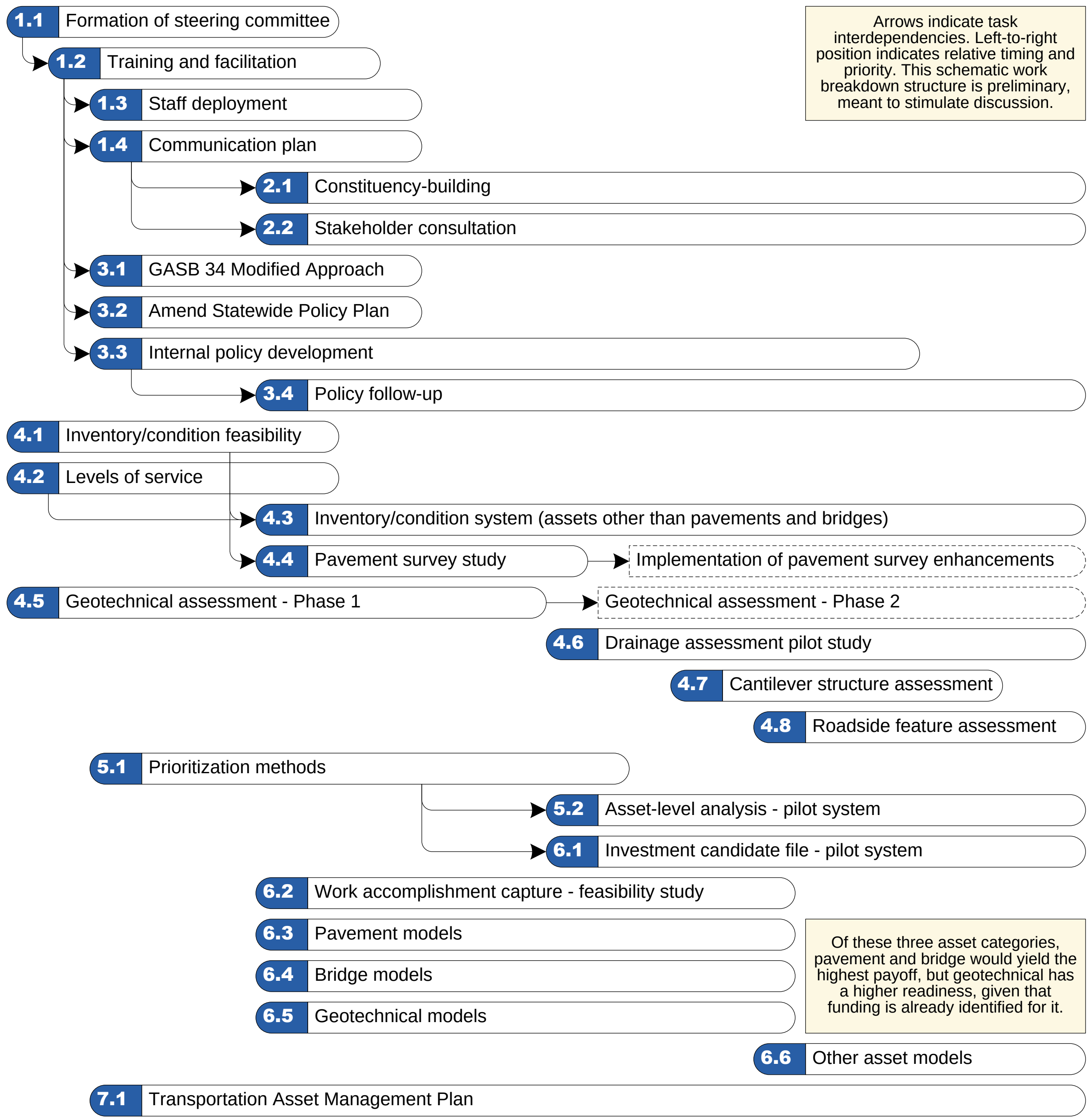
To date, these data resources are not yet used to their full potential to maximize the performance of the Parks Highway Corridor. There are important gaps in the asset inventory, particularly for drainage assets, traffic control devices, and roadside features. Routine processes for monitoring conditions and performance, and for updating a central asset performance database, are missing for important parts of the inventory. Given the complexity of the raw engineering data, there is a strong need for simple means of summarizing performance, forecasting future performance, and predicting the likely outcomes of alternative preservation decisions to keep the corridor in service reliably and at minimum cost.

A few important steps are already underway, such as a set of innovative projects on geotechnical asset management, featuring development of levels of service and forecasting models for unstable slopes; and risk analysis of geotechnical hazards. There is also an investigative study underway on information technology support for asset management. A number of additional tasks are needed in the areas of policy development, organizational issues, stakeholder relationships, asset inventories, performance assessment, and some basic decision support tools.

With the synthesis and gap analysis as context, this report provides a specific work plan with planning-level estimates of cost, resource requirements, and time allowances; and suggests relative priorities based on the inter-relationships among tasks, current Department readiness, and likelihood of success. The work plan is designed for a time frame of 2012-2014, an ambitious but not unusual period in which a significant step in maturity can be achieved. The schematic diagram on the next page presents an overview of the work plan.

Each task in this work plan is conceived as a self-contained project, usually small, capable of being managed with a defined scope, cost, schedule, and deliverables. Each can stand on its own and has benefits in its own right. Most importantly, the tasks all contribute to an integrated vision of asset management that moves the Department forward in maturity, that responds effectively to Federal requirements, and that contributes to delivery of more cost-effective transportation service.

The Parks Highway focus will help to constrain the scope of the effort, enabling quick pilot testing and refinement of new methods while providing the Department with valuable experience. At the same time, early success will enable stakeholders to visualize how the methods and tools of asset management affect decision making and outcomes. This experience will facilitate more effective implementation when modern asset management is extended to additional corridors in the state transportation network.


1.1 Formation of steering committee
1.2 Training and facilitation
1.3 Staff deployment
1.4 Communication plan
2.1 Constituency-building
2.2 Stakeholder consultation
3.1 GASB 34 Modified Approach
3.2 Amend Statewide Policy Plan
3.3 Internal policy development
3.4 Policy follow-up
4.1 Inventory/condition feasibility
4.2 Levels of service
4.3 Inventory/condition system (assets other than pavements and bridges)
4.4 Pavement survey study
Implementation of pavement survey enhancements
4.5 Geotechnical assessment - Phase 1
Geotechnical assessment - Phase 2
4.6 Drainage assessment pilot study
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5.1 Prioritization methods
5.2 Asset-level analysis - pilot system
6.1 Investment candidate file - pilot system
6.2 Work accomplishment capture - feasibility study
6.3 Pavement models
6.4 Bridge models
6.5 Geotechnical models
6.6 Other asset models
7.1 Transportation Asset Management Plan
Arrows indicate task interdependencies. Left-to-right position indicates relative timing and priority. This schematic work breakdown structure is preliminary, meant to stimulate discussion.
Of these three asset categories, pavement and bridge would yield the highest payoff, but geotechnical has a higher readiness, given that funding is already identified for it.

1. Introduction

Transportation Asset Management (TAM) is a strategic and systematic process of maintaining and managing infrastructure assets throughout their life cycle, focusing on business and engineering practices for resource allocation and utilization. It uses data and analysis to improve decision making, with the objective of providing the required level of service in the most cost effective manner.

Alaska DOT&PF desires to improve its asset management practices, as a means to improve the life cycle cost effectiveness and performance of its physical infrastructure. While the Department already has a set of basic asset management business processes, there is considerable room for enhancement through a variety of initiatives involving data, research, procedures, tools, and culture. This study is the first effort to document a comprehensive overview of all facets of TAM across all asset types, to identify the highest priorities for future effort.

In the context of the George Parks Highway (Exhibit 1-1[1]), this report synthesizes and compares existing Department practices with industry best practice; provides a work plan with planning-level estimates of cost, resource requirements, and time allowances; and suggests relative priorities based on the inter-relationships among tasks, current Department readiness, and likelihood of success.

The Parks Highway focus will help to constrain the scope of the effort, enabling quick pilot testing and refinement of new methods while providing the Department with valuable experience. At the same time, early success will enable stakeholders to visualize how the methods and tools of asset management affect decision making and outcomes. This experience will facilitate more effective implementation when modern asset management is extended to additional corridors in the state transportation network.

1.1 Objectives of improving asset management

The Department seeks to improve its capability to use data and analysis to support decision-making, which will have the effect of increasing the cost-effectiveness of Department assets. This entails a coordinated and managed set of initiatives to modify existing business processes with the aid of some additional data and tools. The objectives of these combined initiatives are:

- Maintain or improve the performance of assets in the Parks Highway Corridor, and by doing so, improve the performance of the corridor.

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[1] http://www.dot.state.ak.us/stwdplng/mapping/mapproducts.shtml

- Reduce and optimize life cycle costs, first by knowing what these costs are, then understanding and controlling the drivers of these costs.
- Achieve the full potential return on infrastructure investment, by planning and undertaking life extension opportunities at strategic times, and by increasing the Department's ability to optimize preservation activity.
- Increase the Department's ability to manage risk, which is especially important given the sensitivity of the network to service disruption due to natural and man-made hazards, or due to the programmatic risk that funding deficiencies or lack of staffing or project readiness could prevent the Department from responding effectively and timely to infrastructure needs.
- Communicate more clearly with stakeholders and customers, so they understand the Department's decision-making process and trust Department personnel to do the right things at the right times to keep the corridor in service.

Achieving these significant objectives involves a managed program of steps to improve data and analysis resources, and to integrate decision support tools across the various classes of assets and categories of performance concerns. A systems approach is essential.

1.2 Synthesis and gap analysis approach

The ability to measure performance systematically and reliably across an asset inventory, is an important milestone in asset management. The ability to store and track this information over time (i.e. a periodic data collection program with objective, repeatable results) is a further advancement in maturity. Further advancement provides the ability to forecast future performance, which is a necessary step in developing credible performance objectives for the future. These developments follow a natural sequence. For example, credible forecasting is impossible unless the agency already has the ability to track performance over time; without that, there is no way to know if the forecasts

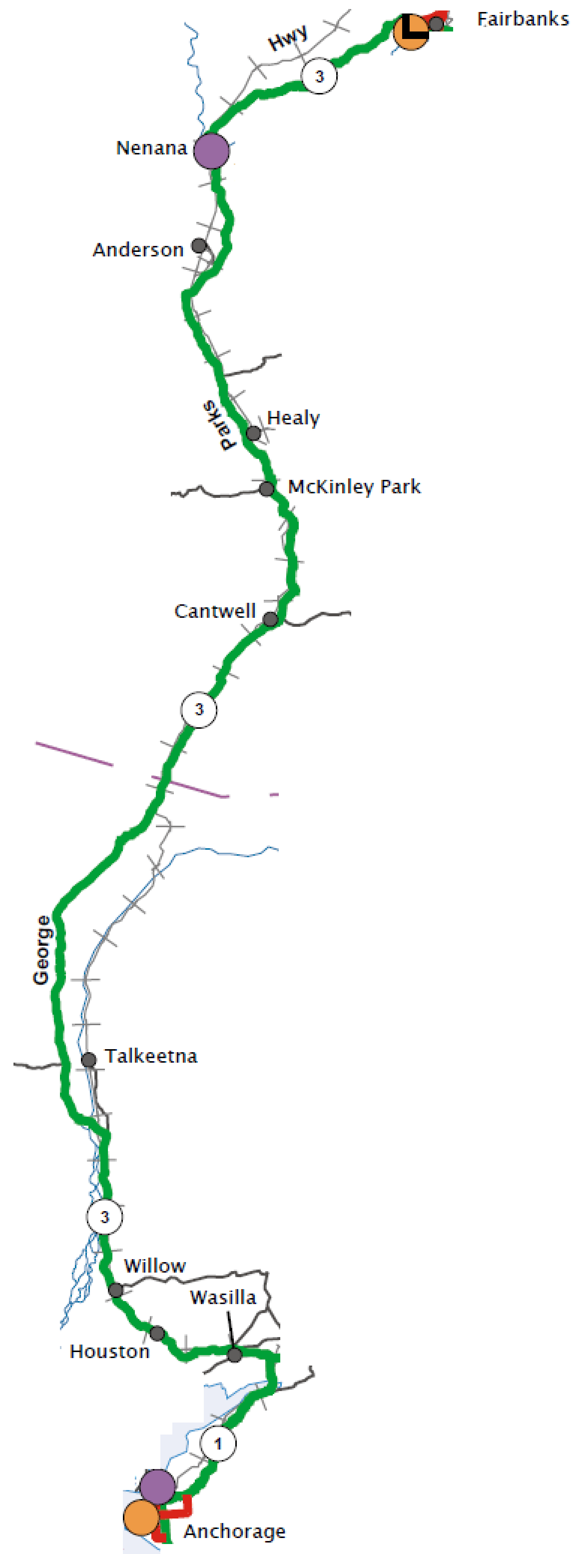


Exhibit 1-1. George Parks Highway

are accurate.

All state DOTs have some experience in trying to improve their asset management capabilities. AASHTO has published the AASHTO Transportation Asset Management Guide, Volume 2: A Focus on Implementation (Gordon 2011) as an authoritative source for describing the state of the practice and as a guide for efforts to improve.

All of the capabilities that make up asset management have identifiable stages of maturity, with inter-dependencies from one stage to the next. Recognizing this fact, the AASHTO Guide defines a maturity scale, as follows:

1. Initial: No effective support from strategy, processes, or tools. Minimal internal use of quantitative performance information. There can be lack of motivation to improve.
2. Awakening: Recognition of a need, and basic data collection. There is often reliance on heroic effort of individuals. Asset inventory and performance information is used by individuals but rarely shared.
3. Structured: Shared understanding, motivation, and coordination. Development of processes and tools. Performance information is tracked and used for internal vertical communication and decision-making, but silos still inhibit horizontal communication.
4. Proficient: Expectations and accountability drawn from asset management strategy, processes, and tools. Performance information, forecast as a function of decision-making, is used for setting objectives and measuring accomplishments. Communication of performance is both horizontal and vertical.
5. Best Practice: Asset management strategies, processes, and tools are routinely evaluated and improved. Performance information is used to optimize decision making.

Maturity levels can vary by business process, by type of asset, by capabilities and their ingredients. The AASHTO Guide provides a method for boiling these variations down into a maturity index. This can be useful for tracking the maturation process over time.

Because of the interdependencies among maturity levels of the various asset management capabilities, it is not possible for most agencies to jump from their current maturity to best-practice maturity in any short time period. Maturation happens in phases. For the present study, the first phase is envisioned as 2012-2014. The key is to identify the critical gaps that inhibit progress at any given time, build support and determination to improve, and implement a plan to overcome those gaps.

1.3 Framework for the synthesis

Exhibit 1-2 shows the framework to be used to organize the synthesis. At the center is a set of key capabilities that make up an agency's asset management power. These are the focus of the synthesis because they are easy to recognize, can often be measured, and can often form the subject matter of manageable tasks having tangible deliverables.

Given the TAM definition given above, decision support capabilities are especially important as indicators of progress. They are the means by which data and analysis can be put to work to improve decision-making.

Each of the capabilities is made up of ingredients which together make each capability possible. Typically a capability will fail if any of the ingredients is missing. For example, the assessment of performance, no matter how comprehensive or sophisticated, is sterile if it is not communicated to all the stakeholders who can use the information. Similarly, the assessment is not credible if quality assurance procedures are absent.

Asset management is meant to be an improvement — a positive change — in the way the Department operates. An object at rest tends to stay at rest unless acted upon by an outside force, which is usually the initiative taken by champions within or close to the agency. Champions are typically a small number of people with limited power by themselves to affect change. Thus change tends not to happen unless a catalyst is also supplied. In asset management, several catalysts are available, and typically act in combination to facilitate progress.

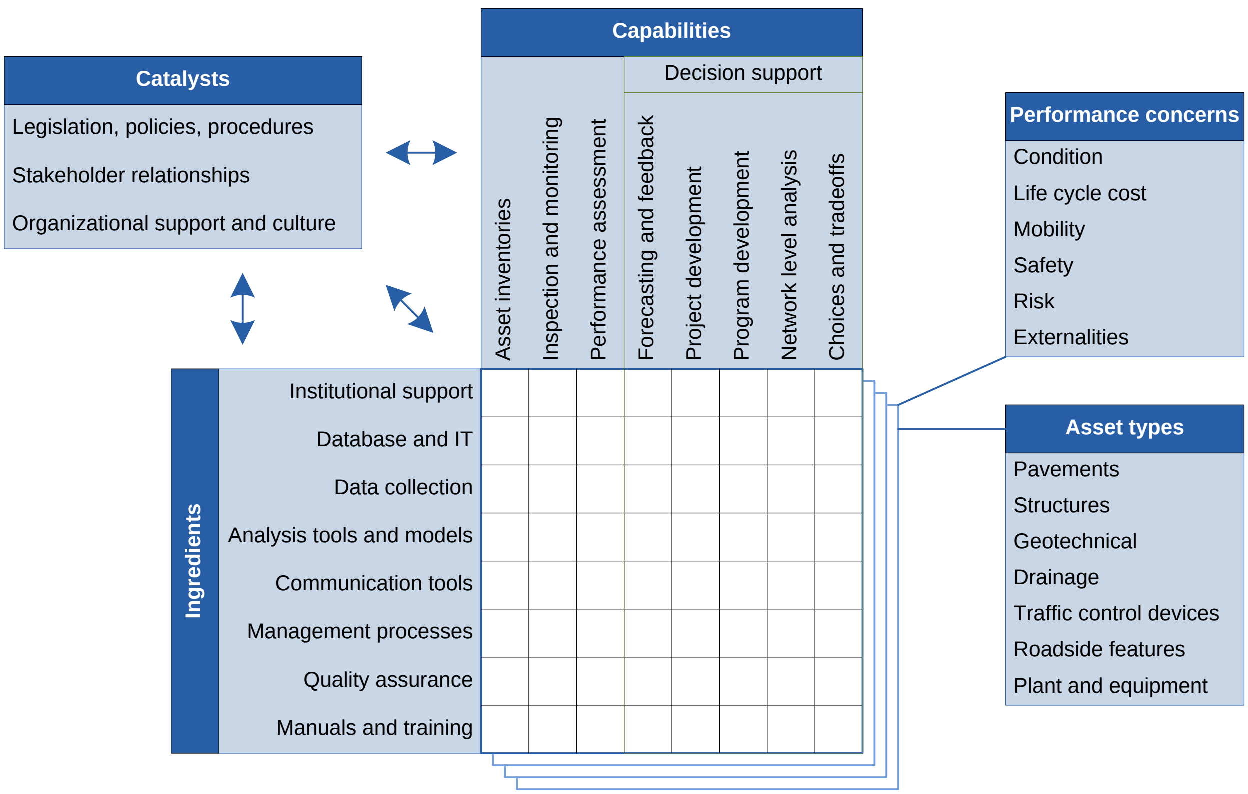


Exhibit 1-2. Synthesis framework

A few catalysts are listed in Exhibit 1-2, but one more is not listed: crisis. Asset management progress has often been propelled by crises, but presumably a goal is to avoid this particular catalyst if possible. Risk management is a key part of the decision support capability, which can help the agency avoid crises.

The relationship among catalysts and capabilities is two-directional. Catalysts enable development of capabilities, but capabilities also inspire catalysts. For example:

- The ability of the Department to assess its performance reliably, may inspire a stronger and more positive relationship with stakeholders, who then help to spur further progress.

- An agency that gains confidence in its performance measurement and forecasting is in a better position to build a culture that values better agency performance.
- When senior management comes to understand that all the necessary ingredients are in place for effective decision support, it is more likely to be pro-active in supporting and promoting further progress in asset management.

Agencies that have been successful in asset management often pay special attention to this ability to fortify catalysts.

Historically, asset management capabilities have been built with a narrow focus on just one type of performance and one type of asset. Early pavement management systems, for example, focused just on condition of pavements. By listing a broader range of performance concerns and asset types in Exhibit 1-2, the diagram emphasizes that there is much more to asset management than pavement condition.

Certain aspects of asset management, especially data collection processes, will always be limited to their silos of technical expertise in specific performance concerns and asset types. Moreover, the level of detail, technology, and investment will vary across these dimensions. For example, the level of resources applied to measuring performance of roadside features will never match the resources necessary for structures. Resource commitments have to fit the level of performance benefits that are at stake.

1.4 Organization of this document

After a preliminary review of the context for asset management in the AKDOT&PF, this document has two main sections:

- Synthesis and gap analysis. For each of the catalysts and capabilities shown in Exhibit 1-2, the general state of the practice is described, including best practices. In most cases there is wide variation in best practices across the industry, so the focus is on levels of maturity that the Department can reasonably attain over the next few years. The gap to be identified is the near-term improvement that is believed to be feasible for the Department.
- Work plan. A set of work tasks is defined, in order to close the identified gaps. Some of the tasks are best done internally, and some by stakeholders or consultants. In each case a recommended approach, planning-level resource estimates, and calendar time requirements are estimated.

The work plan listing closes with a presentation of the author’s sense of relative priorities. Naturally it is up to Department management to set priorities, but some guidance can still be developed from task interrelationships and the assessment of Department readiness and likelihood of success.

2. Synthesis and gap analysis

It is important to recognize that the Department already has in place a number of business processes and tools for asset management. The essence of the present study is the belief that these existing processes can be improved by a set of specific initiatives in a specific time frame, namely 2012-2014.

Many state DOTs are more advanced, and many are less advanced. It isn't useful to make general comparisons of the Alaska DOT&PF with other specific agencies, but much can still be learned by examining how agencies typically advance in maturity over time. Such an analysis can help define the near-term feasible range of improvement, and the logical sequence of new investments in asset management.

AASHTO has published an Asset Management Guide (Gordon et al 2011) which summarizes the state of the practice at all maturity levels. A structured analysis, presented in this report, can locate the DOT&PF on the typical nationwide (in fact, worldwide) maturity scale in order to identify the logical next steps with greatest likelihood of success. That is the goal of this chapter.

2.1 Legislation, codes, and policies

In agencies which successfully implement asset management, written rules are a necessary catalyst. Having a solid basis in law or policy can help the Department in its implementation decision making, as well as help to forestall potential barriers. It is not uncommon for organizational change to meet resistance, and sometimes this resistance is abetted by a lack of statutory or policy support.

2.1.1 Legislation

Federal legislation has specified certain principles of asset management, starting with the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). Although the management system requirements of ISTEA were subsequently made optional, many states, including Alaska, proceeded with some of the initiatives called for in the legislation, on the basis that these represented good management practice.

More recently, the Moving Ahead for Progress in the 21st Century Act (MAP-21), signed into law on July 6, 2012, has made the principles more explicit and more integrated into nationwide transportation decision making, with its focus on performance management. The legislation follows the same principles as the AASHTO Asset Management Guide and describes some of the same products, especially a State Transportation Asset Management Plan for the National Highway System.

The law requires FHWA to issue guidance on the implementation of the new Act. As of this writing it is anticipated that the rule-making process will take place over the next two years. The Act specifies some tight deadlines for compliance with certain of its requirements.

As is the case in other states, Alaska does not have any specific provisions in state statutes related to transportation asset management. Under Title 44, Chapter 42, Section 20, "Powers and Duties" of the Department of Transportation and Public Facilities, the following sub-sections are relevant:

> *(a) The department shall*
>
> *(1) plan, design, construct, and maintain all state modes of transportation and transportation facilities and all docks, floats, breakwaters, buildings, and similar facilities;*
>
> *(2) study existing transportation modes and facilities in the state to determine how they might be improved or whether they should continue to be maintained;*
>
> *(3) study alternative means of improving transportation in the state with regard to the economic costs of each alternative and its environmental and social effects;*
>
> …
>
> *(10) develop facility program plans for transportation and state buildings, docks, and breakwaters required to implement the duties set out in this section, including but not limited to functional performance criteria and schedules for completion;*
>
> …
>
> *(15) at least every four years, study alternatives available to finance transportation systems in order to provide an adequate level of funding to sustain and improve the state's transportation system.*

The key points in the Statute are the responsibility to maintain transportation facilities in sub-section (a)(1); the duty to study existing facilities and to evaluate economic costs and environmental and social effects in (a)(2) and (3); the responsibility for facility program plans in (a)(10); and the emphasis on studying alternatives, which appears in several sections especially (a)(3) and (15).

For more specificity on "*economic costs of each alternative and its environmental and social effects*", the Alaska Administrative Code provides the following guidance in 17 AAC 05.125:

> *(a) In the statewide transportation planning process, the department will consider goals and objectives that will further*
>
> *(1) the economic vitality of the state;*
>
> *(2) the safety and security of users of the state's transportation system;*
>
> *(3) accessibility and mobility options available to people and for freight;*
>
> *(4) the integration and connectivity of various modes of the state's transportation system;*
>
> *(5) the preservation of existing transportation systems; and*
>
> *(6) any metropolitan area plan developed under 23 U.S.C. 134 and 49 U.S.C. 5303-5306.*
>
> *(b) When formulating its goals and objectives in the statewide transportation plan, and the strategies to implement those goals and objectives, the department will consider the concerns of*

> *interested persons and minimize any adverse environmental, economic, or social impact of those goals and objectives upon any segment of the population.*

A more specific reference to performance management appears in the Alaska Statutes in AS 37.07.040, Office of Management and Budget (OMB), which is directed to:

> *(10) establish and administer a state agency program performance management system involving planning, performance budgeting, performance measurement, and program evaluation; the office shall ensure that information generated under this system is useful for managing and improving the efficiency and effectiveness of agency operations.*

This provision motivates the OMB Key Performance Indicators, where the Alaska DOT & PF is characterized using the performance measures shown in Exhibit 2-1. This set of indicators addresses, some, but not all, of the objectives mentioned in 17 AAC 05.125. More to the point, it is a responsibility assigned to the Office of Management and Budget, and not to the Department of Transportation and Public Facilities. Therefore, this section of the Administrative Code does not provide a means of improving the types of performance that it measures, nor any effective linkage to decision making.

Exhibit 2-1. OMB Key Performance Indicators[2]

End result	Strategies to achieve end result
A. Provide a safe transportation system; eliminate injuries, fatalities and property damage.	A1: Build and improve state-owned roads and highways to appropriate department standards. A2: Preserve or improve condition of highway infrastructure.
B: Provide a transportation infrastructure that supports and promotes economic growth.	B1: Enhance economic activities through key transportation services. B2: Enhance economic activities through increased State revenue. B3: Improve efficiency.
C: Carry out safe operations.	C1: Improve employees' awareness of workplace safety requirements.
D: Reduce the risk of accidents or road damage from unsafe commercial vehicles and/or loads.	D1: Reduce number of illegal oversize/overweight Commercial Motor Vehicles (CMVs) on highways.
E: Reduce design and construction project management costs.	E1: Minimize administrative and engineering costs associated with projects.

2.1.2 Public policy

The Department does not have public policy documents that refer specifically to asset management. The Department's Strategic Plan (Exhibit 2-2) also doesn't address the topic. However, the Statewide Policy Plan (AKDOT&PF 2008) provides relevant guidance:

> *Policy 3: Apply the best management practices to preserve the existing transportation system.*
>
> *Policy 4: Increase understanding of and communicate ADOT&PF's responsibilities for system preservation as the owner of highways, airports, harbors, and vessels.*
>
> *Policy 5: Ensure the efficient management and operation of the transportation system.*

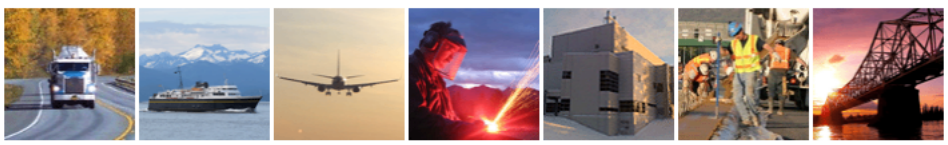
Additional policies refer to specific aspects of performance to be managed, including cost-effectiveness, mobility (encompassing travel time, access, and reliability), safety, security (encompassing facility risk and emergency preparedness), energy efficiency, economic development, and other positive social attributes (environmental, social, economic, human

[2] http://omb.alaska.gov/html/performance/details.html?p=157

health, local community concerns, and quality of life). Policy 14 is the most specific about decision support for asset management:

> *Policy 14: The statewide plan will provide the analytical framework from which ADOT&PF sets investment priorities.*
>
> - *We will monitor, forecast, and report transportation system performance through data-driven management systems.*
> - *We will provide information for performance-based planning and budgeting.*
> - *We will promote and work to improve coordination between public transportation and human services transportation.*
> - *We will use best practice techniques and technology for involving the public in the transportation planning process.*

DOT&PF Strategic Plan



Purpose

Get Alaska Moving through service and infrastructure.

To do this we:

- Provide for the safe and efficient movement of people and goods
- Provide access to state services
- Open opportunities for exploration and development of Alaska's resources

Core Values

From our history to date and from the commitments we all share now about the future, we have defined the values that should guide our activities and staff in the years to come.

These are our core values:

- ***Integrity:*** Ensure honesty, dependability, loyalty, and a high ethical standard
- ***Excellence:*** Personal and department commitment to continually improve individual, team, and organizational knowledge, performance, and methods to provide superior service and products
- ***Respect:*** Positive regard for colleagues and customers

Our Vision

Expand Alaska's transportation system

- We will become the premier state organization known for transparency, accountability, innovation, superior service, and employee retention
- We will create more efficiencies in our current system and develop new corporate and public partners
- We will achieve service-based management of our state-owned transportation assets and facilities
- We will expand the reach of our surface transportation system
- We will provide access to Alaska's undeveloped resources

Strengths

- Strong work ethic
- Experience, expertise, knowledge
- Dedicated workforce
- Quantity and quality of assets
- Interesting challenges
- Opportunity for growth
- Pride of accomplishment
- Good people
- Willing to lead

Exhibit 2-2. Alaska DOT&PF Strategic Plan[3]

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[3] http://dot.alaska.gov/comm/strategic_plan.shtml

As the Statewide Policy Plan proceeds to describe strategies and actions, it sets a very positive direction for asset management while also demonstrating the limits of the Department's current capabilities. In strategy 1, the need is expressed for a system perspective:

> *Because our transportation system is a network of different modes of transportation, and within modes different facilities, we can make better use of funds by starting from a system-level perspective. This is especially important in a fiscally constrained environment because this level of analysis enables consideration of how best to provide the infrastructure to meet the state's diverse travel demands.*

Action 1.1 starts to express one of the key institutional needs, in order for asset management to take root in the Department:

> *The plan distinguishes between routine maintenance, life cycle management, and system development. Going forward we will use planning analysis to support this decision making.*

The current report will have much more to say on the topic of "*planning analysis to support this decision making*". It is evident that the planning analysis is not yet fully established. Action 1.1 goes on to say that the Department plans to fund routine maintenance, preservation, and life cycle management "at current levels." It does not provide any quantitative indication of the performance that can be achieved at current levels of funding, nor at alternative funding levels. It states that

> *If the total budget increases, we will increase preservation and life cycle management funds at a level proportionate to the current allocation.*

As the maturity level of asset management increases, agencies typically are able to offer plans that are much more quantitative and specific. It is not self-evident to policy makers that the best level of investment in preservation and life cycle management should be a constant fraction of total funding.

With improved decision support tools, the Department should be able to quantify an optimal level of preservation and life cycle funding, sensitive to performance objectives. This information would enable decision makers to drive funding based on desired level of service, without appealing to historical funding levels that may no longer be relevant. Some of the early steps to accomplish this, are called for in the Statewide Policy Plan:

> *Action 2.2. Establish a core set of performance measures to monitor performance against plan goals.*
>
> *Action 2.3. Apply life cycle management best practices to the selection of pavement treatments – avoid "worst first."*
>
> *Action 2.4. Implement pavement management system analytical capabilities.*
>
> *Action 2.6. Establish a level of service based approach to maintenance and operations planning and budgeting.*

These are not the only necessary steps. Progress can be made for all types of assets, not limited to pavements. Levels of service are very important for improved planning and budgeting, but other methods and tools will also be needed in order for implementation to be successful. Later sections of this report will address this in much more detail.

A key implication of Action 1.1 is that an objective, fact-based planning analysis can and should be performed for routine maintenance and life cycle management. With a sufficiently mature asset management capability, the cost of effective preservation is directly tied to the level of performance desired (Exhibit 2-3). When given this information, decision makers will have powerful new tools to set and implement public policy. They will be able to:

- Select performance targets, and determine the cost of those targets;
- Determine the gain or loss in performance that will result if funding does not arrive in the amounts forecast;
- Separate network growth decisions (which by nature have significant political and economic development implications) from preservation decisions (which by nature are more dependent on weather, age, and traffic);
- Determine the optimal level of preservation funding to maintain desired service levels;
- Determine the additional preservation cost that comes with decisions to expand the transportation network;
- Establish a process for making agency policy sensitive to resource availability.

None of these tools are likely to be available by 2014. They rely on several preparatory steps, including having a reliable inventory of assets needing to be maintained; a systematic process for monitoring conditions and performance; analytical tools for predicting future performance, sensitive to agency actions; and tradeoff analysis tools to connect estimates of funding with estimates of future performance. Many of those tools are feasible to place into service (at least, pilot testing) in the next two years, to make progress in the desired direction.

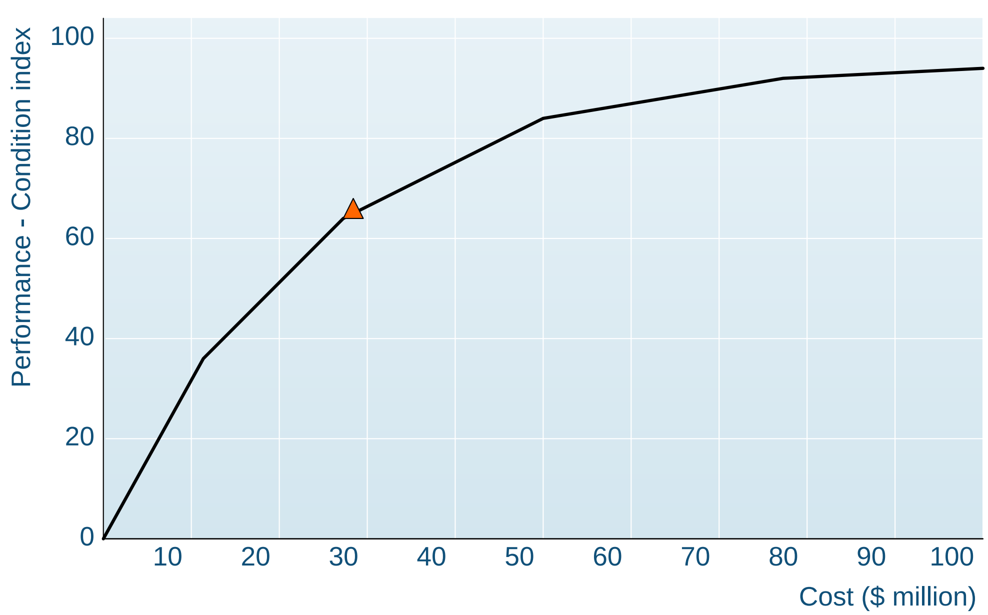

Exhibit 2-3. Performance as a function of investment

2.1.3 Internal policy

Internal to the Department, there is a process for developing and publishing policies and standard operating procedures. These policies are posted on the Department web site (Exhibit 2-4), along with a process (P&P 02.01.010) for developing new policies. So far, few of these policies or procedures are related to asset management.

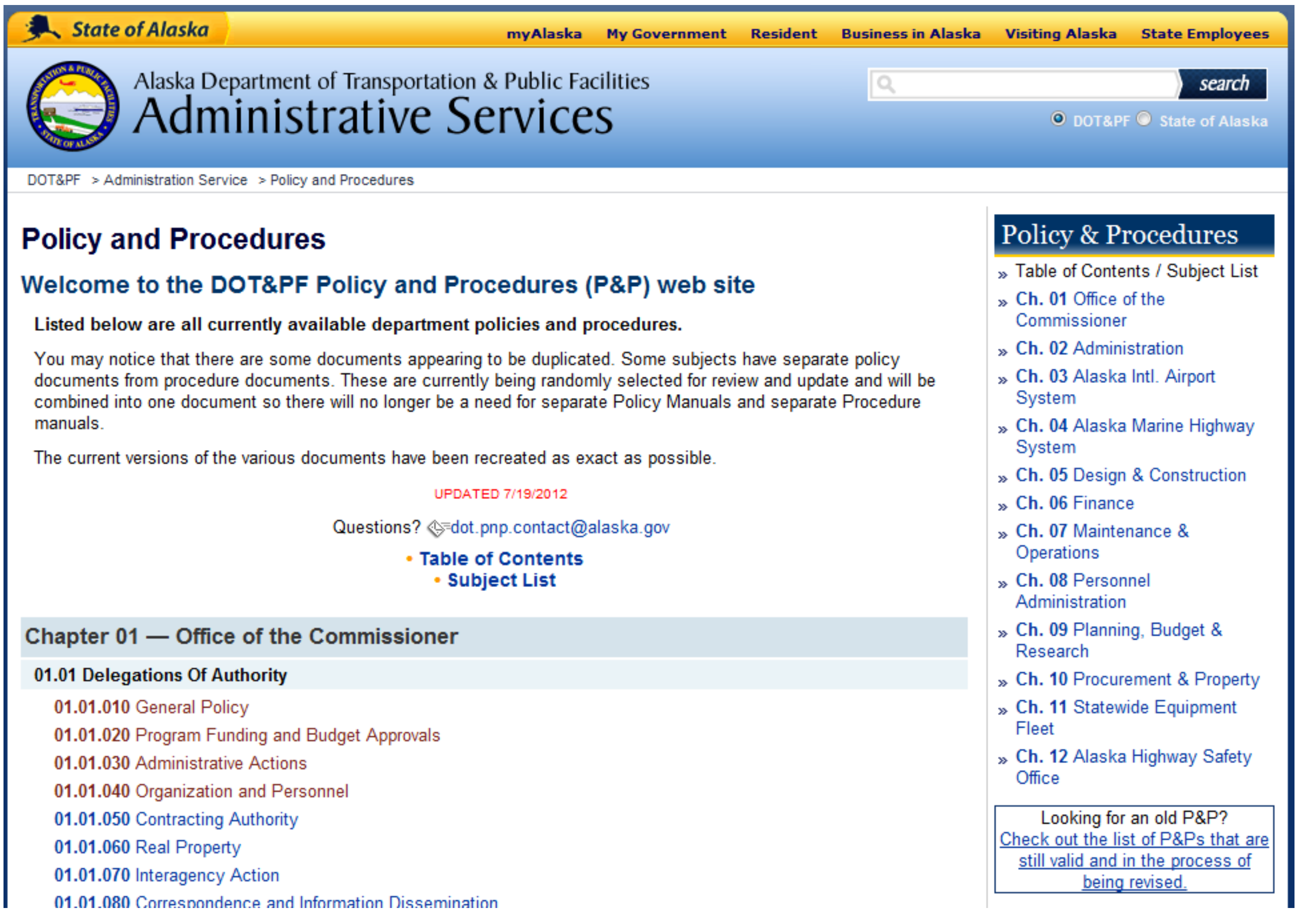

Exhibit 2-4. Policy and Procedures web page[4]

The most relevant documents are[5]:

- The Performance Electronic Tracking System (PETS) will be used to record, track, monitor, and report on both external and internal performance measures (P&P 02.01.017).
- An Information Management Plan will be updated annually by Statewide Information Systems Division and each Region and System (DPOL 02.03.020).

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[4] http://www.dot.alaska.gov/admsvc/pnp/policy_and_procedures.shtml

[5] Based on a summary provided by Victor Winters.

- The department will utilize value engineering techniques in the pre-construction, construction, and operations of selected facilities which will provide the necessary function, safety, and maintenance of the facility at the lowest life-cycle cost (DPOL 05.01.030).
- The department will utilize the Pavement Management System (PMS) to develop a pavement maintenance and rehabilitation program. The intent of PMS is to maintain the network at a desirable performance level at a minimum cost (DPOL 07.05.020).The department will provide immediate corrective or protective action to safeguard the traveling public when a bridge is determined to be critically deficient (DPOL 07.05.060)
- Preventative maintenance will be performed by department M&O forces when it is determined to be cost effective and in the best interest of the state (P&P 07.05.080).
- State Equipment Fleet staff will ensure that the Equipment Management System (EMS) is operational and the database is accurate (P&P 11.01.050).
- The department will manage the Highway Equipment Working Capital Fund (HEWCF) in accordance with procedures established by state statutes and regulations, the Office of Management and Budget (OMB), the Federal Office of Management and Budget Circular A-87, and in accordance with Generally Accepted Accounting Principles (GAAP) (P&P 11.02.001).

It can be seen that the policy support for asset management is spotty. The pavement management policy is fairly detailed, but it is not supported by policies related to inventory, condition assessment, maintenance work accomplishment tracking, project and program development, or priority setting in general. The public policies described in the Statewide Policy Plan are not supported by internal policies and procedures that specify how preservation needs are identified, prioritized, and funded.

Connecting TAM to an agency's business processes requires agreement on common principles and goals, with clear definitions of how each process contributes to overall objectives. TAM activity can be related to general business processes by:

- Formalizing desired outcomes so that specific asset management programs, actions, and budgets can be related back to an agency's strategic objectives;
- Identifying strategic outcomes that the Transportation Asset Management Plan specifically supports and focusing asset management performance measures on these results;
- Developing a performance measure hierarchy that flows downward from strategic planning objectives to operational goals, to support decision-making at every level. This will require asset managers to link their annual work programs back to specific outcomes.

Creation of policies, by itself, does not automatically make the desired outcomes happen. It is very helpful if policies reference and support each other: for example, a policy about project evaluation and priority-setting would be supported by policies that govern the supply of performance data, and the usage of priority criteria in programming and STIP development.

In addition, the successful implementation of new policies relies on several contributing factors:

- Gaining the input and buy-in of stakeholders, including the staff whose activities are driven or constrained by the policy.

- Clear linkage of new policies to existing policies, processes, and deliverables that are already required by external laws and commitments: for example the STIP and the Statewide Transportation Policy Plan;.
- Making a specific individual (identified by title) responsible for the implementation of the policy.
- Making a specific individual responsible for identifying events that make all or part of a policy obsolete, or in need of updating. This person then is responsible for making sure the policy is updated or removed via the policy development process.
- Providing incentives for adherence and improvement of existing policies and procedures.
- Providing tools that help to implement the policies and procedures. These include manuals, training, information systems, spreadsheets and other analysis tools.
- Communicating the policies and their outputs to relevant stakeholders inside and outside of the agency. Examples include reports, web pages, the Annual Report, and meetings and conversations with the stakeholders.

In the last category, the Transportation Asset Management Plan is a particularly important communication tool, which will be described in more detail later in this report.

2.1.4 GASB Statement 34

The Alaska Administrative Code and some of the internal policies make reference to "Generally Accepted Accounting Principles." These principles are documented, in part, by statements promulgated by the Government Accounting Standards Board (GASB) and posted at http://www.gasb.org.

A particularly relevant GASB statement is Statement 34, "Basic Financial Statements—and Management's Discussion and Analysis—for State and Local Governments." This statement has a section that specifies the means of accounting for the value of infrastructure assets owned by transportation agencies. The US Department of Transportation has published a helpful primer on GASB 34 (USDOT 2000).

A significant feature of GASB 34 is the ability to define asset valuation using the "Modified Approach," using the information developed in asset management systems. In the years immediately following adoption of GASB 34, this was often viewed as a potential driver for asset management implementation. With some experience, it is now recognized that GASB 34 is not as much a driver as a catalyst and resource for policy development.

Many agencies that have pursued serious asset management implementation have adopted policies that endorse the Modified Approach. With this in place, additional policies can describe the essential elements of asset management (e.g. inventory data, condition and performance assessment, forecasting, and quantitative processes for project and program development) as a means of supporting the Modified Approach. By making this linkage, the policy legitimacy of asset management is strengthened.

2.1.5 Findings: Legislation, codes, and policies

Finding 1.1. The Alaska Statutes have sufficient direction to reasonably infer the necessity of asset management as a Department responsibility. In particular, the Statutes specify the responsibility to cost-effectively maintain transportation facilities; the duty to study existing facilities and to evaluate economic costs and environmental and social effects; the responsibility for facility program plans; and the emphasis on studying alternatives.

Finding 1.2. The Alaska Administrative Code provides a very important element of support by listing performance objectives for asset management, and by referencing Generally-Accepted Accounting Principles. The Code could be further strengthened if it specifically referenced the "Modified Approach" of GASB Statement 34.

Finding 1.3. The Statewide Transportation Policy Plan further strengthens the mandate for asset management. It has been observed that much remains to be done to accomplish the vision described in the plan. Statements about funding requirements are not tied to any corresponding levels of service or performance. However, the Plan does set the stage for data-driven decision making and the development of decision support analysis capabilities.

Finding 1.4. The Statewide Transportation Policy Plan could have much more to say about fiscally-sensitive levels of service and performance targets. However, the Department currently does not have a way of developing such information.

Finding 1.5. A reasonable process is in place for developing and publishing internal policies. However, these policies offer very little support for asset management. Internal policies to support the public policy statements in the Statewide Transportation Policy Plan, are incomplete or absent. There is no reference to the Modified Approach to GASB Statement 34. There is a policy related to the pavement management system, but not to any other asset types.

Finding 1.6. Successful implementation of a more complete set of internal policies will depend on the development of data, analysis, and communication tools that do not currently exist in the department, and integration of such tools to support a comprehensive asset management vision.

2.2. Organizational and cultural issues

Teamwork and culture are integral to asset management. TAM provides the information and objectives that enable a team to communicate and work together toward shared, measurable ends. A culture that values high performance motivates the efforts to create better processes of asset management. Several factors are necessary for team-building:

- Awareness across the Department, in the management team and at all levels, of the goals of asset management and the benefits that are expected;
- An understanding and agreement that current processes aren't producing the desired result, and thus better processes are needed;
- Involvement of key players at the appropriate level of time commitment;
- Concrete objectives and deliverables for which each player and the group as a whole is responsible, with a suitable time-frame, usually 2-4 years;
- Agreement, documented in writing, of the measures of success;
- Appropriate resources commensurate with the objectives and time frame;
- Training targeted to the needs of each participant;
- A continual process of progress tracking, performance review, and rewards/celebrations for success.

Agencies committed to positive change don't rely on crises as a rationale for change. Rather they challenge the day-to-day process of the organization through a systematic analysis of what is working well, what needs improvement, and how these areas relate to the agency's mission and goals.

Rather than focusing on the concept of what the agency is doing wrong, the process should ask, "What possibilities exist that we haven't thought about yet?" and "what's the smallest change we could make that would generate the biggest impact?" This process helps define what is possible for an agency's future and the rationale for undertaking the changes required to achieve that future vision.

2.2.1 Leadership

Asset management does not require a formal organizational structure of its own, apart from the existing structure of the Department. More accurately, asset management provides a rationale and structure for certain workflows, meetings, and working relationships that may or may not already exist, but are necessary for the agency to accomplish its mission more effectively. Therefore, the leadership structure for TAM is less formal, more ad hoc than the normal organization chart.

Exhibit 2-5 shows an example of a successful leadership structure for asset management. Every TAM implementation effort needs a project manager, the leader of the effort, who devotes a significant part of his/her time to the project. It is understood that the Department already has such a person.

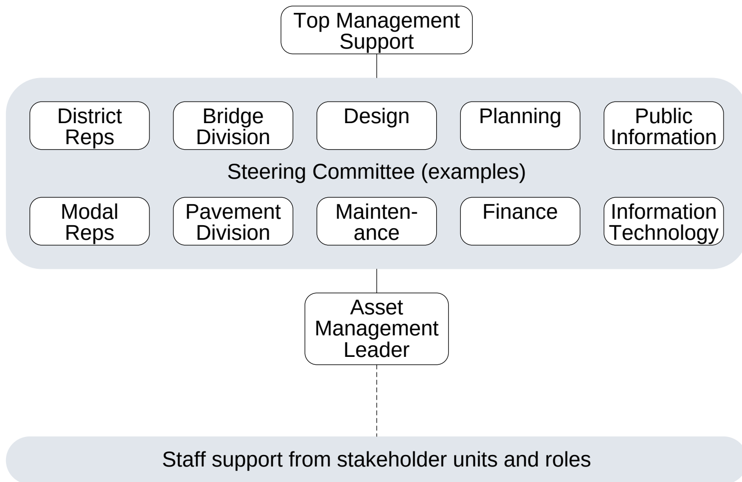

Exhibit 2-5. Example leadership structure
(Gordon et al 2011)

Overseeing the work of the Asset Management Leader, a Steering Committee of relatively senior managers is also essential, for several reasons:

- They provide the necessary breadth of perspective, expertise, experience, and influence.
- They provide staff support.
- They ensure that the asset management process is responsive to the objectives of each agency unit.
- They transmit to their subordinates the purpose and importance of each element of the asset management plan.
- They ensure that the work of the Asset Management Leader is a shared endeavor of the whole Department and not a creation of any one unit by itself.
- As a management team their working relationship builds a shared sense of commitment as well as a shared sense of accomplishment.

Most importantly, Steering Committees like this don't get formed and continue to function without top management support; thus, they are a symbol of that support, that everyone in the organization can see and understand even if the top executives are rarely personally involved.

2.2.2 Leverage

The members of the Steering Committee are senior managers, who routinely manage to meet their responsibilities by means of assistance from the professional and support staff as well as outside partners. They require leverage to be successful.

The same is true of the professional staff leaders. Much of the activity of asset management is off-line but with time-critical communications and decision points. This means the data collection and analysis activities occur on a continuous or seasonal basis over an extended period of time, but decisions usually have to be made within a narrow time window and a premium is placed on communications among the technical leadership team.

With this decision making structure, it is important that the Department's professional staff leaders be leveraged with technical staff, in both professional and technician roles, especially for field work. An issue observed in Department operations is that professional staff leaders are in the field for extended time periods, and unable to participate in key decision points or team activities. As a result, key decisions might be delayed, or key stakeholders left out of decision making.

These informal observations may warrant an investigation to determine if changes in staff complement or deployment might be warranted in certain cases to remove a potential barrier to asset management team-building.

2.2.3 Communication

Successful asset management requires a communication plan and a means of ensuring consistent, reliable, and accurate messaging. When forming a communication plan, change leaders should keep in mind that communication is a two-way street. It involves both the broadcast of a message and the receipt of that message. Listening is as important as speaking. Important considerations when communicating change include:

- The message must be created clearly and with sufficient detail, and must convey integrity and commitment.
- The message recipient must be willing to listen, ask questions, and trust the sender.
- The message must be delivered in a format that is accessible and acceptable for both sender and recipient.
- The message content has to be relevant to the recipient and must connect with the recipient's emotions or beliefs in order to have lasting value.

The communication plan should include approaches to communicating all that is known about the changes as quickly as possible, indicating that information may change as circumstances evolve. The alternative is to withhold communications until all decisions are made; however silence is one of the primary reasons for failure in change initiatives.

The plan should provide time for people to request clarification and provide input, ensuring understanding of the change as well as enrolling employees in the process of creating it. Clarify that everyone is expected to be on board with the change, along with an understanding that this process takes time and effort. Finally the plan should be proactive to avoid rumors, include opportunities for networking, and indicate the timing and process for reviewing progress toward goals.

Currently the Department does not have a communications plan for asset management. Many agencies lack such a plan, but this raises the risk of implementation failure.

2.2.4 Stakeholder relationships

A key strategy of asset management implementation is the idea of managing upward and outward. This is a method of building support from higher levels of the organization and from external stakeholders and partners, by demonstrating the ways in which asset management will directly benefit them in meeting their own responsibilities.

Given that a main benefit of TAM to these stakeholders is the provision of better information for decision making, a valuable strategy is to provide such information as soon as possible. Early successes tend to result in stronger support, which enables the development of better tools. Change agents in the Department should not hesitate to demonstrate partial results, if they are sufficiently accurate and useful, and even if not yet polished. This is the same strategy used by any entrepreneur when seeking investors to develop a new product or service. In fact, the activity is frequently called "intrapreneuring" (Pinchot and Pellman 1999).

Quick prototypes and demonstrations are good for transparency as well as for building support. This kind of activity is very common in innovative organizations of all types, and is a common phenomenon in transportation agencies that have implemented asset management successfully.

The Department is already broadening its asset management effort by developing the draft 2012 Alaska Pavement Report to complement its existing series of Alaska Bridge Reports. Although this study has many specific ideas to improve these reports (by broadening them into a Transportation Asset Management Plan), the existing reports are very well done, forming a solid foundation for positive stakeholder relationships.

Another Department initiative that will help is the development of a GIS-based Data Integration Page (Exhibit 2-6), a performance viewer for the Parks Highway corridor. This new prototype tool will help stakeholders inside and outside the Department to visualize what can be accomplished with better asset management, including better shared knowledge of the infrastructure, better communication, and better decision making.

Building on these recent new initiatives and the recent MAP-21 legislation, it is timely to revisit the concept of performance management, to see if an improved process based more broadly on asset management may serve decision maker needs more effectively. Several elements can help to advance this strategy:

- Treat the earlier service level based budgeting initiative as a first draft of an important, transformative work, since that is exactly what it was. Consult the stakeholders who were initially resistant, to ask for feedback on how to make it more useful and relevant.
- Improve the foundation for performance measurement and performance-based decision making, using the various recommendations made in this Synthesis and Work Plan. This report builds on the excellent work already done, filling in some of the gaps and increasing the Department's ability to reliably measure and forecast performance. Most importantly, the recommendations here will help the Department to link performance with funding, and to answer stakeholder questions and scenarios quantitatively.
- Use the Parks Highway Data Integration Page, now under development, to help stakeholders visualize the use of performance information to improve decision making.
- Continue to involve internal Department personnel in developing better asset management capabilities, as a means of building a team that can, together, overcome the barriers to improvement.
- Bring outside stakeholders into this team, making them responsible for continuing to improve the Department's capabilities.

- Involve new stakeholders who might not be aware of the Department's asset management efforts. Examples include a broader set of legislators, the state Office of Management and Budget, and user groups such as the Alaska Trucking Association, Association of General Contractors, and the oil and gas industries.
- Continue to publish significant asset management accomplishments, such as the Pavement and Bridge Reports, and the Data Integration Page. This will build public expectations of transparency. Over time, the existence of this critical public information will increase Department confidence that it can stand up under scrutiny.
- In internal and external communications, start framing agency performance as though it is the most important measure of success and the most important determinant of future decisions, at least regarding the preservation of existing infrastructure.

These actions work together as an integrated package. Increased expectations, internally and externally, are essential for motivating progress; while at the same time tangible progress makes it possible to turn the expectations into reality.

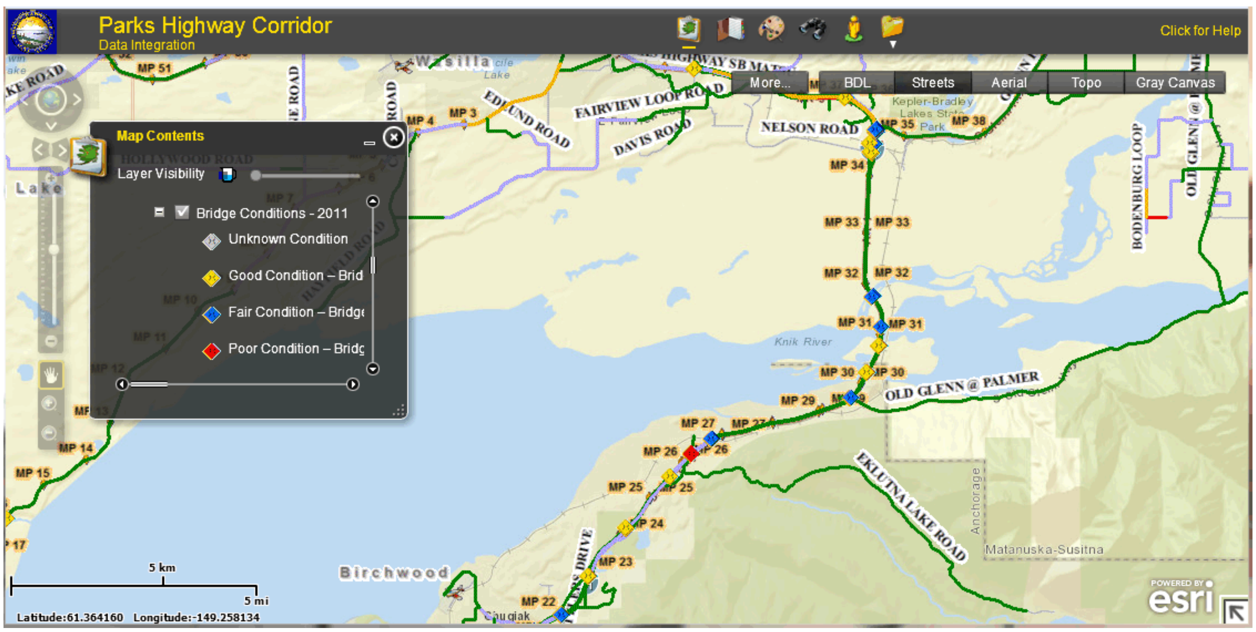

Exhibit 2-6. Parks Highway Data Integration page

2.2.5 Findings: Organization and culture

Finding 2.1. Currently asset management is widely visible within the Department but has not been integrated into organizational culture. The most advanced accomplishments in asset management so far can be characterized as heroic efforts of individuals, rather than a routine team effort. However, there appears to be a growing sense that the Department is ready to engage in team efforts on upcoming initiatives.

Finding 2.2. While there have been a few initiatives to increase the use of performance measurement, Department personnel and stakeholders do not yet see this as essential to their sense of mission or feeling of accomplishment. No evidence was found of any sort of accountability for quantitative performance within the agency or in relationships with outside stakeholders.

Finding 2.3. Recent efforts toward performance-based management can be treated as a first draft of a broader asset management initiative. The Department has already taken steps to significantly improve its capabilities in this area, and much more can be done in the near-term.

Finding 2.4. The Department has, or will soon have, sufficient core staffing to make excellent strides in asset management. It was noted, however, that the Department does not use technicians and interns to the extent common in other agencies for certain tasks such as data collection. As a result, more senior professional staff time is used in performing these roles than is typical in other state DOTs. It may be possible to leverage these senior staff better, thus allowing them to be more engaged in asset management.

Finding 2.5. In the experience of other state DOTs, a Steering Committee is generally viewed as indispensable. The Steering Committee would meet every 1-2 months, and communicate more informally at other times, to facilitate team-building across organizational lines and to ensure that resources are used optimally to advance asset management.

Finding 2.6. Communications with stakeholders on asset management issues are currently inconsistent, and do not give prominence to performance measurement as a critical issue. A formal communications plan may help the various participants within the Department to hone their message and work together more consistently on this matter.

2.3 Asset inventories

An inventory of assets is the foundation on which asset management decision support is built. Every state DOT has at least a partial inventory of its assets, with significant differences among agencies. The most complete and uniform asset inventory across the nation is the National Bridge Inventory (NBI), mandated by Federal legislation. Each state DOT is required to submit an update of this inventory to the Federal Highway Administration (FHWA) each year, for nearly all bridges of at least 20 feet in span that are open to the public, regardless of ownership. The contents of this inventory are specified by the NBI Coding Guide (FHWA 1995). Alaska DOT&PF, like most state DOTs, uses AASHTO's Pontis bridge management system to house its bridge database and to meet the NBI requirements.

All state DOTs also have a pavement management inventory (Flintsch et al 2004), although this does not have the uniform nationwide coverage and is not compiled in a centralized database as is done with the NBI. Other types of assets have significantly less coverage in asset inventories. Exhibit 2-7 summarizes the number of states found to have inventories and condition data for several types of assets, according to a recent survey (Markow 2007).

Exhibit 2-7. Percent of agencies having inventories of each asset type

Asset type	Inventory (percent *)	Condition (percent *)
Traffic signals	78	35
Roadway lighting	69	22
Signs	56	28
Pavement markings	61	42
Drainage culverts	70	50
Sidewalks	31	18

* out of 38 respondents

These are not necessarily complete statewide inventories. In most cases, inventories are limited to assets owned and/or maintained by the state DOT. They often are further limited to the state highway network or to particular corridors, districts, or functional classes. In most cases they are updated each year, but in some cases they are updated more often (especially for roadway lighting) or less (especially for sidewalks). Some have never been updated.

Constraints on staffing and funding typically limit each agency's ability to create and update asset inventories. Most often, the work is performed by consultants or interns. To save money, it is not uncommon for some of the updates to be performed on a sampled basis, especially for small signs and pavement markings.

Also, the inventory unit of analysis is not necessarily the individual asset. For example, traffic signal data may be gathered by mast arm or intersection rather than by individual display head or component. Roadway lighting and pavement markings are often inventoried by roadway segment, with instances of the asset merely counted and classified.

The types of data typically gathered in an asset inventory include:

- Identification: Road and/or facility name, route number.
- Location: Latitude/longitude and linear referencing.
- Description: Including physical classifications, number of lanes, and dimensions.

- Network: National Highway System, Strategic Highway Network, freight networks, school or transit bus routes.
- Jurisdiction: District, maintenance area, functional class, city, county/borough, legislative district, owner agency, maintenance responsibility, delivery responsibility.
- Utilization: Traffic volume, trucks, pedestrians.
- Physiography: geographic features such as rivers, climate zone, presence of permafrost, geology, hydrology.
- Cross-references: Linkages to other assets which are adjacent or related.

Inventories are most often managed in relational databases organized according to a linear referencing system. Each asset is located on the linear referencing system, and is related to other assets through that system. The linear referencing system is used to define road sections, which then may contain a list or count of assets in categories.

2.3.1 Pavements

In its Pavement Management System, the Department maintains a statewide inventory of state-owned pavements, for highways and airfields. The Parks Highway corridor is included in this inventory. Road sections of typically one mile in length form the basis of the inventory, and have a variety of attributes associated with them. In addition to the general highway inventory items listed above, the pavement inventory includes:

- Pavement type
- Equivalent axle loadings
- Materials and thicknesses of pavement layers
- Design parameters
- Past construction and maintenance data
- Pavement condition data as described in a later section

A Pavement Management Engineer is responsible for keeping the inventory up-to-date as changes occur, as the result of new construction, widening, and closing of sections. The linear referencing system used in the Pavement Management System is believed to be suitable for long-term data management and is being used for location referencing of other data stores within the Department. The system itself is owned and hosted by Dynatest, which also gathers the necessary data using a specialized survey vehicle.

2.3.2 Structures

As required by Federal legislation, the Department maintains an inventory of all bridges open to the public, of at least 20 feet in span, regardless of ownership. In addition, certain bridges and culverts with span lengths of 10-20 feet are included. The inventory has all data items required by the Federal National Bridge Inventory Coding Guide (FHWA 1995), and also all structural elements described in the AASHTO CoRe Element Guide (AASHTO 2002, Exhibit 2-8). While the AASHTO Guide is not legally mandated, nearly all of the states use it voluntarily as an authoritative framework for performing maintenance inspections of transportation structures.

Exhibit 2-8. Examples of AASHTO CoRe elements and condition states
(AASHTO 2002)

13 - Concrete Deck - Unprotected w/ AC Overlay	107 - Painted Steel Open Girder/Beam
1. The surfacing on the deck has no patched areas and there are no potholes in the surfacing.	1. There is no evidence of active corrosion, and the paint system is sound and functioning as intended to protect the metal surface.
2. Patched areas and/or potholes or impending potholes exist. Their combined area is 10% or less of the total deck area.	2. There is little or no active corrosion. Surface or freckled rust has formed or is forming. The paint system may be chalking, peeling, curling, or showing other early evidence of paint system distress, but there is no exposure of metal.
3. Patched areas and/or potholes or impending potholes exist. Their combined area is more than 10% but 25% or less of the total deck area.	3. Surface or freckled rust is prevalent. There may be exposed metal, but there is no active corrosion which is causing loss of section.
4. Patched areas and/or potholes or impending potholes exist. Their combined area is more than 25% but less than 50% of the total deck area.	4. Corrosion may be present but any section loss due to active corrosion does not yet warrant structural analysis of either the element or the bridge.
5. Patched areas and/or potholes or impending potholes exist. Their combined area is 50% or more of the total deck area.	5. Corrosion has caused section loss and is sufficient to warrant structural analysis to ascertain the impact on the ultimate strength and/or serviceability of either the element or the bridge.
300 - Strip Seal Expansion Joint	**311 - Moveable Bearing (roller, sliding, etc.)**
1. The element shows minimal deterioration. There is no leakage at any point along the joint. Gland is secure and has no defects. Debris in joint is not causing any problems. The adjacent deck and/or header are sound.	1. The element shows little or no deterioration. The paint system, if present, is sound and functioning as intended to protect the metal. The bearing has minimal debris and corrosion. Vertical and horizontal alignments are within limits. Bearing support member is sound. Any lubrication system is functioning properly.
2. Signs of seepage along the joint may be present. The gland may be punctured, ripped, or partially pulled out of the extrusion. Significant debris is in all or part of the joint. Minor spalls in the deck and/or header may be present, adjacent to the joint.	2. The paint system, if present, may show moderate to heavy corrosion with some pitting but still functions as intended. The assemblies may have moved enough to cause minor cracking in the supporting concrete. Debris buildup is affecting bearing movement. Bearing alignment is still tolerable.
3. Signs or observance of leakage along the joint may be present. The gland may have failed from abrasion or tearing. The gland has pulled out of the extrusion. Major spalls may be present in the deck and/or header adjacent to the joint.	3. There is advanced corrosion with section loss. There may be loss of section of the supporting member sufficient to warrant supplemental supports or load restrictions. Bearing alignment may be beyond tolerable limits. Shear keys may have failed. The lubrication system, if any, may have failed.

The FHWA Coding Guide incorporates many of the inventory data items listed above, including identification, location, description, networks, jurisdiction, and utilization data. It has fields for linear referencing of roadways on and under each bridge, enabling a linkage with the pavement linear referencing system. Physiographic and asset cross-references are not included in the Coding Guide, although many states have extended their bridge inventories to include this information.

Alaska's bridge inventory is maintained in Alaska's implementation of the AASHTO Pontis Bridge Management System. Pontis was developed with FHWA funding starting in 1989, and was turned over to the state governments via AASHTO in 1994. Since then, AASHTO has kept it up-to-date through its AASHTOWare software development program. More than 40 state governments, as well as several municipal and international agencies, use Pontis. Thus there is a high degree of standardization of inventory and inspection practice, enabling the private sector and national research agencies to provide cost-effective products, research, and training centered on Pontis. Alaska has been able to obtain software, updates, and training at very low cost by means of this AASHTO mechanism.

AASHTO has recently published a new update of its element inspection guide (AASHTO 2010), which takes into account a modern understanding of bridge deterioration processes and protective systems such as paint and bridge deck wearing surfaces. It is anticipated that a portion of this guide, called the National Bridge Elements, may become part of the Federal National Bridge Inventory, and become a part of the mandated bridge inspection program. Recent Federal legislation will enable this change. Regardless of the mandate, the Department has determined that the new standard will improve maintenance decision making within the Department, and has expressed an intention to adopt the new AASHTO Guide. AASHTO is updating the Pontis software to facilitate the implementation of the new inspection guide as well.

An implementation date for the new AASHTO Element Inspection Manual has not been set by the Department, but it is believed to be after 2014. This is because there are still a number of steps to be taken to facilitate implementation, including Federal regulatory changes, AASHTO software development, and FHWA/National Highway Institute development of manuals and training classes. To save money and insure against wasted effort, it is advantageous for the Department to continue to follow the FHWA and AASHTO schedule for this upgrade.

Given the existence of a stable and full-featured inventory and inspection system within Pontis, many states have extended Pontis to include other types of structural assets. Common examples are tunnels, portal frames (to protect bridges against over-height trucks), drainage culverts, sign structures, traffic signal mast arms, high-mast light poles, marine piers, and retaining walls. Aviation and other marine structures could also potentially be included. Usually the factor that motivates state DOTs to add these structures to Pontis is the desire to perform periodic inspections for deterioration, fatigue, and damage.

2.3.3 Geotechnical

Because of the climate and topography of Alaska, the state's roads are especially vulnerable to damage from natural hazards such as floods, storm surge, landslides, rockfall, frost heave, permafrost melting, and earthquakes. Moreover, the sparse highway network raises the impact of roadway damage, since alternate routes may be very long or non-existent.

Many of the geotechnical features of the transportation system are, or include, constructed facilities that would benefit from being managed as assets. Such management would include:

- Developing a comprehensive inventory of the facilities or features;
- Creating a survey of the hazards that threaten each facility, with quantitative estimates of the likelihood, consequences, and impacts of extreme events and failures;
- Periodic measurement of the condition and performance of geotechnical facilities and features;
- Gathering data to support the development of cost-effective mitigation actions;

- Developing objective procedures for project selection, priority-setting, and programming of preservation and mitigation actions;
- Collection of data on the cost and effect of preservation and mitigation actions after they are taken.

Examples of geotechnical features that would benefit from asset risk management include soil and rock slopes (especially slopes believed to be unstable), rockfall protection systems (Exhibit 2-9), embankments, materials sites, retaining walls, and foundation elements.

Exhibit 2-9. Rockfall protection system

Currently none of the states has a comprehensive inventory of geotechnical assets, but several states have started work on them, and the National Cooperative Highway Research Program has begun to fund research in the area. Of all the states, Alaska is the most vulnerable, and would benefit most from leading this movement.

Currently the Department has an inventory of materials sites, and an inventory of unstable slopes on the Parks Highway, rated for hazard and risk. An effort is being planned for retaining wall inventory and inspection as well. An ongoing study of the Parks Highway Corridor as a future gas pipeline route could be used as a way of completing the geotechnical inventory. To capture the value of this inventory over the long term, a process of periodic inspection of these assets, and research on preservation and mitigation actions, would be needed.

2.3.4 Drainage

Alaska's Pontis bridge inventory already contains all culverts of over 20 feet in diameter, as well as many smaller culverts of at least 10 feet. In other states, it is becoming common to inventory all culverts of at least 4-6 feet, for inclusion in a periodic inspection process of 2-4 years' interval.

Blockage of any culvert, and deterioration of larger culverts, can result in sudden unexpected erosion and road damage, which often interrupts the flow of traffic until the damage is repaired. Other drainage facilities such as ditches, swales, catch basins, detention ponds, and dikes/levees offer this potential as well. The risk of traffic disruption can be reduced if all of these assets are inventoried, and checked periodically for problems. Assets that prove to have recurring problems can then be discovered and replaced with less vulnerable facilities or outfitted with protection systems (Exhibit 2-10).

In a recent pavement condition survey on the Parks Highway, a photologging process was used to identify locations where culverts may be present. This could help to jump-start the development of an inventory of all culverts, which could then form the basis of an inspection process. Maintenance crews currently check culverts on a non-scheduled basis, as a part of their other duties. So a more formal process would not necessarily add to their workload, as long as the means of recording the assessment is quick and reliable. This would provide a basis for an "institutional memory," that would enable the discovery of patterns, to help the Department reduce the risk of drainage-related road failures.

Exhibit 2-10. Culverts with heating systems

2.3.5 Traffic control

As described in Markow (2007), most of the states now have inventories of significant traffic control devices, such as signs, signals, and pavement markings. In a minority of cases these may take the form of a dedicated information system such as a Sign Management System. More often, these assets are merely added to existing management systems such as those for pavements and bridges, or stored in ad hoc databases or spreadsheets.

Alaska's DOT&PF has started the development of a sign database, and ten years ago created an inventory of cantilever structures such as sign structures (Exhibit 2-11), traffic signal mast arms, and railroad crossing signal supports. An Excel file of passing lanes also exists. The Department would benefit from a more comprehensive effort to develop an inventory of all its traffic control devices and, most importantly, to update the inventory and condition data periodically. The following types of assets could be included:

- Signs (sheeting, posts, sign structures, delineators, mileposts, snow poles).
- Signals (displays, controllers, poles, mast arms).
- ITS equipment (sensors, counters, variable-message signs, weigh-in-motion, cameras).
- Pavement markings (striping, markings, markers, rumble strips).

- Railroad crossings (displays, bells, gates, signal support structures, controllers, crossing surface/flangeway).

An inventory of all of these assets could be built first for the Parks Highway, using the effort to develop, document, and test the data collection processes and information systems. The inventory could then be extended to other types of assets and other corridors.

Exhibit 2-11. Cantilever traffic signal mast arms

2.3.6 Roadside features

A majority of states have inventories of roadside features (Markow 2007, Exhibit 2-12), but this inventory is often ad hoc in nature and not routinely updated. High-mast light poles are frequently inventoried because of fatigue concerns that necessitate periodic inspections. As a result, these are often included in bridge management system databases. Certain roadside features such as guardrails and barriers are often inventoried as part of a photologging process, using pavement survey equipment. However, this process seldom provides the performance and condition data necessary for asset management.

It is likely that these assets will be considered to be of lower priority than traffic control or geotechnical assets, yet they do have an identifiable effect on transportation system performance measures such as life cycle cost, safety, and externalities. If the Department proceeds to develop an inventory system for its more significant assets, it may later want to extend the same inventory to roadside features. The types of assets that could be included are:

- Lighting (luminaires, poles, hi-mast light poles, transformers, controllers).
- Sidewalks, curbs, gutters, medians, bicycle lanes/paths, manholes, drop inlets.
- Guiderails, barriers, impact attenuators.
- Sound walls and fences.

- Landscaping.

These could be added in priority order at any time in the future. To preserve the value of the data collected, it is important to also have an efficient means of updating the inventory, condition, and performance of these assets periodically in the future.

2.3.7 Plant and equipment

Few state DOTs have comprehensive inventories of plant and equipment. Yet, there may be a benefit in life cycle cost and performance management for having such inventories. The key to capturing this benefit is to leverage existing investments in information systems and property management services to capture and update the data. The types of assets that could be included are:

- Parking lots, meters, gates
- Weigh stations
- Maintenance facilities and storage sites
- Highway agency vehicles and equipment
- Right of way (land)

In addition, rest areas could eventually be included, although there are none on the Parks Highway Corridor. Marine and aviation facilities would also be candidates for future inclusion.

Currently the Department has no inventory of these facilities, but it does have some related systems using geographic data, such as right-of-way map images accessible in a geographic information system.

Exhibit 2-12. Guiderail and bike path

2.3.8 Data governance and life cycle

Recent Department efforts in the area of data governance are very relevant to the development and maintenance of asset inventories (Cambridge 2009). Information systems for asset management do not have to be highly technological or complex. However, over time as the systems become populated and used, they do tend to expand to more users and more applications. This natural evolution tends to increase technological requirements and the potential for conflicts over data ownership, quality, and maintenance responsibility.

Because of this natural growth, it is useful to make a few early decisions about the architecture and responsibilities of asset inventory and condition data. Within the specific environment of the Alaska DOT&PF, several factors influence the ideal approach:

- The pavement and bridge management systems within the Department have their own unique development life cycles, influenced by industry standards, ongoing research, and pooled funding. The Department achieves significant benefits from continuing to use these systems, including significant cost savings.
- For other types of assets, the Department does not have information systems in place. Some development options include: developing a new centralized asset management database to accommodate all assets other than pavements and bridges; developing separate information systems for each type of asset; adding more asset types to the existing pavement, bridge, or maintenance management systems; or a mixture of these approaches. This might or might not involve an integrating data warehouse or ERP software framework (such as Cognos).
- Given constraints on staffing and funding, an incremental approach may be necessary for adding new asset types. Even if funding can be identified for system development by consultants, the Department may not have sufficient staffing to supervise the effort and launch all the necessary data collection and quality assurance processes all at once.
- Current business processes within the Department do not feature a significant degree of integrated data collection across asset types. However, such integration is a potential way of improving communication and cooperation in asset management activities, as well as a way to save money and increase quality.
- For assets not currently served by Department information systems, many of the necessary inventory and condition data requirements are very similar in structure to the existing data stores for pavements and bridges. For example, condition data for many asset types readily fit into the element and condition state framework already used for bridges. Inventory and performance data for many asset types may fit the geographic referencing system used in the pavement database.

Given this background, one promising way to proceed is to first investigate the suitability of the existing pavement, bridge, and MMS databases to be linked and expanded to incorporate new asset types. Many state DOTs have been able to do this at low cost. Aside from cost savings, a key benefit is the ability to take advantage of existing software and linkages for geographic referencing, reporting, and possibly certain decision support functions. In addition, this commonality of systems may help to reduce data collection and training costs.

The data governance issues surveyed in the Cambridge (2009) report are highly relevant to this investigation, and may take some time to resolve. Fortunately, it is possible to pursue the matter incrementally, using the existing pavement and bridge databases, or copies of those databases, to provide interim models or scaffolding for systems to support new asset types. This would be one approach that would enable relatively rapid progress and early success. It has frequently been noted in asset management applications that the existence of a working prototype helps to encourage cooperation and reduce risk in cooperative efforts.

2.3.9 Findings: Inventories

Finding 3.1. For the Parks Highway, currently the Department has up-to-date inventories for pavements, bridges, large culverts, material sites, and unstable slopes. It has some pieces of other inventories, but these have not been kept up-to-date.

Finding 3.2. A study is underway to investigate the Parks Highway corridor as a possible location for a new gas pipeline. Potentially this study might be used as a means of expanding the asset inventory in the corridor.

Finding 3.3. The existing pavement and bridge management systems appear to provide the necessary storage and data management for inventories of those assets. These same databases use relatively generic schemes for structural elements and roadway segments, that may be adaptable to additional types of assets. In fact, it is at least within the realm of technical possibility that inventories of all significant asset types could be housed by extending these existing systems. However, many administrative and technical questions would still require exploration in order to select the best approach.

Finding 3.4. It is unknown, but could be investigated, whether any of the existing functionality of the pavement, bridge, and maintenance management systems, or the Cognos system, could be extended for inventory data management for assets other than pavements and bridges. Additional software and tools could be added if found to be necessary for additional asset types.

Finding 3.5. The data governance issues identified in the Cambridge (2009) reports are important and will need to be addressed. In particular, it is important that issues of data ownership and maintenance responsibility be clear, and that all data users be assured of a process to satisfy their needs.

2.4 Inspection and monitoring

Typically the highest priority data collection task in asset management is the establishment of an inventory. After all, an agency has to know what assets it owns, before it can manage them. Once an inventory is established, the next priority is to have a systematic process for tracking condition and performance over time. With this information, it can accomplish several useful objectives:

- Readily identify the assets that are most in need of repair or replacement at any given time, without missing any;
- Apply decision criteria consistently across the entire network;
- Identify systematic problems requiring research, changes in procedures, or management focus;
- Allocate resources fairly;
- Ensure that preventive maintenance is applied in the places and at the times where it is most cost-effective;
- Optimize the performance of the network as a whole;
- Minimize asset failures, service disruptions, and liability;
- Minimize life cycle costs.

Usually the first complete survey of asset condition and performance is performed at the same time as the field work to establish the inventory. However, it is necessary to return to each asset periodically to record changes in condition and performance. This is done most efficiently by means of an inspection or monitoring program. The things that can change between inspections include the following:

- All construction materials and devices deteriorate under the influence of weather, age, and traffic. Once deterioration has proceeded far enough, an asset may stop functioning, or function at reduced effectiveness. This could disrupt service or compromise safety.
- In many cases, an asset will exhibit symptoms indicating prime opportunities for inexpensive preventive maintenance (Exhibit 2-13). If these opportunities are missed, the agency may be forced to undertake much more expensive actions to maintain service or safety.
- Traffic growth may cause problems to arise where they had not been observed previously. This is especially the case with bridge decks and joints, weak pavement subgrades, and pavement markings.
- General warming of the climate, or shorter-term weather events, may cause problems to arise where they had not been observed previously (for example, permafrost melting).
- Roadway features are occasionally damaged by collisions, storms, earthquakes, or passage of heavy loads.
- Agency standards change over time as more is learned about the effectiveness of system components, or as public expectations change.

Exhibit 2-13. Preventive maintenance opportunity

Usually the periodic inspection is also the time to record the effects of agency actions that have taken place since the previous inspection. This may include improvements in condition or function; additions or deletions from the asset inventory; replacement of assets; or changes in asset characteristics. Important decisions, affecting large financial investments, are made based on inventory and performance data. Therefore it is important to ensure that this information remains accurate.

2.4.1 Inspection interval

On the Parks Highway corridor, pavement condition surveys are repeated on each road section on an interval of typically 2-3 years. Bridges are inspected typically on a 2-year interval. These intervals are appropriate given the lifespans and risk exposures of these assets. As a general rule of thumb, most types of assets should be inspected at least 5 times during their typical life, and more often for risk-sensitive assets such as bridges, or timing-sensitive conditions such as pavement cracking.

In most cases it is not necessary to inspect an asset more than once a year, with the exceptions being safety-critical assets such as traffic signals and certain street lighting. Exceptions are also typically made when as asset is seen to have special safety or risk concerns: for example, a fracture-critical bridge where steel cracking has been found, or an unstable slope that is saturated with water and/or showing unusual movement.

2.4.2 Condition and performance monitoring program ingredients

The main elements of an effective asset condition monitoring program are:

- A predictable schedule of visits to every asset in the inventory. This entails a network-wide planning activity that fits with other responsibilities of agency personnel, and that is suitable for asset lifespans and risk exposure.
- Allocation of necessary resources to ensure that all assets are visited by personnel at the right skill level, with the right equipment. In most cases, inspections are performed by trained technicians with occasional engineering supervision, in most transportation agencies. In some cases (such as automated pavement surveys and complex bridge inspections) specialized consultants are used. Often for low-risk assets, the technicians are engineering students working on summer internships.
- Documentation and training for inspection personnel so they can reliably identify the conditions they are expected to record. Often national and state research programs, and AASHTO manuals, can be relied upon for standardized documentation that can be adapted to Alaska conditions.
- An efficient means/logistics of transporting personnel and/or equipment to each inspection site. Usually the travel route of the inspection team is carefully planned, and the team addresses multiple asset types in the same trip.
- An efficient method of capturing the necessary data. The inspectors must be properly trained and equipped for each asset they are expected to inspect. Electronic data capture is becoming increasingly common (Exhibit 2-14). Photographs should also be captured.

Exhibit 2-14. Signs retroreflectivity declines with age[6]

- A quality assurance program. Acceptable levels of accuracy, precision, coverage, and other relevant attributes must be defined. Inspection personnel must be trained and refreshed to ensure they can satisfy the requirements. Independent audits, by random sampling, ensure that the collected data meet the requirements. A process must be established to correct unacceptable inspections as well as to ensure that the inspector's procedure is corrected.

[6] http://safety.fhwa.dot.gov/roadway_dept/night_visib/policy_guide/fhwasa08001

- An information system for storing inspection results, linked with the asset inventory.
- Systems for using the inspection results for a variety of purposes, such as performance tracking, public information, stakeholder communications, project scoping, priority setting, and programming.

These characteristics are typically spelled out in agency policy documents and manuals.

2.4.3 What to inspect

Inspections focus on the performance attributes and asset components that are most important for decision making. In general, a performance measurement or condition state should be monitored only if it has some effect on the actions the agency may take. It may affect the type of action (for example, preventive maintenance or replacement), timing, cost, future deterioration rates, or priority. Data items should be added sparingly after due consideration of the incremental cost and benefit of each item, and only when there is a specific plan for how the data will be put to use by decision makers or researchers.

Exhibit 2-15 lists the asset types and performance characteristics typically inspected by a transportation agency. The table lists the type of data item, the agency performance concerns that each item addresses, the relative priority (according to typical state DOT practice), and the implementation status within the Alaska DOT&PF (with an × indicating that it exists within the Department).

The first two groups of data items are typical condition measures that affect asset management. Pavement and bridge conditions are gathered by all state DOTs at the current state of the practice, due to the large investment each agency makes in these assets. Other asset types are less commonly surveyed.

After the first two groups, the remaining rows of Exhibit 2-15 are performance indicators where changes over time can affect agency actions. Even without systematic performance monitoring, most transportation agencies drive maintenance and replacement actions based on these types of performance. A systematic monitoring program makes maintenance activities more predictable and efficient, and can form the basis for reliable budgeting and funding for asset preservation and management. The result is lower life cycle cost, lower risk, and better performance.

2.4.4 Findings: Inspection and monitoring

Finding 4.1. The Department has a recurring program of pavement condition surveys for roughness and rutting, but lacks this information for other important conditions such as cracking, surface texture and bearing capacity. The first survey of pavement cracking is soon to begin.

Finding 4.2. The Department has implemented the National Bridge Inspection Standards and the AASHTO CoRe Elements. This provides enough data for many common asset management needs. There is no routine monitoring for bridge fatigue, scour, or buildup of ice or debris, which would be necessary for a reliable risk management program.

Finding 4.3. Other than pavements and bridges, there are no other recurring inspection programs on the Parks Highway corridor.

Exhibit 2-15. Data for condition and performance monitoring

		Performance concerns							
Asset type/data item	Description	Condition	Life cycle cost	Mobility	Safety	Risk	Exter-nalities	Priority	Depart-ment status
Pavement									
Roughness (IRI)	Short wavelength unevenness due to wearing and base course problems	x	x		x		x	1	x
Frost heave	Long wavelength unevenness due to freeze/thaw in subgrade	x	x		x		x	1	
Rutting	Wheel path distress due to studded tires or structural weakness	x	x		x			1	x
Cracking	Alligator, longitudinal, or transverse cracking	x	x					2	
Spring bearing capacity	Ability to carry heavy wheel loads	x	x	x				2	
Surface distress	Raveling, skid, other surface defects	x			x			3	
Structural elements									
Bridges, large culverts	Material defects in structural elements, that	x	x			x		1	x
Rockfall protection	can be classified in terms of condition states	x			x	x		1	
Retaining walls	(usually 2-5 states per element). Defect types	x	x			x		1	
Culverts, drainage	include corrosion, cracking, spalling,	x	x			x		1	
Sign supports, mast arms	delamination, material loss, displacement, leakage, blockage, debris buildup, and erosion.	x	x		x	x		1	
High-mast light poles		x	x		x	x		1	
Barriers	Each asset is decomposed into multiple	x			x	x		2	
Sidewalks, curbs, etc.	elements. For bridges, examples are deck,	x		x	x			3	
Sound walls, fences	railings, expansion joints, girders, bearings,	x				x	x	3	
Plant, equip, landscape	columns, and abutments.	x	x		x		x	3	
Bridges - function and risk									
Clearances	Vertical and horizontal clearance restrictions that limit use by large vehicles			x		x		1	x
Load rating	Insufficient strength to carry heavy vehicles			x		x		1	x
Geometry	Deficiencies in travelled way width or alignment, that may reduce safety				x			1	x
Fatigue	Evidence of cracking due to repetitive loading	x	x			x		2	
Scour	Loss of soil support around the bridge foundation	x				x		2	
Ice or debris buildup	Ice or debris jams that apply excessive pressure to the structure	x				x	x	2	
Geotechnical - risk factors									
Slope stability	Movement of soils, or rockfall, that could accelerate	x			x	x	x	1	
Embankment movement	Displacement due to freeze/thaw or water movement within earth mass	x	x	x		x		2	
Scour	Material loss due to flowing surface water or ice	x		x		x		2	
Traffic control, lighting									
Visibility	Usually measured as retroreflectivity of signs and pavement markings	x			x			2	
Function	Indication of whether each component is operational				x			2	
Roadside features									
Collision damage	Evidence of damage from vehicular collision	x			x			2	
Presence where required	Indicates whether safety equipment is present where warrants require it				x			2	
Standards adherence	Indicates whether safety equipment satisfies current standards				x			3	

2.5 Performance assessment

Condition and performance data are used for many different purposes in asset management. As Exhibit 2-15 indicated, the list of performance data items can be too long and complex for many purposes, even though this level of detail is important for engineering tasks such as treatment selection and cost estimation. Once outside the engineering domains (or "silos") of specific asset types, it is necessary to digest the raw performance data into measures that are more descriptive of the transportation system as a whole, and indicative of the effect on stakeholders.

Historically, this additional step of digesting condition and performance information has been difficult. When agencies first begin to report on their performance, they often rely on measures already in use for silo-specific programs. This is convenient for the organizational units producing the information, but very inconvenient — and often confusing and counter-productive — for stakeholders and the public at large.

Exhibit 2-16. I-35W bridge collapse in Minnesota

An example of this problem became widely visible after the 2007 collapse of the I-35W bridge in Minnesota (Exhibit 2-16[7]). The term "structurally deficient" appeared in media reports about the event, but few journalists could explain what it meant, and transportation agencies found themselves on the defensive in trying to explain the structurally deficient bridges in their own inventories. Many are still stinging from the experience. However, to this day structural deficiency is one of the only asset performance indicators used in the Department's Performance Electronic Tracking System (Exhibit 2-17).

Similar problems occur with other measures that are well understood by professionals but not by the public. Is an International Roughness Index (IRI) of 50 better or worse than a Bridge Sufficiency Rating (BSR) of 50? Would a 10-point increase in IRI or BSR be a good thing, and how difficult would it be to accomplish? (That's a trick question, but few in the public would know it.) What does the Bridge Sufficiency Rating measure, anyway? Why are so few functionally obsolete bridges programmed for replacement? How do you know if a sidewalk's condition is acceptable: how is this measured? These are very good questions for stakeholders to ask and very difficult for agencies to answer.

[7] http://www.fhwa.dot.gov/programadmin/contracts/sep14mn2011.cfm

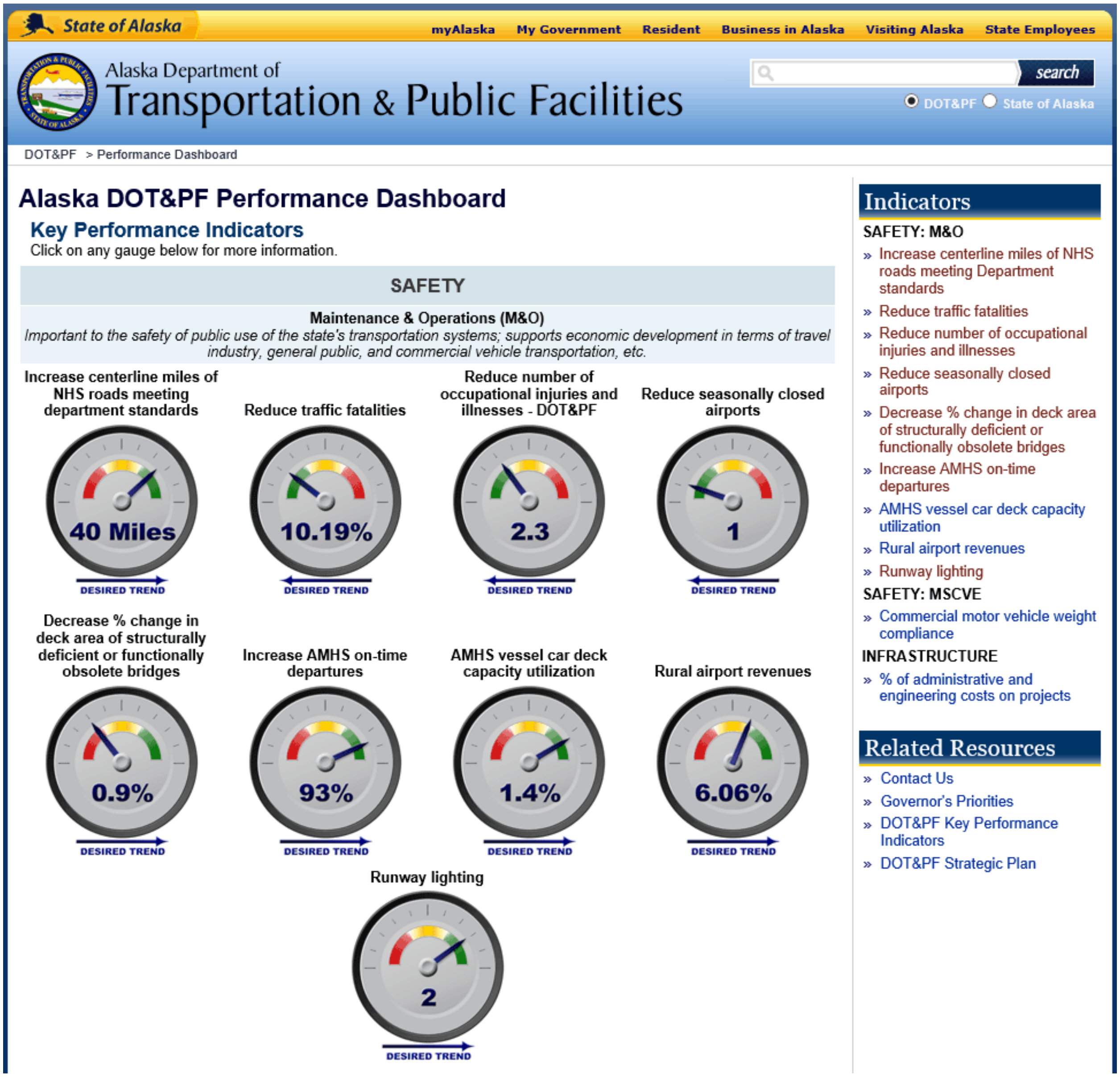

Exhibit 2-17. Performance Electronic Tracking System[8]

If asset management is to become a basis for better communication with stakeholders, it is critical that a common language of performance assessment be developed. Fortunately, some good models exist, and the Department is starting to use them. Much more can fruitfully be done. The key tools for improving communications about performance are:

- Levels of service, which separate acceptable from unacceptable conditions, and provide warrants for action.

[8] http://dot.alaska.gov/performance-dash/index.shtml

- Condition and performance indexes, providing a uniform scale of best to worst, with meaningful correspondence among asset types, and relevance to all asset types.
- Asset valuation models, which are similar to condition and performance indexes but put assets in a context of financial commitment.
- Tracking tools to draw attention to the magnitude and direction of changes in performance over time.

All of these tools have important uses and interpretations at the levels of individual assets, corridors, projects, and networks.

2.5.1 Levels of service

Levels of service are classifications or standards that describe the quality of service offered to road users, usually by specific facilities or services. All services delivered by the network should be covered by agreed levels of service, although it may take some time to achieve this goal. Achievement of levels of service is quantified by performance measures. Fully-developed level of service statements adopt two perspectives:

- Customer levels of service relate to how the customer receives the service in terms of tangible and intangible measures or criteria. They are expressed in terms that customers can understand. Tangibles include the appearance of facilities, frequency of service disruptions, availability of service, frequency of crashes etc. Examples of intangibles include responsiveness to problems, staff attitude, and ease of dealing with the agency.
- Technical levels of service support both the customer levels of service and the agency's strategic objectives. They are usually expressed in technical terms and will relate to service criteria, e.g. quality, capacity, availability or safety. They are recognizable by inspection processes, and are used as drivers for agency actions.

Because levels of service are developed from the mission and goals of an agency (Exhibit 2-18), they should cover all of the asset groups that contribute to the delivery of the service. These include the visible assets, such as pavements, bridges, lighting and signs as well as those which might be less visible or less apparent in terms of being important to users, but are vital in providing service. For example, effective drainage minimizes the risk of flooding and guardrails provide an important safety function.

Level of service can include any aspect of asset performance affecting any stakeholder. So it can be used very broadly to include service to stakeholders in their roles as users, taxpayers, partners, elected officials, and community residents.

Condition is somewhat distinct from other performance measures because it often does not directly affect road users except through its effect on other performance measures. However, condition can be the basis for both level of service standards and performance measures. For example, bridge conditions are expressed as condition states of bridge elements, where the condition state definitions are in the same form as levels of service. (See Exhibit 2-8 earlier in this report.) As another example, pavement skid resistance is a measure of physical condition, and can be the basis for a level of service standard. Agencies often use it as a performance measure, as a proxy for accident risk. Accident risk would be a more direct measure of performance, but it is difficult to measure on a facility-specific basis.

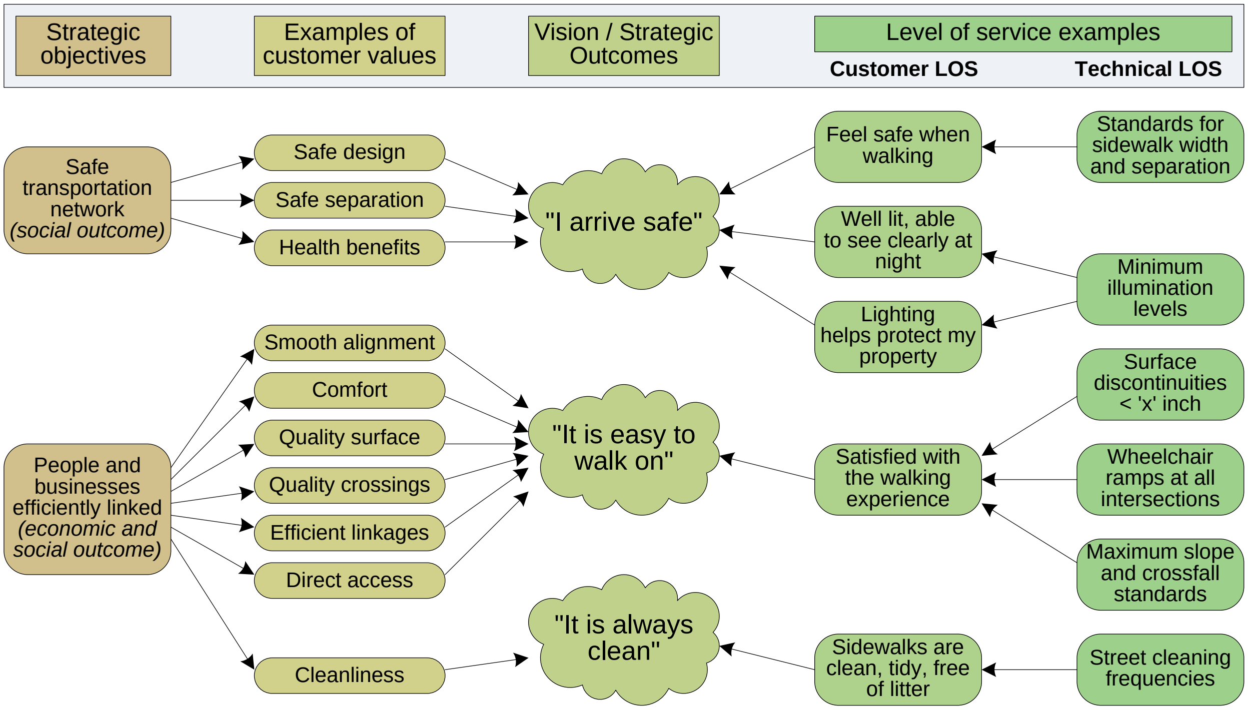

Exhibit 2-18. Linking strategic objectives to levels of service
(Gordon et al 2011)

Level of service definitions are extremely useful as convenient, standardized descriptions of services provided by the agency. As a result, most agencies have them. Moreover, industry guide books such as the Manual on Uniform Traffic Control Devices and the Highway Capacity Manual provide definitions that are nearly universal. However, agencies may wish to develop their own levels of service for specific applications or to address specific strategic concerns. A way to approach this is as follows (Gordon 2011):

- Start by documenting what services the agency is delivering. Check on corporate levels of service that may already be in place.
- Verify this list against existing reporting procedures.
- Do not include aspirational or proposed changes to level of service unless they have been agreed and adopted at the corporate level.
- Write levels of service which represent current practice and which are SMART:

  Specific: Do they adequately reflect specific strategic goals?

  Measurable: Can they be measured?

  Achievable: Are they realistic and affordable?

  Relevant: Do they adequately reflect agency actions and user expectations?

  Timebound: Has a timeframe for delivery of each level of service been stated?

The Department has made considerable progress in developing level of service descriptions for many of its assets and services. Exhibit 2-19 shows an example of language developed for pavement markings. Similar work has been done for drainage assets, gravel roads, guardrails, pavement surface, and signage. Work is underway in developing levels of service for slopes.

Levels of service are useful for many different functions in asset management, including performance management. The work completed thus far is excellent, and deserves to be extended to all types of assets. It is on the critical path for asset management maturity, so further development is considered to be of high priority.

The best way to gain insight about customer expectations is to ask them. Transportation agencies very often perform marketing research for this purpose. The research may take the form of approve/disapprove surveys, tradeoff scenarios, or other types of survey questions that are geared toward quantifying consumer preferences. These help to establish meaningful level of service definitions as well as to determine the relative importance of different services.

Level of service is, by nature, an asset level concept. It answers questions such as: Is this asset performing at an acceptable level? or Does this asset need repairs? For use at the corridor or network level, the level of service concept is usually converted to an aggregate measure, such as "percent of sidewalks in acceptable condition" or "number of bridge decks requiring overlays." If levels of service can be reliably determined at the asset level for a known population or random sample of assets, then the aggregate measures are easy to compute.

2.5.2 Performance indexes

Levels of service are often developed for individual asset types, or even for separate parts of an asset's performance. They are often closely related to the characteristics of those assets. For communicating with the public, it is useful to combine the various facets of each asset's performance into larger concepts that relate to the overall quality of the asset, or even more broadly to the characteristics of a corridor or network. This is done by a process of amalgamation.

One common example of amalgamation is the bridge health index. During bridge inspections, a bridge is decomposed into a number of elements, typically 5 to 10 of them, such as the deck, expansion joints, railings, girders, bearings, and abutments. Each element is classified by assigning a condition state (an integer from 1 to 5), or by distributing the total quantity of the element among the five possible condition states. The overall condition of the bridge is then computed as a weighted average of all the element condition states. The weights used in this computation reflect the relative contribution of each element to the bridge's function, and the relative "goodness" or "badness" of each possible condition state.

As another example, the pavement management system in use by the Department computes a Pavement Serviceability Rating (PSR) as a weighted combination of roughness and rutting, intended to represent an indication of overall condition. If the Department were to start gathering data on additional defects such as cracking or surface texture defects, these could be added to the PSR calculation.

Exhibit 2-19. Levels of service for pavement markings[9]

Performance Target	Description	Illustration
A (Excellent Markings)	Pavement striping and other marking are in generally excellent condition. They have high visibility and reflectivity in daytime and nighttime. There is little or no wearing. Up to 5% missing sections of markings.	
B (Very Good Markings)	Pavement striping and other markings are in generally good condition. Markings have good visibility during daytime and night time. Markings are showing minor wearing with 10% of sections missing.	
C (Fair Markings)	Pavement striping and other markings are in fair condition. Generally visible in daytime and nighttime. Noticeable wearing or loss of retro reflectivity and 20% of markings missing.	
D (Poor Markings)	Pavement striping and other markings are in marginal condition. Extreme wearing or no reflectivity during daytime or night time and 50% of markings missing.	
F (Failing Markings)	Pavement striping and markings are essentially worn or missing. Markings that are still present are not easily visible.	

[9] Compiled by Ocie Adams

It is useful to convert all of the performance indexes onto a uniform scale so meaningful comparisons can be made. For example, a score of 100 could always be perfect condition, and a score of 0 always the worst possible condition. If these scales are calibrated to be uniform along their length, then an improvement from (for example) 10 to 15 would have the same value as an improvement from 70 to 75. Some methods for doing this are described in NCHRP Report 590 (Patidar et al 2007). When this is done, the uniform scale can be interpreted in the same way across all types of assets. This makes the scale easier to understand and use (Exhibit 2-20).

Exhibit 2-20. Scaling of performance measures

2.5.3 Asset value

Performance indexes can be aggregated across a corridor or network merely by computing an average over all the individual assets in the group. This might be misleading, however, if the assets are of different sizes. For example, intuitively an individual traffic signal might not have the same importance as a large bridge or a mile of pavement.

A way to make this aggregation more acceptable is to weight each asset according to its value, usually using an estimate of its replacement cost. With this refinement, a condition index of 50 might be interpreted as indicating that the asset has 50% of its original value, or is 50% depreciated (Shepard and Johnson 2001). This perspective is useful for accounting purposes under GASB Statement 34, and also useful as a reliable way to track changes in performance over time, and differences in performance among dissimilar parts of the transportation network.

2.5.4 Tracking tools

The processed condition and performance data described here are valuable for decision making because they remove the focus from the technical details of pavements, bridges, or other asset types, and focus more on the service provided to the public. They help bring non-engineers into a more understandable conversation about performance, making it possible finally to have productive tradeoff and budgeting discussions with elected officials and other stakeholders.

These performance measures are most useful if decision makers can start to gain an intuitive feel for the manner in which performance can change over time, due to deterioration, aging, traffic, and agency actions. A simple tool for imparting this intuitive feel, is the basic trendline (Exhibit 2-21). Once an agency has developed the ability to compute levels of service, performance indices, and asset values, it must go through a period where it consistently computes and tracks these indicators, to see how they change. This is a natural breakpoint in the advancement of asset management maturity, because stakeholders need time to watch performance measures develop, and see how much influence they may have in changing them.

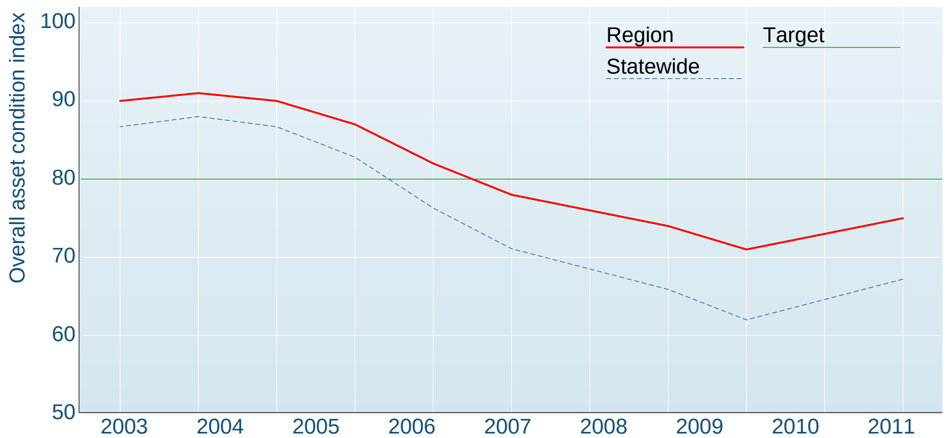

Exhibit 2-21. Example of a trendline

2.5.5 Findings: Performance assessment

Finding 5.1. The Department has developed level of service descriptions and photos for several asset types including pavement markings, drainage assets, gravel roads, guardrails, pavement surface, and signage. These are excellent and could be extended to cover all other asset types.

Finding 5.2. The Performance Electronic Tracking System was meant to be a central repository for performance reporting, but would require considerably more development in order to accomplish this goal. Currently it has only one measure related to asset performance, and does not have a facility to track changes in performance over time.

Finding 5.3. The Department does not have tools or documents that measure the degree of adherence to level of service standards, nor methods to develop performance indexes, asset values, or other performance measures. The two key exceptions are the Pavement Serviceability Rating and the Bridge Health Index.

2.6 Decision support capabilities

Quantitative, proactive decision making is a major step forward in asset management maturity. Rather than relying entirely on measurements of current and past performance, proactive decision making relies in part on forecasts of the outcomes of current decisions on future performance. Without decision support tools, proactive decisions are a matter of educated guesswork, a judgment about the conditions and performance that could occur in the future.

Proactive asset management decision making addresses important questions on the minds of decision makers and stakeholders:

- If funding is cut, how much performance would be sacrificed?
- How much would it cost to keep performance from declining further?
- How much would it cost to improve performance to a desired level?
- Can we get more life out of our assets, and how best to do this?
- What policies would minimize life cycle costs?
- Is a given preventive maintenance program worth the expense, in terms of reducing life cycle costs?
- What is the best long-term preservation program for a given asset, in terms of the scope and timing of future interventions?

These are difficult questions that are notoriously resistant to judgment or experience. Large businesses typically answer such questions using engineering studies, market research, and financial analysis. Transportation agencies are increasingly doing the same thing using the decision support tools of asset management.

2.6.1 Basic analysis framework

Support for proactive decision making requires an inter-related set of models that are sensitive to the types of asset management decisions commonly made in the agency, at the asset, project, program, and network levels. These models can obtain their data from existing management systems (such as the pavement and bridge management systems) and from new inventory and condition assessment systems for other types of assets. A key ingredient that is necessary for an integrated system is a file of investment candidates presented in a format that is the same for all asset types. Exhibit 2-22 shows how this key element supports decision-making across all types of assets.

Investment candidates may include new construction, replacement of existing assets, rehabilitation, repairs, functional improvements, or policy changes. They may involve any asset type, or groups of assets in a corridor or project. The investment candidate file (Exhibit 2-23) identifies each potential investment and summarizes its cost, resource requirements, and effects on transportation system performance. It is most often prepared as an Excel spreadsheet file, which is simple, flexible, and entails minimal system development costs. The data may be entered into the spreadsheet manually, or by means of an automated procedure such as a Visual Basic macro that accesses a pavement management system.

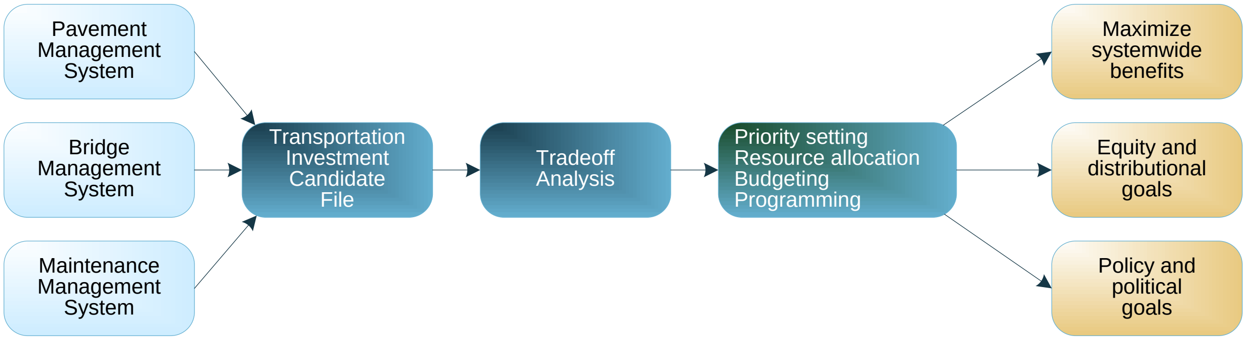

Exhibit 2-22. Analysis framework for decision support
(Gordon et al 2011)

Each investment candidate may have effects on any of the major performance measures, such as condition, life cycle cost, safety, mobility, and risk. Forecasting models (such as the ones found in the Department's pavement and bridge management systems) provide the estimates of these effects. The separate performance forecasts are then combined into a single indicator of priority. State DOTs have historically used some form of priority formula to rank investments. More objective methods include social cost calculations and utility functions, as described in NCHRP Report 590 (Patidar et al 2007). All of the priority setting methods in common use are implementable as spreadsheet formulas.

A tradeoff analysis is the engine that supports the business processes of priority setting, resource allocation, budgeting, and programming across all asset types. In its simplest form, the tradeoff analysis is merely a feature that allows decision makers to change the relative weighting given to different program objectives. For example, if the forecast of systemwide performance does not satisfy safety goals, the decision maker can give safety more weight, causing projects with safety benefits to have higher priority, and be scheduled for implementation sooner. This would come at the expense of other performance objectives, which would then have lower relative priority.

Using this basic priority-setting analysis, agencies can establish performance targets for all or portions of the transportation network, decide on the allocation of resources, and track actual performance against the targets. While the diagnostic and forecasting methods of pavement and bridge management systems are often scientifically based and may be complex or proprietary, the cross-asset tradeoff analysis is most successful if it is relatively simple and open. Agencies typically modify these tools frequently as their understanding improves, as policy issues and priorities evolve, and as leadership changes take place.

By varying funding levels and relative weights of performance objectives, decision makers and stakeholders can perform "what if" analysis, gain a deeper understanding of the relationship between funding and performance, and appreciate the tradeoffs among different aspects of performance. The tradeoff analysis then acts as a valuable tool for communication and collaboration, helping to build a constructive relationship with stakeholders.

Exhibit 2-23. Typical contents of the investment candidate file
(Gordon et al 2011)

Type of information		Data items	Description	Purpose
Identification		Project or work order ID Responsibility (organization or unit) Means of execution (contract, in-house, etc.) Desired/planned year Planning/delivery/workflow status	Identifiers here would feed into project tracking or enterprise resource planning systems where applicable.	Uniquely identify projects. Interface with related information systems. Support project development workflow.
Assets	For each cost object:	Identification Geographic location Jurisdiction Value Utilization	List the assets and/or policy concerns that are affected by the action.	Support mapping and reporting by geography and jurisdiction. Provide planned work status to asset management systems. Provide asset weighting in the computation of benefits.
Activity Drivers	For each activity driver:	Performance measure or deficiency Threshold level Actual level	Includes action warrants, level of service standards, vulnerability conditions, damage, or defects. Existing or forecast.	Document the direct justification of projects.
Activities	For each activity:	Classification Quantity (of output) Cost	Includes any type of activity within the scope of asset management: capital, maintenance, preservation, functional improvement, expansion, etc. Also includes engineering, mobilization, traffic control.	Describe the work to be performed and build up the cost estimate.
Resources	For each resource:	Classification Quantity (of input) Cost	Includes labor, materials, equipment, or contract pay items.	Interface with resource management to forecast staffing, stockpiles, and other resource needs.
Forecast Outcomes	For each performance measure:	Forecast change in performance Scaled change in performance Effect of advancement or delay	Includes measures of condition, life cycle cost, user cost, mobility, safety, reliability, comfort/convenience, externalities, risk, etc.	Forecast the performance resulting from the work, and compare with performance targets. Support performance based management.
Project Inter-Relationships		Projects that must be completed first Projects that can't be programmed together Projects that must be programmed together Projects that are mutually exclusive	Constraints on the scheduling and funding of work.	Ensure that traffic control plans are valid, that projects are compatible, and costs are fully recognized.
Evaluation		Total and incremental cost Total and incremental benefit Total and incremental benefit/cost ratio	Priority setting and budgeting criteria.	Set priorities, manage funding limitations.

2.6.2 Elements of forecasting

The evolution of asset management from guesswork to analysis, is analogous to many other advances in civil engineering, when design methods based on subjective experience were replaced by detailed structural analyses and specifications. In order for this leap to occur, it was necessary to develop and validate analytical models; to use them alongside expert judgment to ensure a safe and smooth transition; to develop a language and written specifications that are widely understood; and to continuously monitor and improve the methods as experience is gained and more research is completed.

For certain types of assets, this evolution has already made considerable progress. Forecasting of pavement deterioration was largely guesswork until the 1980s, when products of the AASHO Road Test became widely utilized. Since then, researchers have developed more refined forms of deterioration models, and have learned to customize these models to fit specific conditions of traffic, materials, soils, and other factors. Once the forecasting of pavement condition became reliable, agencies were able to build on these models to improve decision making in maintenance and design, thus increasing pavement life and reducing life cycle costs.

In bridge management, the industry went through an experimental stage with National Bridge Inventory data in the 1980s, but validation efforts failed. Many different model forms were tried, but their forecasts did not sufficiently match actual conditions that were later observed. It was determined that the condition data gathered in NBI bridge inspections did not provide sufficient detail on the type, severity, and extent of distress, to support reliable forecasting.

As a result of this experience, in the 1990s AASHTO developed a more detailed guide for maintenance inspections, which most of the states, including Alaska, have implemented. Initially it was necessary to develop forecasting models using a quantified form of expert judgment. However, as agencies have passed the 10-year milestone with the new inspections, they have started developing models using the more detailed data. These new models have successfully stood up to validation tests. With improved confidence in bridge condition forecasting, it is now possible to use these tools to improve the scoping and timing of bridge preservation, with confidence that life cycle costs can be reduced.

The lessons learned in forecasting of condition of pavements and bridges, have been applied to many other asset types and other aspects of performance in NCHRP Report 713 (Thompson et al 2012). Forecasting is also a mature discipline in the travel demand models used in planning and designing new roads.

AASHTO's Asset Management Guide (Gordon et al 2011) offers a broad overview of forecasting methods in common use. To begin implementing proactive decision support, the following are especially important:

Base case (also known as "do nothing"). The base case scenario in asset management is typically defined as a project or policy alternative where no initial expenditure is made. Instead, the assets in question are merely allowed to deteriorate under expected weather and traffic (Exhibit 2-24). Normal physical deterioration may cause condition to decline, and risk of natural (e.g. scour or earth movement) or man-made (e.g. fatigue) hazards to increase. Traffic growth and land use changes may lead to congestion, loss of mobility, and increased accident rates. Forecasting models attempt to quantify these changes in performance.

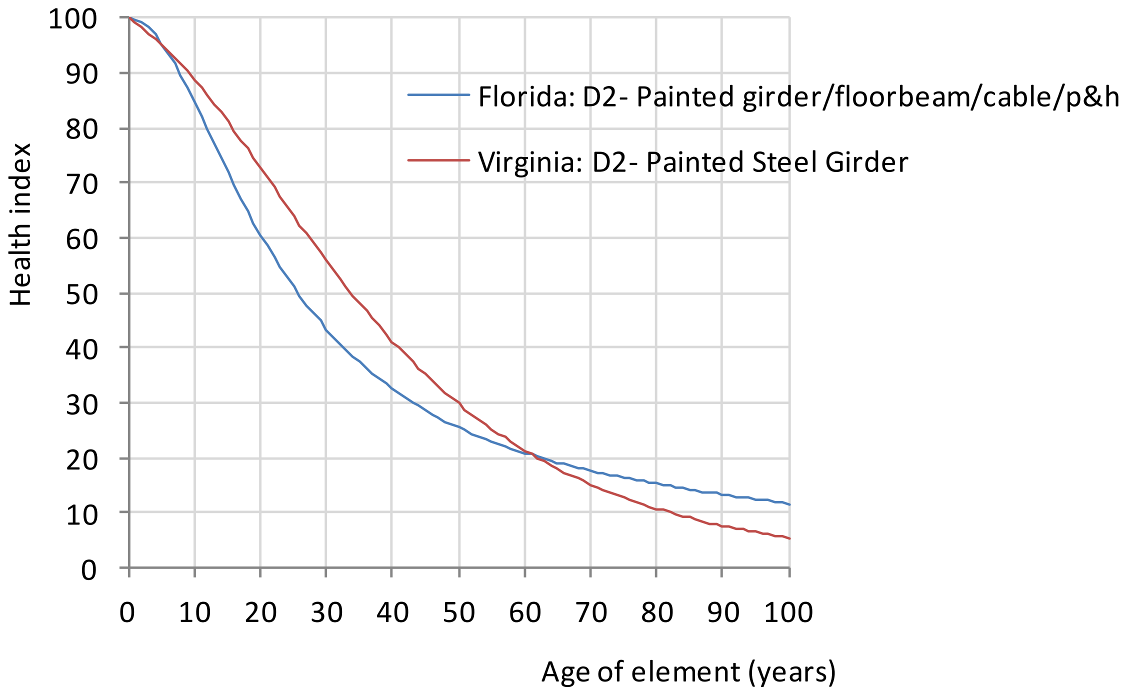

Exhibit 2-24. Examples of bridge deterioration models

In some cases the designation of "do nothing" as a base case may be misleading or may conceal certain alternatives. For example, assets may undergo routine maintenance work such as bridge washing and pavement crack sealing which affect the rates of future deterioration. If it is desired to evaluate the benefits of these activities, then careful refinement is needed in the definitions of the alternatives to be considered.

Choices of actions. At any given point in time, the Department may intervene in the life cycle of an asset by performing some type of routine or programmed action. Asset characteristics and conditions may determine whether a given action is feasible, or if feasible, whether it is warranted. Pavement management systems often contain "decision trees" to simulate a typical agency decision making process to determine which actions are feasible, warranted, or required for a given asset at a given time.

Simpler rules are also necessary for bridges and all other types of assets when forecasting future expenditures in an asset's life cycle. In addition, special rules may apply to certain types of assets, such as the "10-year rule" for Federally-funded bridge rehabilitation (recently rescinded[10]).

In a life cycle cost analysis, it is often necessary to identify future actions even in a "do nothing" scenario where no work is to be done in the near-term. For assets in deteriorated condition, the lack of a near-term maintenance action may increase the likelihood or cost of future work that becomes necessary to keep an asset in service.

[10] http://www.fhwa.dot.gov/map21/qandas/qabridges.cfm

Cost of actions. Asset management analysis includes a prominent role for cost estimation, which has the same importance as in any planning or programming process. Since asset management analyses are typically conducted prior to any design work, the cost estimates cannot rely on much precision. Typically the available inventory and inspection data are the only basis for the estimate. Cost models often distinguish two general categories:

- Direct costs include labor, materials, and equipment usage which vary smoothly with the quantity of work to be done, which in turn often depends on the extent of deterioration or the magnitude of improvement required.
- Indirect costs include mobilization, land acquisition, maintenance of traffic, demolition, and sometimes engineering costs that are insensitive to the quantity of work but more dependent on the type of work, location, and the characteristics of the affected roadways.

Indirect costs are especially difficult to estimate without a substantial amount of site-specific design data (Exhibit 2-25). Agencies often use a simple multiplier to represent these costs if better data are not available. The best way to estimate cost models is to perform a statistical analysis of maintenance and contract data. The methodology should ensure that all important cost factors are included in the calculation.

Exhibit 2-25. Indirect costs are a significant part of the analysis

Effect of actions. After an action is performed, the result should be an improvement in condition or performance. This may take effect immediately, or may have its impact over time by reducing the rate of deterioration.

User costs. Certain aspects of condition and performance may increase the costs borne by road users for fuel, vehicle maintenance, or travel time. In addition, a risk analysis on many Alaska highway links would need to include the costs of fares for marine or air modes of transportation.

Externalities. A complete asset management analysis should consider the environmental and external impacts of transportation decisions, such as air and water emissions, noise, greenhouse gases, and impacts on property values and regional economic development. The Statewide Policy Plan places some emphasis on these impacts, but currently they are very difficult to quantify and manage.

The Department has not made very much progress thus far in the development of forecasting capabilities, but such capabilities are necessary before progress can be made on more advanced decision support models. The agency has a pavement management capability to extrapolate past condition trends, and has an expert judgment-based model of bridge deterioration. It has no forecasting models for any other types of assets, and no validation history even for the pavement and bridge models. Maintenance history data are available but it is unknown whether the data are suitable for estimation of cost or effectiveness models. This makes forecasting a relatively high priority for future work. However, forecasting depends on inventory, condition, and performance data which are lacking or incomplete for most types of assets. This logical dependency implies a necessary ordering of tasks for near-term development.

2.6.3 Credibility and the feedback loop

When engineers design new types of bridges, they rely on the credibility of their structural analysis models and specifications to ensure that the structure, once built, will provide the desired level of service safely for its design life. The confidence they have in their models is not given quickly or lightly. The models are constantly tested and validated. The models start simple, and are refined incrementally over time. Expert judgment is always a backup.

All of these statements are also true for asset management forecasting models. Agency commitments to performance targets are difficult to take seriously unless the forecasting models, on which they are based, are proven reliable. When moving from pure judgment and guesswork to a more quantitative, objectively sound method of managing assets, it is advisable to start simple and ensure that judgment is still available as a backup. It will take time to validate and refine the models, and build confidence in them.

To minimize the amount of time this takes, it is important to ensure, early in asset management implementation, that forecasting models for performance and costs are periodically held up to scrutiny. For this to be possible, a feedback loop is required (Exhibit 2-26). The feedback loop consists of records of actual conditions and project costs, expressed in the same units and form as the planning models used in planning the projects. Comparisons of actual vs. predicted outcomes, help to set priorities for further research and improvement.

When new asset management models are first developed, usually the inventory and inspection processes are new, and historical data are scarce. The initial models frequently rely on expert judgment as data for developing forecasting models. These models are often inaccurate. For example, Florida DOT developed its first bridge deterioration models in 2001 using expert judgment, and then replaced these with more scientific models, using inspection data, in 2010. It found that the expert judgment models estimated bridge element lifespans that were, on average, only half the median lifespans found in real inspection data (Sobanjo and Thompson 2011). This was not regarded as a failure of the old models, but merely a natural result of improved bridge inspection, maintenance management, and analysis methods, which are now producing very credible models. Asset management is a learning process.

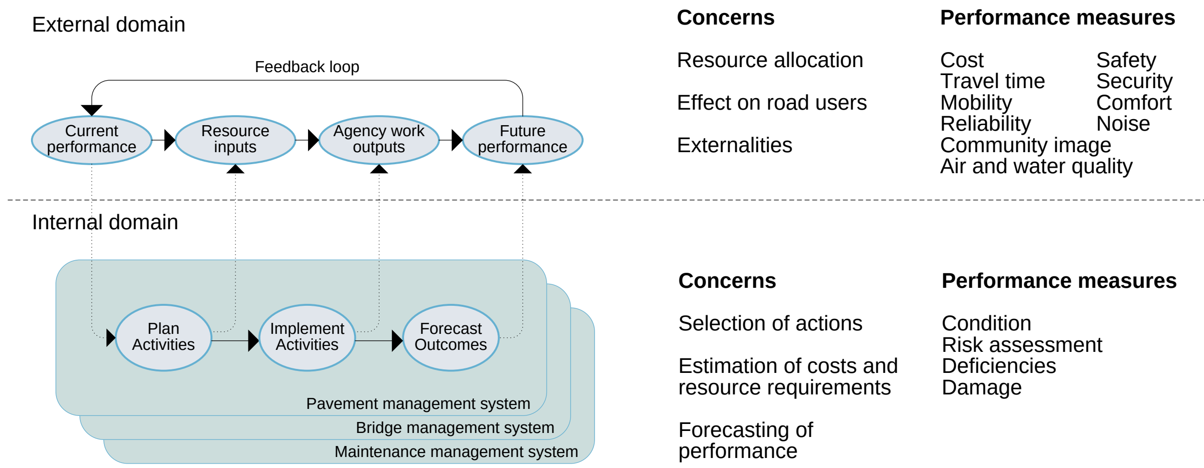

Exhibit 2-26. Feedback loop to ensure planning inputs correspond to reality
(Gordon et al 2011)

2.6.4 Tradeoff analysis and decision support tools

Given the steps that must be completed first — such as inventory, condition assessment, and forecasting — it is unrealistic to expect a complete decision support capability to be operational in just two years, even for the limited scope of the Parks Highway corridor. However, there is nothing to stop the Department from proceeding to develop a prototype of the Transportation Investment Candidate File, even if the data to populate that file are initially developed from judgment. After all, the Department already updates its Statewide Transportation Improvement Program (STIP) each year, with processes that are already in place.

An initial prototype of the Investment Candidate File could be developed to follow the STIP development process and interface with the prototype Parks Highway Data Integration Page which is already under development. It would be logical to develop this as an Excel spreadsheet, with a list of initial capabilities similar to the following:

- Ability to store and report on all the data items listed in Exhibit 2-23 for all investment candidates on the corridor. This would include investments listed in the STIP as well as alternatives that might become attractive at different funding levels.
- Ability to access the pavement and bridge management systems for investment candidates and inventory data for those asset types.
- Geographic referencing to enable graphical display on the maps developed for the Data Integration Page.
- Ability to compute utility functions and benefit/cost ratios for priority setting, using the methods described in NCHRP Report 590 (Patidar 2007).
- Ability to summarize changes in network level performance at any given funding level for any given set of performance weights. This could include graphs of performance vs funding based on the investment candidates provided in the file (Exhibit 2-27).
- Ability to determine the cost to achieve a given performance target, using the investment candidates in the file.

This analysis would be rough at first, since it must rely on existing STIP projects and existing pavement and bridge management capabilities, as well as some manual data entry. Even so, it would be a useful tool for preparing STIP reports and for presenting the STIP and its consequences to the public.

Most importantly, the initial prototype would be designed to be expanded and improved over time as more of the essential asset management capabilities come online. This would entail adding new asset types, such as culverts and geotechnical assets; adding new performance impacts as forecasting models of condition, life cycle cost, safety, mobility, and risk are developed; and adding more investment candidates as improvements are made in existing management systems to generate such candidates. Ultimately the spreadsheet could expand to include more corridors or the entire state.

Developed in this way, the decision support tool would start small and simple, and would build incrementally. This philosophy means the Department does not have to wait for a large, expensive project with a risky schedule and uncertain results. Early results would help the Department to educate its stakeholders and control the pace of development, while at the same time keeping the flexibility to adapt to future policy issues and stakeholder needs.

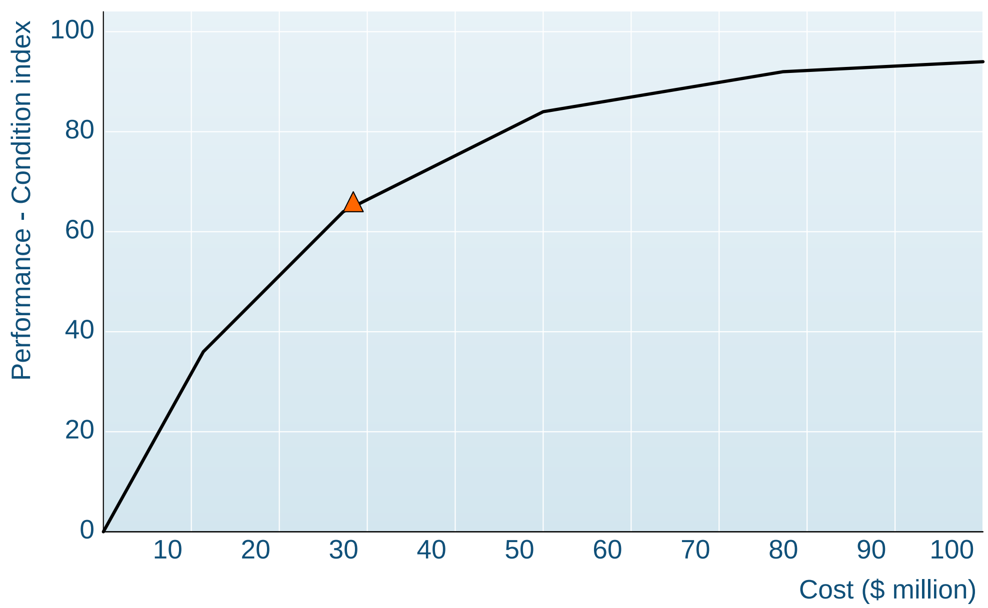

Exhibit 2-27. Example of performance vs cost graph

2.6.5 Findings: Decision support capabilities

Finding 6.1. The Department has a pavement management capability to extrapolate past condition trends, and has an expert judgment-based model of bridge deterioration. It has no forecasting models for any other types of assets, and no validation history even for the pavement and bridge models.

Finding 6.2. Because of a lack of inventory and condition/performance history, development of forecasting models for any additional asset types would need to be performed using expert judgment. Some work accomplishment data are available, but it is unknown at this time whether the data are suitable for estimation of models of cost or action effectiveness.

Finding 6.3. Currently the Department does not have any other decision support tools for asset management. In particular it does not have a reliable way to estimate life cycle costs or to forecast future preservation needs. It does not have a means of relating funding to performance or of investigating tradeoffs.

2.7 Transportation Asset Management Plan

It is apparent in this synthesis that asset management is made up of a rather large set of policies, relationships, procedures, data, and tools, all working together to maximize performance and minimize life cycle cost of the transportation system. These capabilities and ingredients all share a common focus on physical assets, but are otherwise as widely dispersed as the state transportation network itself.

The Work Plan in the next chapter will show that asset management is also a locus of investment in staff resources, operating and planning funds, consulting services, data, and equipment, which is just a small part of the larger investment the state has made in its physical infrastructure. Given the magnitude of the investment and stakeholder expectations for its performance, it is appropriate that the Department establish a locus of documentation to show how the state's valuable assets are being managed for the public good.

AASHTO's Asset Management Guide (Gordon et al 2011) suggests that a best-practice approach to this documentation would take the form of a Transportation Asset Management Plan (TAMP, Lindquist 2012). The new MAP-21 legislation now makes the TAMP a requirement for the National Highway System. A TAMP answers a variety of important questions that stakeholders and senior managers often have:

- Do we have an accurate picture of the scope of ALL assets that we manage, their financial value, their position in their lifecycle, the risks faced by the assets?
- Have we documented the levels of service or performance of the assets that we are providing, and researched what our customers value?
- How do we know whether the agency's mission is being accomplished with maximum effectiveness and efficiency? Do we have the evidence to convince stakeholders of this?
- Have we considered all the options in developing upgrade and preservation programs?
- How have we optimized our planned expenditure in asset preservation?
- Do we understand growth and demand for the services provided through transportation infrastructure?
- As the asset base grows due to system expansion, is there sufficient information to ensure that maintenance and operations budgets grow accordingly?
- How do we report on performance to our regulators, stakeholders, management and staff?

The TAMP will typically span an implementation period of 2 years, sometimes ranging from 1 to 4 years (Exhibit 2-28[11]), and address close to one increment on the asset management maturity scale. The initial self-assessment, as presented in this Synthesis, can be the baseline against which the desired improvements are compared. For each dimension of maturity, the plan must establish achievable objectives in the agreed time frame, and a step-by-step plan to reach the objectives. The steps are expressed as the Improvement Plan, a work plan with specific responsibilities, assumptions, and timelines.

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[11] http://www.nzta.govt.nz/resources/state-highway-asset-management-plan/docs/state-highway-asset-mgmt-plan-2012-2015.pdf

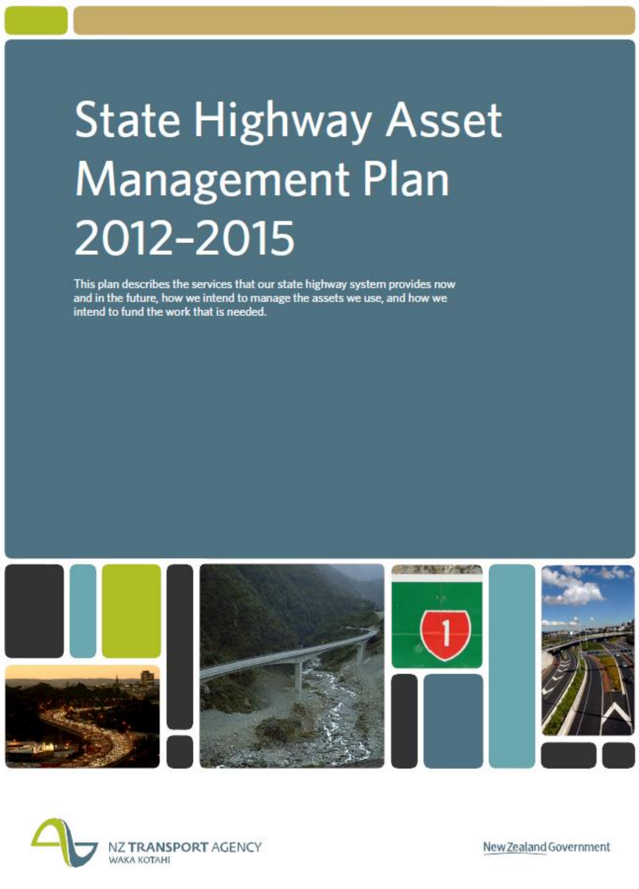


Exhibit 2-28. Example TAMP

The level of advancement of the TAMP can be an indicator of where the agency lies on the TAM maturity scale. Typically, the first TAMP can be developed at the Awakening stage when an agency has recognized the need, has some data and is able to document its current practices and improvement intentions. As the maturity level improves through Structured and Proficient towards Best Practice the TAMP should become more and more advanced reflecting higher levels of knowledge and analysis. In fact, the practice of writing and updating the TAMP also helps an agency to step up the maturity scale, as the process highlights the data needed, the decisions that need to be made, and the practices that need to be improved in order to make better decisions (Oregon 2011).

In terms of existing documents produced by the Department, the TAMP can be a complement to the STIP and the Statewide Policy Plan, providing more detail on the status of the transportation infrastructure, the near-term outlook in performance, and near-term plans for improving performance and life cycle cost. The TAMP can be a successor to the existing Pavement and Bridge Reports, having a more comprehensive treatment of Department assets.

A TAMP can be a single document, a collection of documents, and/or a collection of online resources. For the DOT&PF, a likely format for the state transportation network as a whole would be a PDF document of around 100-150 pages, accompanied by linkages to other data and resources provided on the Department's web site. If focused on just the Parks Highway Corridor, the length would be shorter. The main document could contain the following sections:

1. Introduction: Background on the Alaska DOT&PF, the Parks Highway corridor, and its infrastructure. General data and maps of the corridor focused on utilization, expected growth, recent history, and established plans.
2. Goals and objectives for asset management: Discussion of the legal and policy background in the Statutes, Administrative Code, and Statewide Policy Plan.
3. Asset inventory: Detailed tables and graphs on all types of assets (for which data are available) in the corridor, including types, magnitude, replacement value. Statistics on recent and future growth, including demand growth and industrial requirements.

4. Performance management framework: Background on levels of service, performance measurement methods, and data collection methods. General discussion (to aid a layman's understanding) on the specific types of performance to be managed, including condition, life cycle cost, mobility, safety, risk, and externalities. Discussion of how the Department determines preservation needs and how it sets performance targets.
5. Current performance and past trends: In the first iteration of the TAMP, the historical data and trendlines may be limited to pavements and bridges. Future iterations will be able to broaden the perspective as more data are gathered.
6. Future performance: Exploration of alternative futures for the corridor's infrastructure, sensitive to funding levels. In the first iteration this would be very rough, perhaps based on the first draft of the Investment Candidate File. This section would be intended to become much more authoritative in future iterations as the Department's data and analysis capabilities improve.
7. Processes: Current business processes of asset management, and proposed improvements. This chapter includes a discussion of the barriers to improvements (staffing, funding, legislative cooperation, etc.) and proposals/plans for overcoming the barriers.
8. Work plan: A specific list of tasks, similar to the one in this document, for improvements to asset management capabilities in the following two-year period (e.g. 2014-2016).
9. Financial plan: Includes a summary of the most recent STIP as well as operating funds necessary to achieve the process improvements and the desired performance improvements for the assets in the corridor or network.

An alternative outline for the TAMP, used in some agencies, has separate chapters on each general area of performance (condition, life cycle cost, risk, environment, etc.). Then each chapter describes the relevant asset inventory; past, current, and future performance; and the resources required for different scenarios of future performance. This alternative is more accessible for many readers, but it hides the inherent tradeoffs among the various performance areas. In other words, it encourages the reader to think in terms of ambitious goals for each type of performance but makes it more difficult to understand that a combination of all these ambitious goals might not be achievable with available funding.

The MAP-21 legislation lists some general requirements of the TAMP as it applies to the National Highway System. It is likely that these requirements will be spelled out in more detail by upcoming rule-making.

Regardless of the outline, the report would be supplemented with tables, graphics, and maps published on the Department web site. These more detailed presentations could focus on specific segments of the corridor, functional classes, or other relevant subdivisions of the network. Typically an automated process is required for generating the more detailed presentations, so the timing of such enhancements would depend on the availability of new information systems which can produce them.

3. Work plan

The following sections list the specific work plan tasks envisioned in order to advance by one step in asset management maturity. They are conceptualized to be feasible within the time frame of 2012 to 2014. However, it is important to set priorities among this large number of tasks, and it is very likely that some of them will need to be outside the 2012-14 time frame, or may be only partially completed in that time frame. Many of these tasks have economies of scale, such that they may be completed faster and less expensively if combined into projects.

The task descriptions are based on a relatively limited 2-month review that included a tour of the Parks Highway Corridor, meetings in the headquarters and regional offices, and quick review of a few relevant documents and systems. Some important documents and stakeholders were not available to the author during the limited time window of the study. A more thorough review might result in a more refined work plan. In many cases, the recommended near-term action is a feasibility study that can more deliberately review all relevant documents, involve all relevant Department staff and stakeholders, and provide more detailed design guidance.

3.1. Organizational structures

Action 1.1. Creation of Steering Committee. This committee would consist of the leaders of the various organizational units that participate in asset management, as suggested in Exhibit 2-5 above. Regional representation is essential. Pursuant to an earlier draft of this report, a Steering Committee was formed and first met on September 17, 2012.

Action 1.2. MAP-21 adaptation, training and facilitation. Consultant support is likely to be needed in order to train the Department participants, or supplement their existing knowledge in key areas. Facilitation by an outside expert would also help to negotiate new procedures and help the Department to take advantage of the experiences of other states. Given the new requirements of the MAP-21 legislation, it is timely to consider expanding the scope of this Synthesis and Work Plan to address at least the entire National Highway System in Alaska. Therefore this action may include an update of this report as affected by the legislation. This may entail services in the range of $60-110,000.

Action 1.3. Staff deployment and leverage. Improved staff efficiency and effectiveness in asset management processes may be possible with certain adjustments in staffing and deployment, with the goal of providing better leverage for key senior professionals. This could entail assistance from technicians, interns, consultants, local agencies, or others. The best way to proceed would be to discuss this matter within the Steering Committee and then make appropriate recommendations to senior management.

Action 1.4. Communication plan. Successful management of organizational change depends on clear, consistent communication within the Department and with stakeholders. There is also a need for clear two-way communication with the public regarding asset management. As asset management capabilities develop, there will be considerably more hard information available for public consumption, as well as an improved ability to gather and use public opinion data. The internal and external plans are closely related and need to be consistent with each other. This type of work typically requires 2-3 months of time by a consultant or internal expert, with 1-2 weeks of staff time for supervision and review.

3.2. Public and stakeholder initiatives

Action 2.1. Constituency-building. A major goal of the Communication Plan is to build public awareness and support of the idea that the Department is managing its assets for the public benefit, that performance and funding are linked by predictable forces, and that the Department is doing everything possible to maximize the value of the investment the state has made in its transportation assets. An additional goal is to keep the public informed of specific conditions, decisions, and plans, including corridor performance, STIP plans, and near-term work zone plans. An indirect goal, and a measure of success, would be for stakeholders to hear from their own constituents that the Department is doing a good job of keeping them informed and preserving the public's investment. This action involves maintenance of the web site as well as communication through other media according to the Communication Plan. This action would not necessarily increase the resources already devoted to communications, but the Communications Plan would have more to say about whether any additional resources are required.

Action 2.2. Stakeholder consultation. Expand formal and informal contacts with stakeholders. One specific topic to be addressed early, is to obtain feedback on the service level based budgeting exercise that was recently attempted. A more general topic is to discuss the ways in which the Department's performance is measured, and the ways that stakeholders can use the information. Demonstrations of the Parks Highway Data Integration Page would be helpful. The existing Performance Electronic Tracking System could be a focal point for a discussion of increasing the scope of performance monitoring and tracking in the Department. Stakeholders should be made to feel they are part of the team, attempting to improve life cycle costs and performance of Alaska's transportation system.

3.3. Policy documents

Action 3.1. Official adoption of the "Modified Approach" of GASB Statement 34. If possible, this would most effectively be done by means of the Alaska Administrative Code, but should also be reinforced via an internal policy document.

Action 3.2. Amendments to Statewide Policy Plan. When the Statewide Transportation Policy Plan is next updated, references to pavement management should be expanded to include all types of assets having significant cost or significant impact on Department objectives. Additional changes could be made to reflect the work plan described here.

Action 3.3. A focused push on internal policy. A concentrated effort is needed to develop a set of internal policies to guide and support further asset management development. These policies should support (and be supported by) the other actions described here, should apply to all types of assets and all aspects of performance identified in the Statewide Policy Plan, and should identify the means of implementation and the individual (by title) responsible for implementation. This action and the related policy development and review process is estimated to require 2-3 person-months of effort over 12-18 months, at least half by Department staff (the remainder may use consultant assistance).

Action 3.4. Policy follow-up. A policy coordinator will need to be appointed to ensure that the new asset management policies remain current and relevant. This might or might not be the same person who develops the policies, but should be a member of the Department staff. The same person could be responsible for follow-up on existing policies, some of which appear to be outdated or obsolete. Over the long-term this may require only 5% of a person's time, but the initial cleanup may require 1-2 months of concentrated effort over a 12-month period.

3.4. Asset inventories and condition assessment

Action 4.1. Inventory and condition feasibility study. A feasibility study should be undertaken to prepare a conceptual design for management of inventory and condition data for asset management. The study would prepare a logical database design, and determine whether the data models of the existing pavement, bridge, or maintenance management systems might contribute to the new design for other types of assets. Other development models, such as the use of COGNOS or development of an entirely new system, would also be investigated. It is appropriate in this study to investigate also whether the existing PETS system can be expanded to address all asset management needs for performance assessment and tracking, or whether an alternative approach is required. Methods for data capture and reporting would be investigated, for all relevant types of assets. This effort is estimated to require consultant services of $100-150,000, with approximately 3-5 weeks of staff supervision and review by affected units over a period of 6-8 months.

Action 4.2. Statewide GIS server. Funding has already been identified to expand and permanently host the Parks Highway Data Integration Page, to enable scaling to a statewide system for visualizing infrastructure conditions and performance. This work would be performed in-house, possibly with consultant assistance.

Action 4.3. Levels of service. Existing level of service documentation should be adapted and expanded to cover at least the priority 1 and priority 2 condition data items identified in Exhibit 2-15. These primarily technical definitions would form the basis for visual condition and performance assessment for all asset types that are not inspected by existing procedures. This could be done in-house using the same process as has been followed thus far. However, since the relevant staff are extremely busy, consultant or university assistance is advisable to help accelerate the process. This may require an effort of $40-70,000 over 4-6 months, with 3-5 weeks of staff support and review. Department staff participation is especially important to verify level of service and condition state language, and to supply photographs.

Action 4.4. Inventory/condition information system. The conceptual design from Action 4.1 and the level of service language from Action 4.3 should be implemented in the form of a database and information system, which may be created as an extension of existing systems, or as an entirely new system. The level of effort will need to be refined based on Action 4.01, and could range from $150,000 to $1 million, with the higher amount applying to an entirely new information system for inventory and inspection management if that is found to be necessary. The implementation time period would range from 1 to 3 years.

Action 4.5. Pavement condition survey enhancements. In the current state of the practice, pavement condition surveys typically cover additional defect types which aid in asset management. An investigation should be conducted to determine the cost and work plan to bring such measures into Alaska practice. The most important defects are: long-wavelength unevenness caused by frost heave and permafrost melting (Exhibit 3-1); alligator, transverse, and longitudinal cracking; surface texture defects and skid resistance; and spring bearing capacity. Such data are likely to be necessary for advancement in the life cycle management of Alaska pavements, given the state's unique exposure to freeze/thaw and permafrost. A cooperative effort with other northern agencies may help with development of suitable equipment and methods. An initial research study may cost in the $100-150,000 range. Additional costs for pilot testing in the Parks Highway corridor (or elsewhere) and for full implementation would need to be determined. These activities are highly suitable for university research.

Exhibit 3-1. Long-wave unevenness caused by permafrost and freeze/thaw

Action 4.6. Geotechnical assessment process. An inventory and condition assessment process should be established for material sites, retaining walls, rockfall protection systems, slope stability, embankment movement, and non-bridge scour. This would entail the development of documentation and policy statements governing the inspection process and interval (including inspection responsibility and training requirements); identification and procurement (when necessary) of necessary personnel and equipment; a quality assurance process; and any necessary software to be added to the Action 4.4 information system. This effort may be implemented in phases, with the highest-priority geotechnical assets addressed first. An initial phase might cost in the $100-150,000 range.

Action 4.7. Drainage assessment process. An inventory and condition assessment process should be established for all culverts not already included in the Pontis bridge inventory. Certain additional drainage structures (swales, levees, etc.) may be included. This would entail the development of documentation and policy statements governing the inspection process and interval (including inspection responsibility and training requirements); identification and procurement (when necessary) of necessary personnel and equipment; a quality assurance process; and any necessary software to be added to the Action 4.4 information system. A pilot study for the Parks Highway corridor would take about one year and would cost $40-80,000. This would develop metrics that would enable a more precise estimate for full statewide implementation. This activity is potentially suitable for university research.

Action 4.8. Cantilever structure assessment process. An inventory and condition assessment process (including fatigue assessment) should be established for sign structures, mast arms, high-mast light poles, and other cantilever structures. This would entail the development of documentation and policy statements governing the inspection process and interval (including inspection responsibility and training requirements); identification and procurement (when necessary) of necessary personnel and equipment; a quality assurance process; and any necessary software to be added to the Action 4.4 information system. A pilot study for the Parks Highway corridor would take about one year and would cost $70-150,000. This would develop metrics that would enable a more precise estimate for full statewide implementation.

Action 4.9. Roadside feature assessment process. A feasibility study should be prepared for the requirements of asset management for barriers, guiderails, traffic control devices (signs, signals, flashers, delimiters, etc.), lighting, and roadside safety features. This would then be implemented with the development of any necessary inventory and condition assessment processes, policies, and documentation. A phased implementation over many years may be appropriate. The initial study would cost $50-100,000 and take about one year. It is suitable for university research.

3.5. Levels of service and performance assessment

Action 5.1. Prioritization methods. Expand and refine the levels of service from Action 4.3 to ensure that the customer perspective is represented. Develop a set of performance indexes with appropriate scaling and weighting functions. This task will require a survey of stakeholders and customers in order to quantify the scaling functions and weights. This work would typically cost $80-150,000 and take about one year, possibly including the services of a marketing research firm for survey execution.

Action 5.2. Asset-level analysis. For all types of assets addressed by the inventory and performance processes put into place, develop software to estimate asset value, and to perform the scaling, weighting, and asset valuation computations. Develop reports to support trendline analysis for these performance indicators. The effort required for this work would depend in part on the results of the inventory and condition assessment tasks described previously. Ideally the simplest approach would be a spreadsheet model that accesses the relevant databases. Graphics extracted from the model could be posted to the Department web site and used in reports. This type of work would typically cost $100-150,000. More elaborate systems could be developed to present trendlines and indicators in real time in web pages, at a higher cost in the range of $150-250,000.

3.6. Decision support capabilities

Action 6.1. Investment candidate file. Develop a first draft of the Investment Candidate File as an Excel spreadsheet using as data sources the STIP, pavement and bridge management systems, and manual data entry. Subsequently this file can be expanded to include automated generation of needs for other kinds of assets. The capabilities would be as described earlier in this report. This would most efficiently be developed as a joint exercise where Department staff populate the spreadsheet with STIP and management data, while a consultant develops the automated capabilities such as system interfaces, prioritization methods, and reports. This type of work is likely to take about $70-120,000 in consulting fees plus 1-2 person-months of Department staff time over a period of about 1 year.

Action 6.2. Capture of maintenance work accomplishment data. A feasibility study would investigate existing and potential methods of capturing work accomplishment data for use in development of planning models and for tracking of program implementation. The study would address information systems, work classification schemes, data collection devices, linkages to inventory and condition assessment systems, policies and procedures, crew reporting procedures, and contractual provisions. It would produce a work plan for maintenance management system improvements. As a stand-alone study this would cost in the $100-200,000 range, but might be less expensive as part of a larger effort to redesign or upgrade the Department's existing maintenance management system.

Action 6.3. Models of pavement deterioration, actions, costs, and effects. This study would analyze existing data on pavement conditions and work accomplishments to develop quantitative forecasting models. The new models would be compared to the existing models in use in the pavement management system, and would be used to improve the forecasting capabilities of the PMS. The study would identify weaknesses in current data resources, and recommend improvements to procedures and systems to enable better planning models in the future. This type of work is typically in the $70-150,000 range and would take 6-12 months. This work is suitable for university research.

Action 6.4. Models of bridge deterioration, actions, costs, and effects. This study would analyze existing data on bridge conditions and work accomplishments to develop quantitative forecasting models. The new models would be compared to the existing models in use in the Pontis bridge management system, and would be used to improve the forecasting capabilities of Pontis. The study would identify weaknesses in current data resources, and recommend improvements to procedures and systems to enable better planning models in the future. This type of work is typically in the $120-200,000 range and would take 12-18 months. Portions of this work, especially the cost model development, may be suitable for university research.

Action 6.5. Models of geotechnical asset deterioration, actions, costs, and effects. This study would use an expert judgment elicitation process to develop a first draft of forecasting models, for use while inventory, condition, and work accomplishment data collection processes are put into place. This type of work is typically in the $20-50,000 range and would take 2-4 months.

Action 6.6. Models of other asset deterioration, actions, costs, and effects. This study would use an expert judgment elicitation process to develop a first draft of forecasting models, for use while inventory, condition, and work accomplishment data collection processes are put into place. This type of work is typically in the $30-70,000 range and would take 4-8 months.

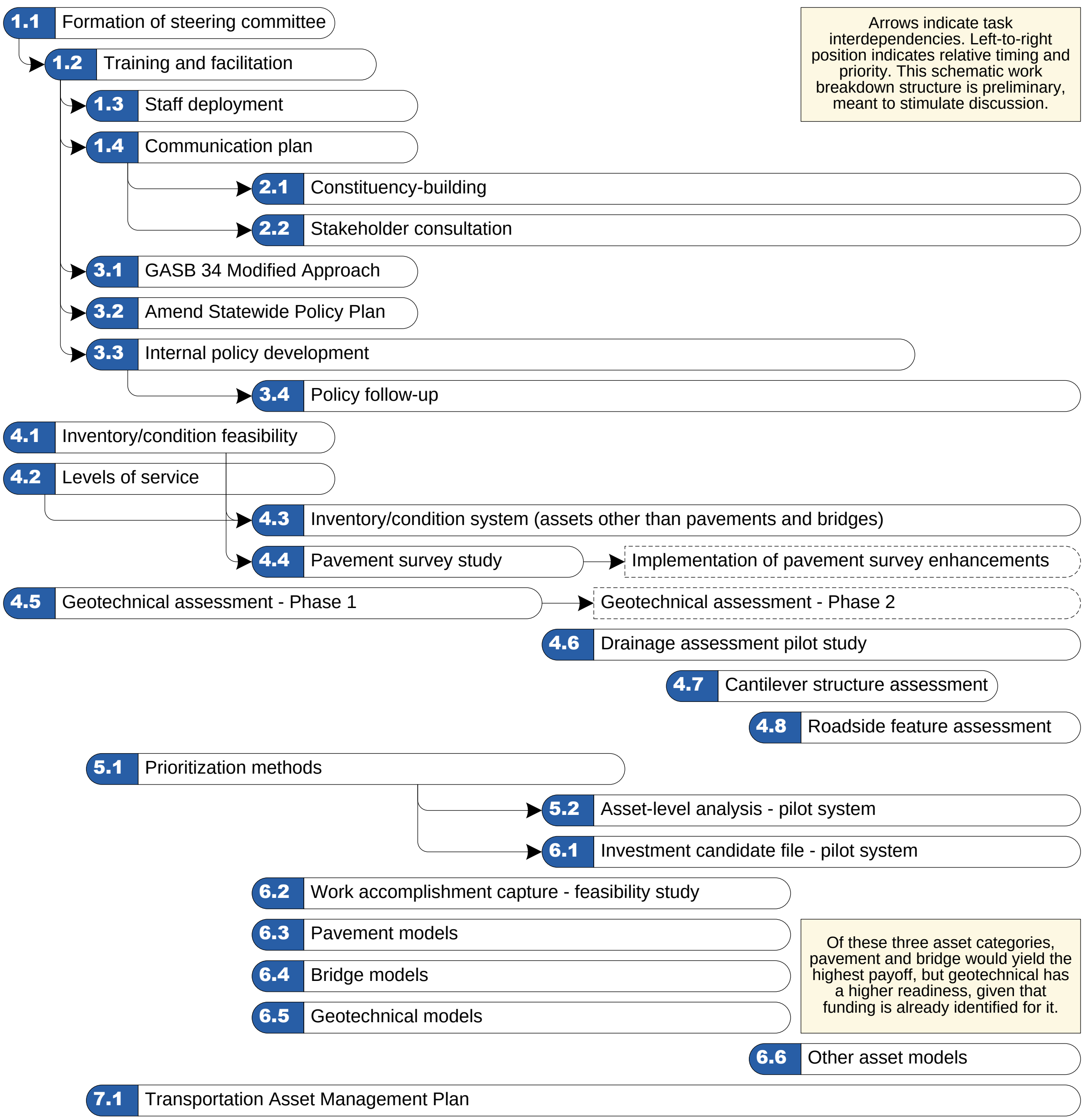
3.7. Transportation asset management plan

Action 7.1. Develop a first draft of a transportation asset management plan, focused on the Parks Highway Corridor or potentially expanded to include other corridors, the entire National Highway System in Alaska, or statewide. The contents would be as described earlier in this report. This would likely be developed as a joint effort between Department staff and a consultant, with staff time requirements in the 3-6 month range and consulting costs in the $100-150,000 range. The effort would be spread over the entire period from 2012 to 2014 but more concentrated toward the end of the period, especially in the last 6 months. In the initial version a considerable amount of manual data processing may be necessary while supporting systems are developed. Thus, costs are lower if the first draft is limited to the Parks Highway. Economies of scale would be developed once automation is available to extend the TAMP to other corridors or statewide.

3.8 Logical flow and priority of work plan tasks

Exhibit 13 shows the task relationships schematically, indicating inter-relationships and likely priorities. This assessment is very preliminary, meant as a starting point for discussion by the Steering Committee. The timing of the various tasks may depend on task inter-relationships, project readiness, and priorities. Within tasks, there is often a potential for phased implementation, as discussed in the text above. Some of the tasks might not be completed, and some might not even be started, in the 2012-14 time frame.

Exhibit 13. Preliminary work breakdown structure for 2012-14 asset management tasks



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