Guidebook for Data and Information Systems for Transportation Asset Management

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1. Introduction

This chapter provides an overview of the guidebook: its purpose, scope, and organization.

1.1 Background

State Departments of Transportation (DOTs) have made steady progress in the use of data and information systems to manage transportation assets. Advances in data acquisition, management, and reporting tools and technologies are enabling more automated, efficient, and integrated flows of data across systems and more agile and effective ways of delivering information needs to end users.

DOTs have strong incentives to take advantage of these advances; they face growing expectations from the public, increasing demand for transparency and accountability, and challenges to make best use of limited resources to deliver value.

This guidebook provides step-by-step techniques and a digital tool to:

- **Assess current practice and establish a desired state.**
- **Identify and evaluate data- and information system-related improvements.**
- **Secure agency support for improvements and plan an implementation strategy.**

Transportation Asset Management is defined by the American Association of State Transportation Officials (AASHTO) as a "strategic and systematic process of operating, maintaining, upgrading, and expanding physical assets effectively throughout their life cycle. It focuses on business and engineering practices for resource allocation and utilization, with the objective of better decision making based upon quality information and well defined objectives.

Institutional challenges faced by DOTs in effectively and sustainably advancing how information is managed, shared, and used within and across organizations require much more than procuring new tools and technologies.

In recognition of these challenges, this guidebook identifies **organizational capabilities and typical strategies** which will help DOTs accelerate and implement cross-functional and enterprise-wide changes to how data are collected, managed, shared, and used in their TAM related programs.

Purpose and Scope

The purpose of this guidebook is to assist DOTs in advancing use of data and information systems for transportation asset management (TAM). It is intended to be used in conjunction with a companion digital tool – the TAM Data Assistant – providing a comprehensive way to benchmark agency practices and identify and evaluate improvements.

Guidebook Purpose

TAM is by nature data and analysis-intensive. Data (and information derived from data) about asset inventory, condition, performance, and related work activities are used to inform agency strategies for maintenance, rehabilitation and improvement. Data also inform allocation of increasingly scarce resources.

Most transportation agencies have asset management systems in place and use a variety of systems to plan and track maintenance activities and capital projects. However, they face challenges with integrating data across systems and across the asset life cycle. They also seek to capitalize on opportunities to adopt new, emerging tools and technologies for data collection and analysis.

This guidebook provides a structured approach that agencies can use to assess current practices in use of data and information for TAM. This approach can be applied in a comprehensive fashion; it can be targeted for a particular asset; or it can focus on a particular topic area – such as data collection or data integration.

A companion digital tool – the TAM Data Assistant – is available for conducting the assessment, identifying improvements, and evaluating candidate improvements. This guidebook is intended to be used initially to help agencies plan and organize an assessment. It also provides supplemental resources that can help agencies with each step of the process – understanding the context for each of

the assessment elements, learning about and evaluating possible improvements, and planning an implementation strategy.

Guidebook Scope

The guidebook is structured around a data life-cycle framework. This life-cycle (illustrated in Figure 1-1) consists of five essential steps for making efficient and effective use of data and information for TAM. The data life-cycle approach was selected to reinforce the importance of anticipating how data will be used prior to collecting it. The data life-cycle can be viewed as a supply chain in which the finished product is a data-informed decision. Getting a quality product depends on sound practices for specifying data, collecting it, storing and integrating it and providing access to potential users, and having suitable analysis tools and processes in place.

Each step of the data life-cycle represents an assessment *Area* in the guidebook. An overview of each *Area* is described on the following page; further detail is provided in Chapters 2 and 3.

For each Area, the guidebook provides *Benchmarks* and *Candidate Improvements*. The *Benchmarks* describe different levels of practice – representing a trajectory for advancement from a non-existent or minimal practice to an advanced practice. The *Candidate Improvements* describe initiatives that agencies can pursue to move from one benchmark level to the next.

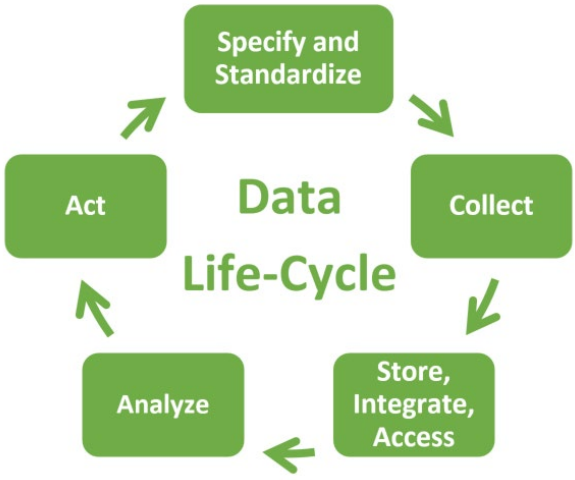


Figure 1-1. Guidance Framework

The guidebook provides two types of supplemental resources to help agencies select and plan improvements.

Case Studies provide examples of implementation experience.

Organizational Practice descriptions highlight approaches that can be taken to overcome the very real challenges of implementing data and information improvements.

Technical Framework

Data Life-Cycle Area Overview

Specify and Standardize Data

Supports the understanding of the needs and full costs of asset inventory, condition and performance, treatment, and work history data. Also addresses the documentation of data meaning, derivation, and quality, and the establishment of governance structures and processes and stewardship roles and responsibilities.

Collect Data

Explores TAM related data collection processes, tools and technologies, and quality as delivered with respect to existing data standards.

Store, Integrate, and Access Data

Addresses data availability across the enterprise and the elimination of redundant and duplicative data. Specific asset life-cycle process areas are identified for data standardization and integration, as well as other data and process areas important to TAM decision-making.

Analyze Data

Examines decision-support tools, techniques, and practices that facilitate development of actionable information and insights supporting decision-making. Data exploration, reporting, visualization, and asset modeling are a focus within this Area.

Act Informed by Data

Covers data-informed TAM practices, exploring asset life-cycle management through resource allocation and prioritization, project planning, scoping, and design, and maintenance decision-making.

Anticipated Uses

The guidebook is intended to be used to carry out a formal assessment and improvement planning effort. However, it can also be used as a resource for DOT's that are not ready to pursue an assessment process but are interested in what they can do to improve their practices.

Formal Uses: Formal application of the guidance involves selecting a focus area, forming a team, using the companion

tool to carry out the assessment, and then producing a plan of improvements.

Informal or Individual Uses: The guidebook can be used as a reference for individual agency managers or TAM practitioners to understand possible future directions for advancement, review case studies, and provide ideas for evaluating improvement strategies.

Intended Outcomes

Completing the full assessment process will result in:

- A shared understanding of current agency practice – and a shared vision for how the agency wants to advance.
- A list of candidate data and information system improvements that could be used to close the gap between current and target practice levels.
- A prioritized list of improvements – created based on a systematic process of evaluating likely impact versus effort required; and implementation challenges.

Intended Audience

This guidebook is targeted at state DOT asset managers, business leads, system owners, and stewards interested in evaluating and improving how data and information systems are used within their TAM programs. While state DOTs are the primary intended audience for the guidance, it is also applicable to other transportation asset owners (such as transit agencies).

To fully realize the benefits of the assessment, other business, technical, and supporting functions should be involved in the process, including:

- Field asset management staff,
- Information technology managers,
- Business intelligence and GIS managers and
- Workforce, human resource, and organizational change management leads.

The TAM Data Assistant

A companion digital tool is available for agencies to use to conduct the assessment. This tool supports benchmarking of the agency current and desired state, improvement identification and evaluation, and results summary and communication.

While this guidebook contains all of the materials needed to carry out the assessment process, use of the TAM Data Assistant is strongly recommended as it will streamline workflow and provide summary materials useful in communicating and engaging with agency executive management or other decision-makers. A brief overview of the

TAM Data Assistant functions is provided in **Chapter 2**.

Chapter 4 details TAM Data Assistant uses supporting improvement evaluation, results summary, and executive communication.

Appendix H provides uses of the TAM Data Assistant to facilitate the complete assessment process.

Appendix I contains a quick reference guide that explains the functionality and use of the TAM Data Assistant in detail.

Relationship to Other Guidance

This guidebook provides a comprehensive perspective on data and information system use in TAM. However, there are other related assessment and guidance products available. These include:

- The Asset Management gap analysis tool developed under National Cooperative Highway Research Program (NCHRP) Project 08-90,
- Data Management self-assessment tools developed under NCHRP Project 08-92,
- The Transportation Performance Management Self-Assessment tool and
- Guidance on management and use of data for Transportation Performance Management

This guidebook and companion tool complement these existing tools by providing an in-depth look specifically at how data and information systems are applied to TAM practice.

TAM Digital Assistant

Digital Tool Functional Overview
Chapter 2

Improvement Evaluation Uses
Chapter 4

Result Summary and Executive Communication
Chapter 4

Assessment Facilitation
Appendix H

Tool Quick Reference Guide
Appendix I

Guidebook Organization

This guidebook is organized to help agencies step through the process of preparing for an assessment, conducting an assessment, evaluating improvements, and planning for implementation.

The self-assessment and improvement identification materials are organized in a three-level hierarchy:

- **Areas – representing each phase of the data life cycle (e.g. data collection)**
- **Sections – representing topics relevant to a data life cycle phase (e.g. asset inventory, condition and performance data collection)**
- **Elements – representing items for benchmarking and improvement (e.g. asset inventory, condition an performance data quality)**

Guidance Process Overview and Organization

The guidebook is organized into five chapters and several technical appendices.

Chapter 1 – Introduction: This chapter describes the purpose, scope and target audience for the guidebook and provides an overview of the assessment process.

Chapter 2 – Pre-Assessment Preparation: This chapter helps prepare an agency for conducting an assessment. It covers selecting a focus area, assigning a facilitator, and engaging the right participants. It also reviews the steps for conducting the assessment and selecting and evaluating improvements.

Chapter 3 – Self-Assessment and Improvement Identification: This chapter provides guidance and links to resources that can be used as participants step through the process of assessing current practice and selecting improvements. This content is organized around the five Areas representing data life cycle phases.

Chapter 4 – Evaluation and Summary: This chapter provides guidance that can be used as participants evaluate candidate improvements, set priorities, and develop materials for gaining executive support for improvements.

Chapter 5 – Implementation Support: This chapter describes additional resources that can be used to support implementation of data and information system improvements. These include case studies of DOT practice and general organizational practices (such as change management).

2. Pre-Assessment Preparation

This chapter describes activities needed to prepare for conducting an assessment of agency practices.

2.1 Selecting a Focus

Transportation asset management practices and context vary by DOT, asset area, and individual business function or working group. Data and information system related practices also vary between and within DOTs. Selection of a focused used case is essential to developing meaningful results from the use of this guidance.

An asset-specific focus allows the DOT to examine data and information system practices within a given asset program, across one or more of the five data life-cycle areas of the framework.

An area-specific focus supports DOT examination of enterprise practices impacting multiple assets within a specific area of the data life-cycle.

Each of these use cases and its anticipated value is examined within this section of the Guidebook.

Use Case Overview and Value

Many DOTs will want to use this guidance to improve a targeted asset program. In this application, a DOT can evaluate and improve how data is defined, collected, accessed, analyzed, and used in that asset program's decision making processes.

DOTs may also target a specific data life-cycle area to identify improvements benefiting the TAM program (or enterprise) at large.

It is not advisable to undertake assessment of multiple data life-cycle areas without narrowing the focus to an individual asset program. With such a broad scope, achieving meaningful results is impractical at best.

Asset-Specific Focus

Improve outcomes or prepare for a major system or business process change within a specific asset program.

Bring together diverse, informed perspectives in a well-documented discussion of asset related needs and possible improvements to maximize the value of this effort. Central office program management and analysts, district decision-makers, field staff, and other key stakeholders should be involved to raise awareness of key contexts and challenges faced across the program and identify meaningful improvements.

Examples of how an asset-focused effort could add value are provided on the following page.

Asset-Specific Focus

Anticipated Value by Data Life-Cycle Area

Specify and Standardize Data – *Standardize Data and Information Meaning and Use*

- Identify where existing asset data standards are not serving the needs of various stakeholders.
- Examine how location referencing and design file standards are inconsistently applied between various asset systems and processes.
- Raise awareness of resource allocation and decision-making values and criteria, identifying inconsistencies between field, central office, and executive values.
- Improve understanding and involvement in metadata- and governance-related activities.

Collect Data – *Deliver Asset Data Collection Needs, Improve Data Quality and Generate Efficiencies*

- Identify asset data collection needs, technologies, or efficiencies within the asset program.
- Examine field based tools and systems to collect needed project and maintenance information.
- Capture public perception and decision-maker values to inform asset priorities and decisions.

Store, Integrate, and Access Data – *Increase Data Access and Integration within the Asset Program*

- Evaluate database tools and structures to ensure data is stored and accessed efficiently and able to be integrated across various asset life-cycle systems and workflows.
- Examine other data sources (such as revenue, budget, expenditure, demand, utilization, or environmental information) needed to improve asset decision-making.
- Explore field data access needs, public data access needs, and data access security considerations.

Analyze Data – *Advance Analytical and Reporting Capabilities Supporting Asset Decision-Making*

- Evaluate TAM analysis capabilities, including improved tools, practices, and environments.
- Identify methods to improve asset performance prediction, optimization, and prioritization models.

Act Informed by Data – *Improve Asset Management Decision Quality and Outcomes*

- Consider methods to integrate data into network-level resource allocation and prioritization decisions; project planning, scoping, and design; and infrastructure and equipment maintenance.

Area-Specific Focus

Improve data and information systems, tools, practices, and techniques within a given data life-cycle area, advancing related TAM program capabilities.

Achieve desired results by including asset management staff and business system owners, as well as information technology and business support staff.

Examples of how an Area-specific focus could add value are provided in the following figure.

Area-Specific Focus

Anticipated Value by Data Life-Cycle Area

Specify and Standardize Data

- Advance and standardize asset related data models, including location referencing, resource allocation, and project design standards.
- Define and implement enterprise metadata and governance programs.

Collect Data

- Streamline collection of asset and project data through standardized tools and multi-purpose collection programs.
- Capture public opinion and decision-maker values to support cross-asset and/or cross-program investment prioritization.

Store, Integrate, and Access Data

- Explore cross-functional data integration initiatives and examine enterprise data and information system solutions.
- Increase internal and external stakeholder access through TAM related data warehouses and dashboards.

Analyze Data

- Develop advanced, cross-asset resource allocation or multi-objective project selection systems, processes, or tools.
- Provide enterprise business intelligence and/or analysis solutions meeting TAM program needs.

Act Informed by Data

- Establish enterprise performance targeting and project prioritization programs.
- Advance data-driven, project-level design and scoping decisions.
- Improve agency infrastructure and equipment maintenance practices.

2.2 Key Roles and Responsibilities

This Section highlights key participants and general process involved in the efficient, effective use of this Guidebook.

Key Roles

A diverse set of perspectives are needed to examine current and desired capabilities and identify targeted improvements.

A cross functional team should be formed and led by a knowledgeable, trusted, and respected facilitator. Participants should be selectively targeted for their background, ability to constructively participate in the focused discussion, and position to advance the anticipated outcomes of the process.

Recommended participants and their respective responsibilities are shared below.

Project Sponsor

It is strongly recommended that a "project sponsor" be identified for any formal application of this guidance.

The project sponsor should have decision-making authority, be willing to be engaged throughout the process, and share enthusiasm for improving within the focus area.

The project sponsor should:

1. **Provide Leadership:** Provide executive or management level endorsement and support for the assessment and recommended improvements.
2. **Select a Facilitator:** Appoint an assessment facilitator to organize, communicate and manage the process and detailed activities.
3. **Be a Champion:** Engage with leadership and management to ensure enthusiasm and cross-functional participation by targeted business, information technology, and support units.

Assessment Facilitator

It is essential that an assessment facilitator leads and organizes self-assessment, improvement identification, and improvement evaluation activities. A good candidate for this role is organized, empathetic to the diverse perspectives of the participants, and able to command the attention and respect of the group.

Ideally, this individual should be knowledgeable about the DOT asset management program and supporting data and information systems. The facilitator should also not have a particular agenda or bias with respect to the outcome or conclusions of the group (their role or perspective would not be seen as inherently favoring certain assets or data areas).

The ideal candidate for such a role is a program or project manager from the enterprise asset management, business process improvement, or other such program. Use a qualified, external consultant if candidate agency staff are not able to dedicate the time necessary to prepare, facilitate, document, and summarize the results of the process.

Key responsibilities of the assessment facilitator are:

1 **Assessment Scoping:**

- Establish the assessment focus with the Project Sponsor.

2 **Participant Selection:**

- Identify and engage targeted participants in the process.

3 **Participant Preparation:**

- Share context and direction throughout the process.
- Ensure expectations are clear and individuals are adequately prepared to constructively participate.

4 **Group Facilitation:**

- Organize meeting attendance and provide direction to meeting activities.
- Ensure productive discussion and full participation.
- Document key meeting outcomes.
- Provide summary materials for group review and preparation in advance of future meetings or activities.
- Utilize the TAM Data Assistant to capture group consensus during assessment, improvement identification, and improvement evaluation activities.

5 **Assessment Leadership:**

- Capture group consensus on current and desired state and selected improvements.
- Document supporting contexts and takeaways from the assessment meetings.
- Delegate action items (e.g. gaps in understanding that need to be closed by targeted participants).

6 **Improvement Evaluation Leadership:**

- Review practice gaps, assessment notes, and consider organizational needs, challenges, and context.
- Ask questions that support informed discussion of agency improvement priorities.
- Prepare supporting materials (such as "radar" charts).
- Capture group consensus on improvement challenges, impact and effort, and priority.
- Consider when "reassessment" is needed to refine the assessed current or desired state, or to identify additional or remove previously selected improvements.

7 **Results Summary:**

- Summarize outcomes for implementation action.
- Present improvement priorities for executive endorsement and action.

8 **Implementation Support:**

- Work with the project sponsor and other participants to advocate for implementation.
- Seek funding opportunities.
- Lead efforts to incorporate recommendations into the agency technology, business, and/or process improvement plans, initiatives, and actions.

Asset Program Leads

Program leads from within the selected TAM focus area, or who rely upon the data and information systems within the identified data-lifecycle area are critical participants within the process.

These are typically central office program management, project managers, analysts, or engineers who understand asset management decision-making needs from a statewide and policy perspective. These individuals should also be able to discuss organizational challenges posed by substantial data, information system, or business process change.

A typical team includes:

- Several such individuals, spanning key asset and/or program areas.
- At least one Program Lead who is able to share executive management perspectives.

Field Asset Management Leads

District asset managers, engineers, or maintenance supervisors who are involved in day-to-day field asset management decision-making and execution. These staff must share the practical realities, challenges, priorities, and constraints of field asset management staff.

A typical team should include several of these individuals with differing perspectives. A district management perspective is necessary, as well as project-level decision-making and boots-on-the-ground field perspectives.

Information Technology (IT) Management and Staff

Key IT staff, particularly those who have an understanding of existing technologies, applications, and priorities within the targeted area. This may include IT relationship managers (those engaged with or integrated with key business units or applications), system administrators, project managers, or business or technical analysts.

IT staff should be prepared to share data, technology, or application related context and perspective as business needs or capabilities are discussed. These individuals should identify technology solutions from other agency business functions which may be useful to the TAM program.

During improvement evaluation, IT staff should share the technical process, challenges, and constraints anticipated when delivering IT solutions.

Data Life-Cycle Area Subject Matter Experts

As appropriate to the asset program, or when focusing on specific data life-cycle areas, other key perspectives should be represented. For example:

- **Specify and Standardize Data:** Computer aided design and drafting (CADD) and location referencing system (LRS) managers and technical experts, metadata and governance leadership or staff.
- **Collect Data:** Statewide data collection (e.g. LiDAR or image-based vehicle collection), geographic information system (GIS) program, and/or mobile data collection program managers.
- **Store, Integrate, and Access Data:** Data warehouse and GIS program managers and technical experts, business, data and/or enterprise architecture staff.

- **Analyze Data:** Business intelligence, data analysis/science program managers or staff.
- **Act Informed by Data:** Performance management or performance dashboard staff, capital, operations, and maintenance program budgeting, and/or field project and construction managers.

Recommended Preparation

This Section outlines the recommended process for guidebook use and identifies keys to success. Detailed instructions are provided in Appendix H.

Process Overview

Full, formal use of this guidance includes the following activities:

1. Initial Scoping
2. Participant Engagement
3. Process Kickoff Meeting
4. Self-Assessment and Improvement Identification Meetings
5. Improvement Evaluation Meetings
6. Outcome Summary and Communication
7. Implementation Support

These activities are led by the assessment facilitator, though initial scoping should also involve the leadership of a project sponsor.

Keys to Successful Use

Facilitator preparation, participant engagement, and use of the TAM Data Assistant are strongly recommended.

- **Facilitator Preparation:** an active, prepared assessment facilitator is essential. **Appendix H** provides a detailed walk through of each activity in the process, sharing anticipated outcomes, detailed facilitator instructions, digital tool uses and supporting materials (such as sample meeting agendas or participant engagement materials).
- **Participant Engagement:** a small, cross-functional group of knowledgeable and engaged individuals is needed to share perspectives on existing TAM processes, related data and information systems, and potential improvements.
- **TAM Data Assistant Use:** an online, supporting digital tool is available. This tool provides a streamlined workflow to create assessments, benchmark performance, select, evaluate, prioritize improvements, and summarize and communicate outcomes. **Appendix I** provides a detailed user quick reference guide.

TAM Data Assistant

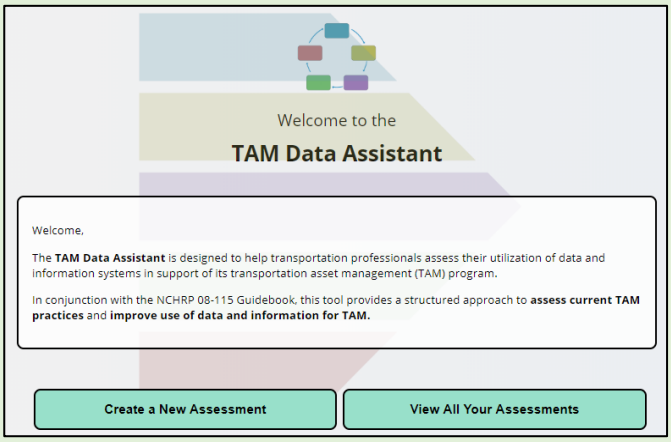
Facilitator Materials
Appendix H

TAM Data Assistant User Quick Reference Guide
Appendix I

TAM Data Assistant

The companion digital tool is available online, through the AASHTO TAM Portal, at: www.dataassessment.tam-portal.com.

Create Assessments



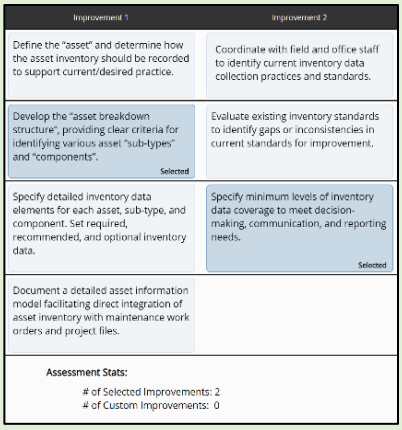
Create and customize assessments of your TAM programs.

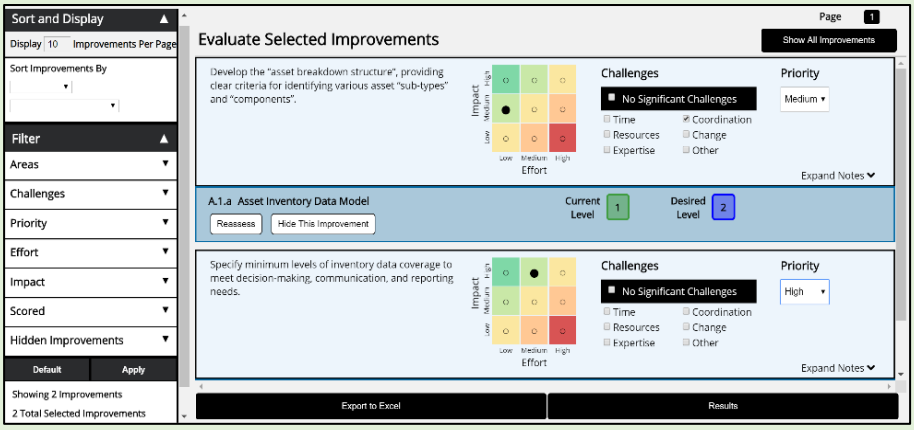
Benchmark Performance

Benchmark Practice Level Description	Current Level	Desired Level
The agency has not defined any consistent definitions or methodologies for tracking inventory information for a given asset or asset type.	0	0
The agency has defined the "asset", documented how this asset's inventory should be tracked (e.g. modeling vs. true inventory) and defined the general form for inventory data (e.g. asset points, lines, or polygons, or roadway segments, general asset counts).	1	1
The agency has established an asset breakdown structure for the asset, defining various asset subtypes and components. Clear and comprehensive criteria for evaluating these assets into these sub-types and identifying various components are established.	2	2
The agency has identified a minimum set of standard inventory attributes to be stored for the asset (e.g. unique identifier, location, install date, asset subtype, size/measure). Required, recommended, and optional data elements are identified. Desired extent of collection is established.	3	3
The agency has defined a detailed asset information model that supports direct integration with project and maintenance information, contracts and/or design files.	4	4

Benchmark current practices and desired state for 51 individual elements.

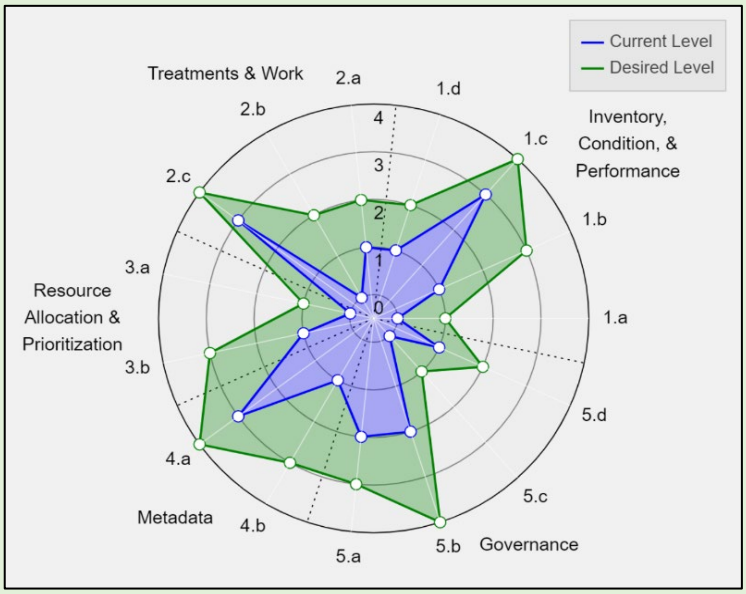
Select, Evaluate, and Prioritize Improvements

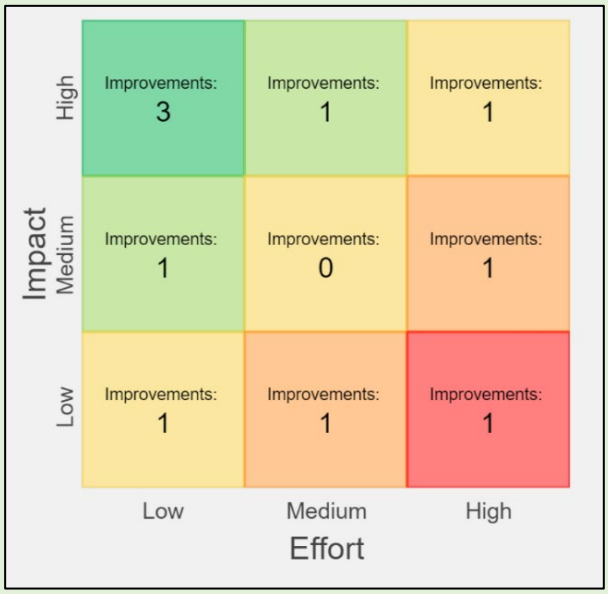


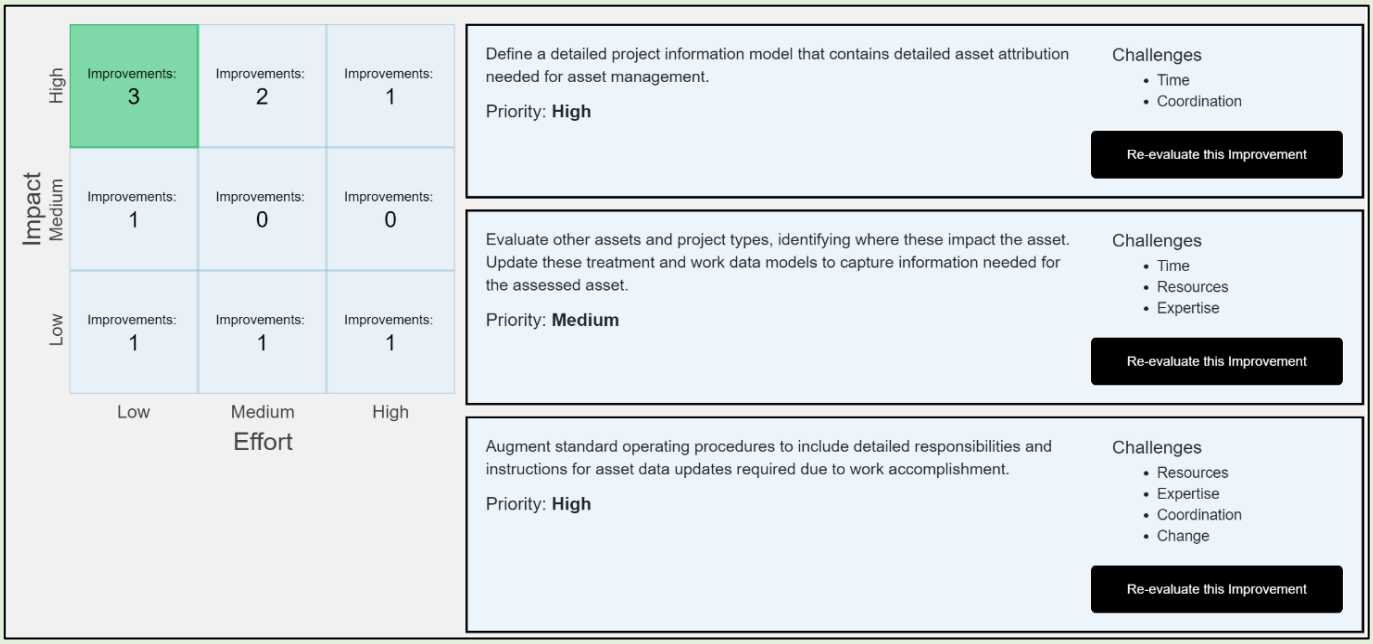


Select from candidate improvements to address identified practice gaps. Prioritize selected improvement based on implementation impact, effort, and challenges.

Summarize and Communicate Outcomes







Export summary communication materials, directly from the tool. Use these for communicating to executives and to advocate for implementation priorities.

3. Self-Assessment and Improvement Identification

This chapter provides detailed supporting materials for assessment and improvement identification.

This content is organized around the five Areas of the data life-cycle.

Agencies are encouraged to limit the scope of the assessment to a single asset class – or to 1-2 data life-cycle areas for multiple assets. This approach will ensure that the process doesn't pose an undue burden on participants – while providing a substantive look at a specific area of interest.

3.1 Self-Assessment Framework and Materials Overview

This section details the technical framework used to organize the assessment and improvement identification materials, and provides Area- and Section-specific materials to support the assessment process.

Detailed Technical Framework

The technical framework is developed around the data life-cycle, which for the purposes of this guidance is broken down into five (5) Areas.

Each data life-cycle area is further organized into several Sections and their individual Elements.

Figure 3-1. Guidance Framework

Area A: Specify and Standardize Data

This Area supports the understanding of the needs and full costs of asset inventory, condition and performance, treatment, and work history data. This Area also addresses the documentation of data meaning, derivation, and quality, and the establishment of governance structures and processes and associated stewardship roles and responsibilities.

This Area is subdivided into fifteen individual elements, grouped into five associated sections:

- Section A.1 – Inventory Condition and Performance Standards
- Section A.2 – Treatment and Work Standards
- Section A.3 – Resource Allocation and Prioritization Standards
- Section A.4 – Metadata Standards
- Section A.5 – Governance

Area B: Collect Data

This Area explores TAM related data collection processes and practices, tools and technologies, and quality as delivered with respect to existing data standards.

This Area is subdivided into eleven individual elements, which are grouped into four associated sections:

- Section B.1 – Inventory Condition and Performance Collection
- Section B.2 – Project Information Collection
- Section B.3 – Maintenance Information Collection
- Section B.4 – Priority Criteria and Values Collection

Area C: Store, Integrate, and Access Data

This Area addresses data availability across the enterprise and the elimination of redundant and duplicative data.

Specific asset life-cycle process areas, as well as external data and process areas, are identified for data standardization and integration in order to streamline business processes and improve decision-making.

This Area is subdivided into fourteen individual elements, which are grouped into four associated sections:

- Section C.1 – Databases
- Section C.2 – Asset Life-Cycle Data Integration Workflows
- Section C.3 – Other Data Integration Workflows
- Section C.4 – Data Access

Area D: Analyze Data

This Area examines decision-support tools, techniques, and practices that facilitate development of actionable information and insights to support decision-making.

This Area is subdivided into five individual elements, which are grouped into two associated sections:

- Section D.1 – Data Exploration, Reporting and Visualization
- Section D.2 – Modelling

Area E: Act Informed by Data

This Area covers data informed TAM practices, exploring asset life-cycle management through resource allocation and prioritization, project planning, scoping, and design, and maintenance decision-making.

This Area is subdivided into six individual elements, which are grouped into three associated sections:

- Section E.1 – Resource Allocation and Prioritization
- Section E.2 – Project Planning, Scoping and Design
- Section E.3 – Maintenance

Detailed Data Life-Cycle Framework

Figure 3-2 provides a representation of the complete data life-cycle framework, comprised of 5 Areas, 18 Sections, and 51 Elements.

This Chapter shares supporting guidance and context for each Area and Section within this framework, to supplement and support detailed element-level practice benchmarks and potential improvement recommendations.

A. Specify and Standardize		
A.1 Inventory, Condition and Performance Standards	A.1.a	Asset Inventory Data Model
	A.1.b	Asset Condition and/or Performance Data Model
	A.1.c	Design Model Standards
	A.1.d	Location Referencing
A.2 Treatments and Work Standards	A.2.a	Treatment and Work Data Model
	A.2.b	Treatment and Work Location Referencing
	A.2.c	Process Documentation and Management
A.3 Resource Allocation and Prioritization	A.3.a	Prioritization Factors
	A.3.b	Analysis Parameters
A.4 Metadata	A.4.a	Data Dictionary Standards and Guidelines
	A.4.b	Dataset Metadata Standards and Guidelines
A.5 Governance	A.5.a	Data Stewardship
	A.5.b	Data Standards & Guidelines Development / Adoption Processes
	A.5.c	Data Collection Approval / Coordination Practices
	A.5.d	Change Control (Systems and Data) Processes

B. Collect		
B.1 Inventory, Condition, and Performance Collection	B.1.a	Inventory, Condition, & Performance Coverage
	B.1.b	Inventory, Condition, & Performance Automation
	B.1.c	Inventory, Condition, & Performance Quality
B.2 Project Information Collection	B.2.a	Project Information Coverage
	B.2.b	Project Information Automation
	B.2.c	Project Information Quality
B.3 Maintenance Information Collection	B.3.a	Maintenance Information Coverage
	B.3.b	Maintenance Information Automation
	B.3.c	Maintenance Information Quality
B.4 Priority Criteria and Values Collection	B.4.a	Public Perception
	B.4.b	Decision Maker Values

C. Store, Integrate, and Access		
C.1 Databases	C.1.a	Efficient Storage
	C.1.b	Database Linkages
	C.1.c	Document Linkages
	C.1.d	Data Storage Capacity
C.2 Asset Life-Cycle Data Integration Workflows	C.2.a	Asset Management Data to Project or Work Order
	C.2.b	Project Planning to Project Development
	C.2.c	Project Development to Project Delivery
	C.2.d	Project Delivery to Asset Management Data
C.3 Other Data Integration Workflows	C.3.a	Revenue, Budget, and Expenditure Data
	C.3.b	Demand and/or Utilization Data
	C.3.c	Environmental Data
C.4 Data Access	C.4.a	Field Access to Data
	C.4.b	Public Access to Data
	C.4.c	Access Security

D. Analyze		
D.1 Data Exploration, Reporting, and Visualization	D.1.a	Analysis Environment
	D.1.b	Analysis Practices
	D.1.c	Analysis Tools
D.2 Modeling	D.2.a	Asset Performance Prediction
	D.2.b	Optimization / Prioritization

E. Act		
E.1 Resource Allocation and Prioritization	E.1.a	Performance Targeting
	E.1.b	Project Prioritization
E.2 Project Planning, Scoping, and Design	E.2.a	Data-Driven Project Planning and Scoping
	E.2.b	Data-Driven Project Design
E.3 Maintenance	E.3.a	Infrastructure Maintenance
	E.3.b	Equipment Maintenance

Figure 3-2: The Complete Data Life-Cycle Framework

Assessment and Improvement Identification

The TAM Data Assistant includes descriptions of each assessment element, practice benchmarks, and associated improvements. Printable versions of these descriptions are included in the form of Element-Level Response Templates in Appendices A-E. Assessment participants can use these to become familiar with the material before using the tool in a group setting.

Prior to completing an assessment, participants are encouraged to review the Area- and Section-specific guidance materials that follow. These materials provide context and examples that will help participants to understand the benchmark levels and their associated improvements

Evaluate the current and desired state of agency practice against element-level practice benchmarks and select from potential improvements to close identified gaps.

Completing the Assessment

The following steps are recommended for individuals completing the assessment:

1. **Review the element-level response templates** in Appendix A-E to familiarize yourself with the material. You only need to look at those Areas/Sections that have been selected as relevant to your assessment.

2. **Read the guidance material for your selected Areas/Sections** that follow in this chapter. This material will help you to understand the scope of each portion of the assessment.

3 **Work through the assessment** prior to getting together with your team, either using the templates in Appendix A-E, or in the tool. This will allow you to think through the material in advance.

4 **Share your results at group assessment sessions** and listen to what others have to say. Work towards a set of consensus results to characterize your current practice levels, your desired practice levels, and the improvements to be considered.

Understanding Benchmark Levels

You will be selecting a level from 0 to 4 for each of the assessment elements – first to represent your agency's current practice, and second, to represent your agency's target level.

The general meaning of each benchmark level is described to the right. However, keep in mind that each assessment element has a tailored set of level descriptions.

Selecting Target Levels

Don't assume that your target should be the highest possible level (4) for all of the assessment elements. You may currently be at a level 0 for an element because there is no particular benefit to advancing in that area. For example, it may not be cost-effective to collect data or do sophisticated analysis for an asset that has a very short life cycle and accounts for a small portion of your agency's budget.

Keep in mind that the levels are defined in a way that assumes you must pass through each one – it isn't possible to skip levels. This means that often the most reasonable target (if you want to advance) is the next level up from where you currently are. It is helpful to use a standard timeframe (e.g. 2-3 years) when setting target levels. The target level should be one that (1) is beneficial for your agency to reach and (2) one that is realistic to achieve within the target timeframe.

Benchmark Levels

General Practice Level Descriptions

0 **Non-Existent:** The DOT does not have any significant practices within this aspect of their business.

1 **Initial Steps:** DOT practices are found, however these are characterized by ad-hoc or informal application and are not likely to be endorsed by management.

2 **Incremental Improvement:** The DOT is beginning to see formalization of the processes and structures within this aspect of their business.

3 **Advanced Practice:** The DOT is performing at a level at or above the standard of their peers.

4 **Top Performing:** The DOT is a leading example of practice amongst their peers.

Selecting candidate Improvements

Candidate improvements are suggested for each benchmark level. These improvements are designed to move your agency from its current level to the next level up.

Keep in mind that not all of these candidate improvements will be appropriate for your agency. You should feel free to tailor them to your situation – or create new candidate improvements that would help your agency advance from your current level to the next level up.

Area and Section Guidance

The following pages provide guidance for each assessment Area and Section. You can use this guidance to:

- Understand the definition and scope of each assessment Area and Section;
- Understand some of the issues and key decisions to be made when considering improvements related to each Section; and
- Review conceptual examples of agency practice relevant to the Section.

Response Templates

Appendices A thru E provide paper response templates that can be used to complete self-assessment and improvement identification independently of the TAM Data Assistant digital tool. This is not recommended for full application of the guidebook, however it can be useful for individual preparation in advance of group self-assessment discussion.

Response Templates

Area A – Specify and Standardize
Appendix A

Area B – Collect
Appendix B

Area C – Store, Integrate, Access
Appendix C

Area D – Analyze
Appendix D

Area E – Act
Appendix E

Area A – Specify and Standardize Data

Establish asset, treatment, and work data standards, standard prioritization factors, metadata standards, and comprehensive governance programs.

Area Overview

The Specify and Standardize Data Area includes five distinct Sections:

A.1 **Inventory, Condition, and Performance Standards:** Asset inventory, condition, and performance data models, as well as supporting design and location referencing standards.

A.2 **Treatments and Work Standards:** Asset treatment and work data models, as well as the supporting design and location referencing standards.

A.3 **Resource Allocation and Prioritization:** Definition of standardized prioritization factors and analysis parameters.

A.4 **Metadata:** Data set-level and data element (data dictionary) metadata standards and guidelines.

A.5 **Governance:** Roles, responsibilities and processes for adoption of data standards and guidelines, data change control, and data collection approval and coordination practices.

Improvements in this Area aim at specifying data requirements to align with agency business needs, standardizing data models so that information from different systems can be integrated and aggregated for analysis and reporting, and formalizing roles and processes to ensure alignment and coordination across different stakeholders.

A.1 Inventory, Condition, and Performance Data Standards

Credible, reliable data begins with well-defined and understood standards.

Inventory, condition, and performance data are the most important components of a data-informed TAM program.

Location referencing and design standards are also essential to support integration across life-cycle systems and with other data (such as roadway use, or environmental data).

Required, Recommended, and Optional Data Attributes

Establish clear data requirements by documenting comprehensive inventory, condition, and performance data models. Gather input from key stakeholders to ensure models meet business needs and are practical to collect and maintain.

Clearly identify required, recommended, and optional data attributes. Required and recommend fields should be feasible to collect and maintain; optional fields may only be collected under specific circumstances. Data that cannot be reliably collected or maintained should be excluded from the data model.

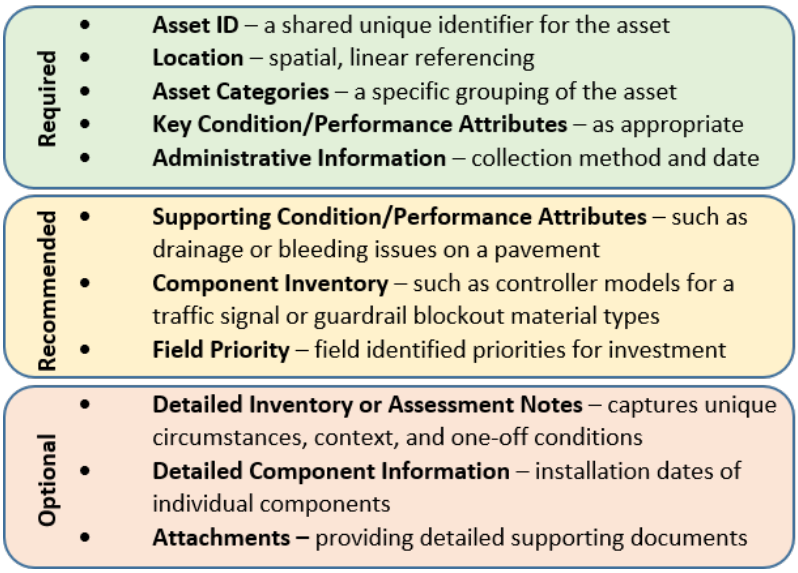


Figure 3-3. Examples of Required, Recommended, and Optional Asset Inventory, Condition, or Performance Data Attributes

Minimum Data Coverage

Examine asset and performance management decision-making needs to establish clear requirements for where, when and how often asset inventory, condition, and/or performance data will be collected.

In some cases, complete network-wide collection may not be needed or may not be practical given resource constraints. In these situations, collection can be limited to what can be collected and maintained in a timely, cost-effective manner – and targeted to what is most valuable to decision-makers.

Important Terminology

The following terms are used within this Section.

Data Attribute:

A specific piece of the data model, describing a data entity. A data element contains a specific fact important to the business (e.g. Bridge ID, Sign Type, Pavement Roughness, or Install Date).

Asset Breakdown Structure:

A hierarchical model of the agency's assets, with high level categories (such as "traffic assets" and sub-categories (such as "traffic signals").

Location Referencing System:

A set of data and procedures for managing locations of geographic objects using one or more methods for specifying location. For TAM this often includes a linear referencing system that specifies location as the distance along the roadway from a reference point (such as a county boundary or intersection).

Component Breakdown:

Models that divide complex assets into individual parts of the larger whole, such as dividing a bridge into the deck, superstructure, and substructure.

Asset Information Model:

As defined by Building Information Modeling (BIM) standards (ISO 19650), a model that compiles the data and information related to or required for the operation of an asset.

Conceptual Examples

Targeted Data Coverage based on Asset Life-Cycle Considerations

Streamlining Pavement Marking Performance Data Collection

Certain pavement marking materials have a service life of less than 1 year. An annual retro-reflectivity performance data collection adds little value where these markings are used, therefore these can be excluded from collection.

Network-Level Data Collection Requirements

Focusing Network-Level Collection

Maintaining network-level data collection to meet detailed project-level design requirements is not generally cost-effective – data do not stay accurate due to changing field conditions as well as maintenance and project work. Focus statewide collection on meeting requirements for network-level use cases (such as performance management, needs analysis, investment prioritization).

Associated Response Templates

Appendix A

A.1.a - Asset Inventory Data Model

A.1.b - Asset Condition and/or Performance Data Model

A.1.c – Design Model Standards

A.1.d – Location Referencing

A.2 Treatments and Work Data Standards

Standardized data on asset treatments and work allows agencies to coordinate improvement planning across funding programs, understand asset maintenance and rehabilitation costs, compile a unified work history for an asset and build meaningful models of the performance of different treatments.

Required, Recommended, and Optional Data Elements

Required and recommend fields should be feasible to collect and maintain; optional fields may only be collected under specific circumstances. Data that cannot be reliably collected or maintained should be excluded from the data model elements.

Minimum Data Coverage

Examine asset management decision-making needs to establish clear requirements to what extent treatment or work history data attributes will be collected (e.g. Interstate work history may be required, while other work may not be captured).

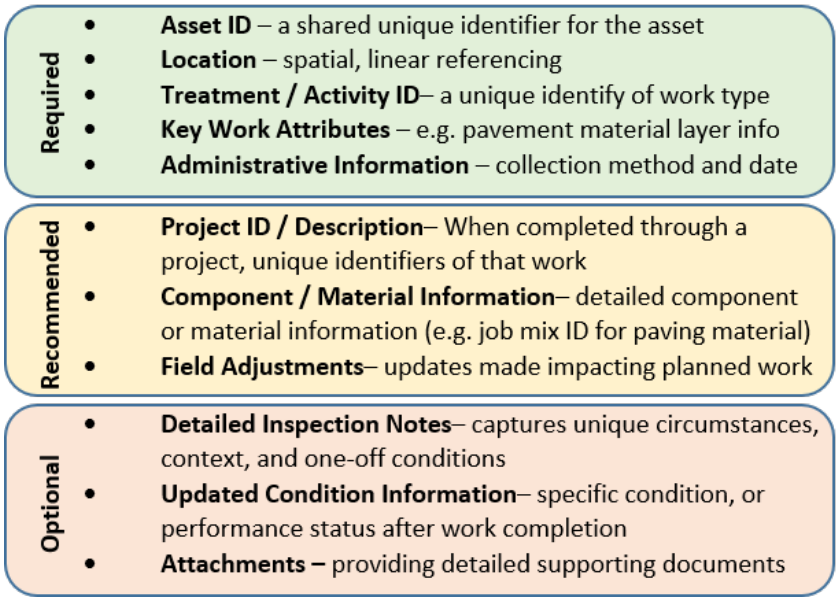


Figure 3-4. Examples of Required, Recommended, and Optional Treatment and Work Data

Balance the cost of tracking treatment information against the value it will add to decision making. For example, it may be costly to record itemized, location-specific information about certain minor or routine maintenance activities, if they can be tracked in a more aggregated manner and provide the needed information.

Location-Based, Asset-Based and Other Work Tracking Mechanisms

Asset treatment and work can be captured by work location (e.g. paving on particular route between specific mile points) or against the asset inventory (e.g. rehabilitation of a specific bridge). In some cases, geographic or organizational-level (e.g. county-wide summary) or contract or project-level information is sufficient. For each work type, consider and incorporate the necessary level of granularity for tracking into the data model and collection requirements.

Important Terminology

The following terms are used within this Section.

Work Accomplishments:

The type and quantity of completed work on assets (e.g. inspections, repairs, or replacements); may include other information such as date completed, whether the work was performed by state forces or contract, resources used, and cost.

Data Exchange Protocol:

Standard rules for data transfer between project design, delivery, and asset life-cycle management systems and/or process participants.

Project Information Model:

As defined by the ISO 19650 standard, a model developed during project design and construction that begins as a design intent model, and then evolves to be a virtual construction model.

Conceptual Examples

Targeted Data Collection for Minor/Routine Work

Streamlined Guardrail Damage Repair Treatment Data Collection

When spot repairs to the guardrail rail sections do not impact the overall guardrail system length, configuration, product type, or functional condition, detailed work or project information may not be necessary for asset management purposes. This can be reflected in the data model and requirements.

Confirmation of As-Built Data

Pavement Maintenance Treatment History

Planned paving activities may be subject to field adjustment – project limits may be shortened or extended, paving sections added or removed, or treatment material types or thickness may be modified based on prevailing field conditions or available funding. For certain activities, it may only be necessary to reflect adjustments to the work location (where treatment details are unlikely to change – e.g. patching). In other cases, detailed treatment information may need to be captured in the field (to ensure accuracy of critical information, such as material types and thicknesses). Consider these circumstances when establishing detailed field data collection data models and requirements.

Associated Response Templates

Appendix A

A.2.a – Treatment and Work Data Model

A.2.b – Treatment and Work Location Referencing

A.2.c – Design Model Standards

A.3 Resource Allocation and Prioritization

Standardized prioritization factors and analysis parameters are critical to support high-level asset management decision-making and resource allocation.

When standardized across the agency asset portfolio, these support alignment of investments with the agency mission, goals, and objectives and transparency in decision-making.

Alignment with Planning

TAM resource allocation prioritization factors and analysis parameters should reflect the organizational goals, objectives, and priorities established in the agency long range transportation plans, state transportation improvement plans, transportation asset management plans, and other similar or related documents. Through alignment with planning, TAM can effectively communicate program value, priorities, and needs, to better compete for limited agency funds.

Typical Prioritization Factors

There are any number of ways a DOT might prioritize asset or investment decisions. Example prioritization factors are shared on the following page.

Analysis Parameters

Typical analysis parameters include:

Analysis Horizon: Establish the base and future years for the analysis.

Network or Inventory: Identify the included/excluded subsets of the asset inventory or agency network.

Available Funding: Document current and/or projected funding constraints.

Minimum or Desired State: Set minimum or desired condition or performance levels that must be

delivered by an optimized TAM investment strategy.

Treatment Benefits and Costs:
Quantify eligible investment types, their impact on asset condition, performance, or other metrics included in the analysis, and their associated cost.

Asset Deterioration Models:
Model the impact of the lack of investment to asset condition, performance, or other metrics.

Important Terminology

The following terms are used within this Section.

Cross Asset Metrics:
Metrics allowing for measurement and comparison of outcomes across asset programs, typically established based on the agency goals and performance objectives. Examples can include benefit, value, need backlog, safety, operational performance, etc.

Investment Prioritization Factors:
Factors allowing individual projects or other asset management investment opportunities to be evaluated against program goals or performance objectives for purposes of investment optimization or prioritization (see examples above).

Analysis Parameters:
Key inputs to agency asset management or investment optimization analysis, such as asset deterioration rates, treatment condition reset values, treatment unit costs, or analysis time horizons.

Conceptual Examples

TAM Investment Prioritization Factors

Asset Tiers

Group assets into management tiers to support cross-asset prioritization. For example, Bridge, Pavement, and ITS assets may be prioritized over other assets.

Roadway Classification

DOTs commonly prioritize maintenance or replacement of assets on Interstate or higher functional class roadways over roadways with lower classifications.

Asset Classification

Examine asset sub-types or classifications to identify investment priorities. For example, 4-bolt cantilever structures may be prioritized for maintenance or inspection over other types of structures due to safety concerns.

Asset Condition, Performance, or Known Deficiencies

Prioritize investment in assets within certain condition or performance levels. For example, traffic signals which are operating inefficiently may be prioritized for retiming, component repair or replacement, or even for a full rebuild.

Asset Usage or Risk-Based Factors

High use or risk assets are often prioritized TAM investment. For example, bridges with long detour lengths, or use of roadway departure crash rates to prioritize roadside safety hardware investment.

Associated Response Templates

Appendix A

A.3.a – Prioritization Factors

A.3.b – Analysis Parameters

A.4 Metadata

Standard formats and processes for documenting data element definitions and calculations, as well as dataset level information, ensure that data are well understood and useful to TAM staff, IT staff, and data users.

Accurate, accessible metadata enables users to identify data sources and elements available across the enterprise and understand their limitations.

Metadata Upkeep

Metadata upkeep is often a challenge for an agency. Ensure that appropriate procedures, roles, and responsibilities are in place for adding, changing, or deleting metadata items. Additionally, consider what metdata data management tools (such as a web-based metadata repository) are needed to ensure efficiency in recording and sharing.

Data Dictionary Standards

When establishing standards for data dictionary metadata, consider available national/international standards (e.g. ISO 19115 and other supplemental IS191** series standards) and the following standardized attribution:

Application, System, Table, and Field Names: unique name and/or identifier of the associated IT application, specific table, and associated field associated with the data dictionary entry.

Description: a meaningful description of the documented field or data element.

Required: is the field a required entry?

Field Type and Requirements: capture information relating to the nature of the information being stored in the field, such as the field type, length, precision, or acceptable values.

ID / Key / Uniqueness: capture if the field a primary or foreign key, or otherwise required to be unique.

Confidentiality/Sensitivity: classify the potential confidentiality or sensitivity of the field (for example, if it contains personally identifiable information).

Usage: document any particular context or limits to the use of the data in the field.

Associated Business Terms: identify what business terms or concepts are represented by the field.

Dataset or Database Level Standards

When establishing standards for dataset level metadata, consider the following standardized attribution:

Application or System Name: a unique name and/or identifier of the IT application or system or that which is associated with the dataset.

Owner/Steward: a business point of contact or subject matter expert.

Creation/Update Dates: the date when the dataset was last created or updated.

Security/Sensitivity: categorize the security or sensitivity level of the dataset or system.

Acceptable Uses: document the acceptable uses of the system or dataset.

Important Terminology

The following terms are used within the assessment and improvement identification materials associated with this Section.

Metadata: Data providing information about other data. This information can be technical (e.g. field names and formats) or business-oriented (e.g. data definitions).

Data Catalog: A listing of available data resources complied to facilitate discovery and understanding.

Data Dictionary: A table documenting individual data elements in a dataset containing information such as data element name, description, and type.

Associated Response Templates

Appendix A

A.4.a – Data Dictionary Standards and Guidelines

A.4.b – Dataset Metadata Standards and Guidelines

A.5 Governance

Formal policies and procedures, oversight structures, roles and processes are critical for data standards development and adoption.

Data governance helps to ensure that data collected and maintained are well understood, used appropriately, and are effectively and efficiently collected and leveraged across the enterprise.

Governance of Complex Data-Informed Business Processes

Implementing or advancing data informed TAM business processes will increase the amount, complexity, and integration of data collected and managed by DOTs. Data management challenges will grow as practices advance, requiring increased emphasis on governance to sustain advanced practice.

Data Governance Structure

A commonly used governance structure consists of an upper-level committee establishing governance policy and direction, supported by one or more lower level committees. These governance committees establish data

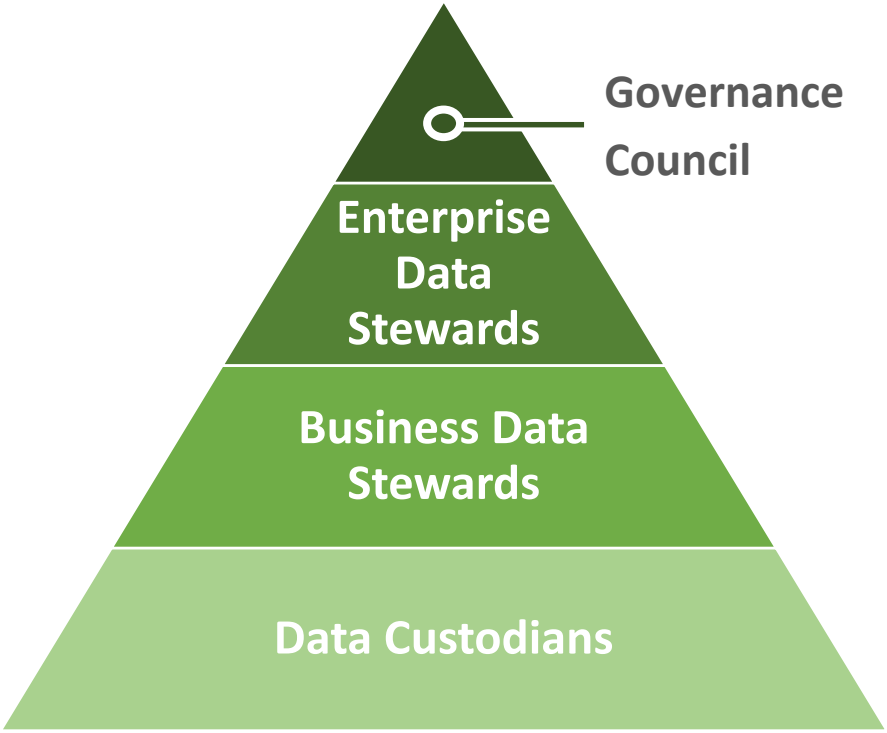


Figure 3-5. Example Data Governance Structure

stewardship roles to provide accountability for data within individual business units, functional areas and/or data subject areas.

Data Governance Policy

Adopt policies that establish data governance roles and responsibilities, and ensure data is treated as an agency asset. Such policies can define data of agency-wide interest and lay the groundwork for data standardization and other processes to ensure coordination across business units on data collection and development.

Conceptual Examples

Data Governance Roles and Responsibilities

Upper-Level Policy Committee (e.g. Governance Council)

A decision- and policy-making authority, typically reporting directly to high-level executive management, providing oversight and direction to the enterprise governance program.

Technical Working Committee (e.g. Enterprise Data Stewards Committee)

Develop governance policy, standards, practices, and guidance, address implementation issues, and promote adherence within the agency.

Enterprise Data Stewards

Represent enterprise interest in data within a specific subject area, facilitating coordination and agreement across business units.

Data Stewards

Are accountable for data within a specific business area, working with individual business owners to ensure data is well managed and providing value to the organization.

Data Custodians

Technical staff responsible for execution of governance and data management activities by supporting direct entry, quality control, and maintenance of data under the direction of the data steward.

Important Terminology

The following terms are used within this Section.

Data Governance:

The accountability for the management of an organization's data assets to achieve its business purposes and compliance with any relevant legislation, regulation, and business practice.

Data Stewardship:

The formal, specifically assigned and entrusted accountability for business (as opposed to information technology) responsibilities ensuring effective control and use of data and information assets.

Associated Response Templates

Appendix A

A.5.a – Data Stewardship

A.5.b – Data Standards & Guidelines Dev / Adoption Processes

A.5.c – Data Collection Approval / Coordination Processes

A.5.d – Change Control (Systems and Data) Processes

Community of Interest:

A group of stakeholders with a common interest in a type of data or other topic area. In contrast to a Community of Practice – where members have similar job functions, Community of Interest members may come from different parts of the organization and have different goals.

Change Management or Change Control:

Processes in place to review, evaluate, and coordinate changes to data products, applications, and systems to minimize impacts to users and reduce any change-related errors.

Area B – Collect Data

Collection of asset inventory, condition and performance, treatment and work history, and external decision-maker and public perception in a manner that can be incorporated into DOT TAM programs.

General Area Overview

The Collect Data Area is organized into four distinct Sections:

B.1 **Inventory, Condition, and Performance Collection:** Collection of asset inventory, condition, and performance data - with specific consideration of coverage, automation, and quality.

B.2 **Project Information:** Collection of project work accomplishments to update asset inventory and maintain work history for specific assets - with focus on collection coverage, automation, and quality.

B.3 **Maintenance Information:** Collection of maintenance work accomplishments to update asset inventory and maintain work history for specific assets - with focus on collection coverage, automation, and quality.

B.4 **Priority Criteria and Values:** Capture of public perception and decision-maker values to help guide DOT TAM decision-making.

Improvements in this Area are aimed at advancing methods for collecting and assuring the quality of key data supporting TAM analysis, reporting, and decision-making, Improvements may include deployment of innovative technology solutions, as well as improved quality control and assurance techniques and streamlined business processes.

B.1 Inventory, Condition, and Performance Collection

Understanding asset inventory, condition and performance is fundamental to TAM. Data collection activities must be planned to ensure that the right data are gathered – with sufficient quality to support decision making. Data collection is costly so agencies must carefully manage scope and work to achieve efficiencies.

Data Collection Program Review

Most DOTs have programs in place for collecting inventory, condition, and performance data. However, needs and requirements change over time, as technology advances and new data sources create opportunities to improve efficiencies.

Therefore, periodic review of data collection programs across assets is helpful to determine if adjustments are warranted. Key questions include:

- What data collection is happening now and how can those processes be automated?
- What information is available in other departments that could be brought into the data collection program?

Quality Management and Governance

A comprehensive data quality management plan (DQMP) enables a consistent collection process across assets and departments. The development of a DQMP can begin with individual assets and be expanded and integrated over time.

Governance processes should also be put into place to ensure that data collection and quality control measures remain aligned with business processes and needs.

Digital Transformation and Automation

As asset collection is standardized, manual and paper processes can be replaced by digital systems and automated processes. Agencies with several disparate collection and management tools can find opportunities for consolidation.

Data Sourcing and Collection Opportunities

Evaluate existing data sources before developing a new data collection program. If new collection is needed, consider whether outsourcing would be more sustainable than establishing a new, internal data collection program.

Conceptual Examples

Network-Level Collection

Mobile LiDAR

Data for multiple asset categories (e.g. pavements, roadside assets, signage, marking, drainage) can be bulk-captured using mobile LiDAR vehicles. The data can be processed to extract feature inventory, asset condition, and detailed asset attribution.

Project-Level Collection

Destructive and Nondestructive Pavement Investigation

Project-level data collection for pavements can be informed by destructive methods such as drilling/coring rigs or nondestructive deflection testing via falling weight deflectometers. Ride-quality can be measured using tools such as a high-speed profiler.

Important Terminology

The following terms are used within this Section.

Data Collection Plan:

An initiative or program planning document that outlines how a data collection program will be executed and improved to meet identified business needs. This should attempt to make the best use of current resources, leverage capital investment and technology, and be guided by documented business cases and value for data collection.

Data Quality Management Plan:

A Data Quality Management Plan (DQMP) is a documented management system that details the quality objectives and controls to be applied during the various phases of asset data collection. Its purpose is to ensure quality in all work processes, products, and outputs, and to support continuous quality improvement. Management sponsorship and governance is critical to ensuring the success of the plan.

Associated Response Templates

Appendix B

B.1.a – Inventory, Condition, and Performance Coverage

B.1.b – Inventory, Condition, and Performance Automation

B.1.c – Inventory, Condition, and Performance Quality

B.2 Project Information

Agencies track information about capital projects from planning through construction phases. If properly structured, this information can be leveraged within TAM to update asset inventories and condition projections, and maintain asset-specific work histories that can be used to better understand asset performance.

Network-Level Tracking

Program level asset investments and accomplishments may be quantified from project scoping documentation. Typically, this information is only useful for the primary asset in the project and provides limited activity or asset specific information. With this level of detail, project information is useful in estimating general, network-level trends and/or impacts to the TAM program.

Activity-Level Tracking

Project-level asset information is often extracted from project development documents (e.g. contract bid tab information) or project delivery systems used to track contract payments (e.g. AASHTOWare Project SiteManager). Information is often not structured in a manner that can be related to specific assets, however provides valuable insight into activity-level investments and accomplishments within the project limits.

Asset-Level Tracking

Tracking project activities against specific project line-items and including asset information (i.e. Asset ID, Location, Manufacturer, etc.) allows asset managers to understand specifically what assets were impacted or installed through a project. Developing a comprehensive work history for an asset is very valuable to support detailed TAM decision-making.

Project Data Template Creation

Developing project delivery templates that include key assets and standard asset data naming supports data extraction and integration.

Legacy Project Data Conversion

Historical projects files contain valuable asset inventory information. Programmatic conversion of these files is an effective means of asset data collection. Useful technologies include:

- **Optical Character Recognition (OCR)** tools are useful for automated recognition of typed, handwritten, or printed text within imagery.
- **Text Analytics and Natural Language Processing (NLP)** techniques can be used to process text into useful data.

Conceptual Examples

Legacy Project Data Extraction

Regulatory Signage Extraction

Standard design templates for regulatory signage can include individual cells or blocks at each sign location and modern design files are prepared utilizing real local/global coordinate systems. The combination of consistent nomenclature and geo-positional information allows for the automatic extraction of signage assets within a project file for upload to a GIS-based asset management system or asset inventory.

Asset Level Project Information

Regulatory Signage Asset Information

Project information models that include regulatory signage in a consistent format and with geospatial accuracy enable the automatic extraction of these items. Additional meta-data applied to these assets can be extracted alongside the type and location – e.g. installation date, sign dimensions, sheeting material.

Important Terminology

The following terms are used within this Section.

Automated File Validation:

Specific software created for the purpose of "running" or "processing" project digital files to validate and quality assure information located within.

Project Data Extraction Automation:

Digital project files (whether current or legacy) contain asset and non-asset information within.

Project Data Templates:

Pre-populated project files that include asset types and standard asset information. Using these templates to begin projects enables better quality management and consistent delivery of asset information.

Associated Response Templates

Appendix B

B.2.a – Project Information Coverage

B.2.b – Project Information Automation

B.2.c – Project Information Quality

B.3 Maintenance Information

Capture of standard maintenance work order and accomplishment information can provide valuable insights for asset life cycle planning and maintenance budgeting.

Digital Work Order Data Collection

Field maintenance forces have a unique opportunity to capture needed asset information while on-site. Traditionally, DOT maintenance programs have been delivered through manual (often pen and paper) business processes. Converting to a digital work order process or a Computerized Maintenance Management System can bring uniformity and efficiencies to these tasks. It also supports development of a useful, comprehensive work history.

Mobile Data Collection

Mobile data collection devices and applications significantly improves the quality of field collected information. These tools offer simplified data collection and share valuable reference information. Built in GPS and GIS capabilities support accurate location against aerial imagery or custom base maps. Field maintenance information can also be directly collected against the asset inventory.

Work Order Automation

Automation of the service request to work order process dramatically streamlines maintenance business processes. As an additional benefit, these techniques improve the accuracy and efficiency of work accomplishment data collection.

More conceptual examples are provided on the following page.

Associated Response Templates

Appendix B

B.3.a – Maintenance Information Coverage

B.3.b – Maintenance Information Automation

B.3.c – Maintenance Information Quality

Important Terminology

The following terms are used within this Section.

Routine Maintenance:

Routine maintenance are maintenance tasks that are planned in advance. These can be recurring or one-off scheduled preventative care.

Service Request:

Assets requiring repair due to damage or wear are identified via a service request. These requests can originate from inside or outside an agency.

Computerized Maintenance Management System:

Computerized maintenance management system (CMMS) is software that manages an organization's maintenance operations.

Work Order:

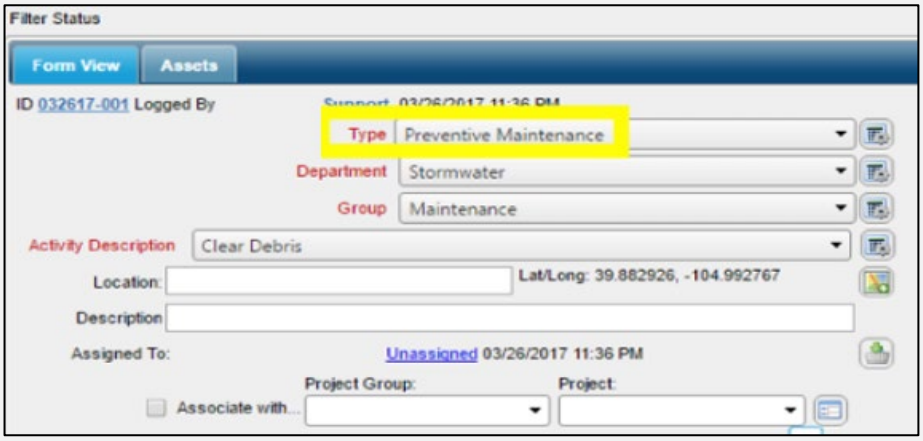
Work orders are authorized maintenance tasks. These can result from approved service requests or via planned preventative or routine maintenance schedules.

Conceptual Examples

Work Order Management Software

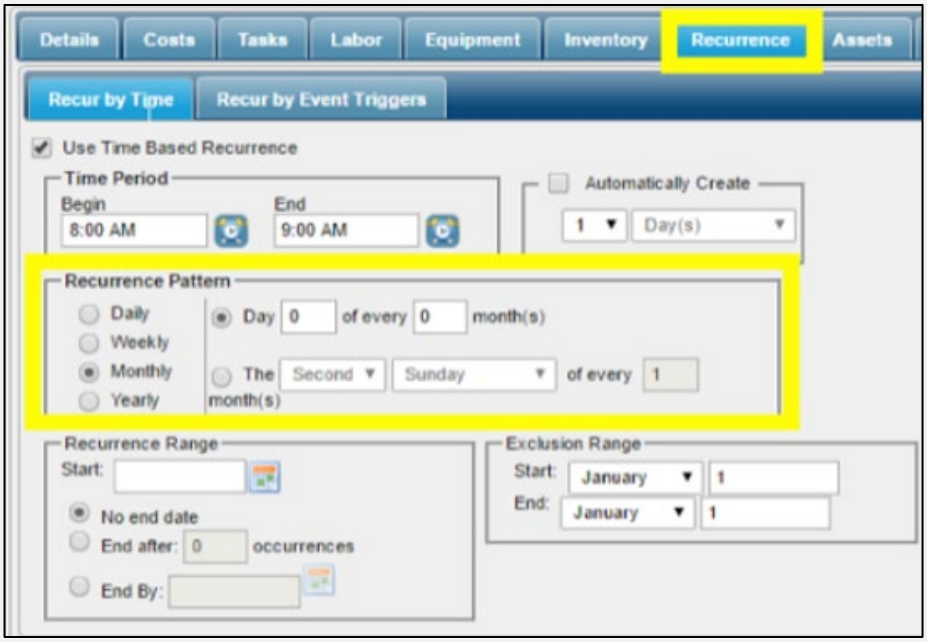
Work Association with Asset and Organizational Structures

Transforming traditional maintenance programs to a centralized Computerized Maintenance Management System will allow association of maintenance work accomplishments with organizational, work, and asset hierarchy.



Automated Work Ordering

A simple example of work order automation is through the use of scheduling tools to generate recurring work orders for routine maintenance activities.



B.4 Priority Criteria and Values

While many TAM decisions are based on technical factors such as condition indices, it is important to put processes in place to understand both asset user and decision maker values. These values can be used to make appropriate use of the technical information for decision making.

Public Perception

The public's perception, and priorities for transportation infrastructure is a critical component to long-term TAM planning and strategic TAM prioritization.

Public perception and priority data collection can begin through ad-hoc engagement, during individual public meetings, or with targeted surveys. In more advanced application, these techniques should be coordinated and refined into standardized, continuous feedback programs.

Valuable tools to public perception data collection include:

- **Focus Groups** where small, diverse groups of people are directly engaged to gather feedback.
- **Surveys and Polling** to gather broader samples of public opinion.
- **Social Media Outreach** offering two-way communication with the public regarding TAM priorities and values.
- **Public Meetings** to directly engage interested members of the community regarding the TAM program.

Agency Value and Perception

Internal agency perception and leadership values are additional data points needed to plan asset management capital programs. These requirements can originate from historical/legacy organizational

structures as well as from political influences affecting executive leadership.

Decision makers should be targeted using a structured approach. Some example tools and approaches are:

- **Delphi Technique** which provides a structured, interactive approach to build consensus among a panel of experts.
- **Nominal Group Technique** which offers a group process for problem solving and decision-making, useful in groups of ranging sizes, but where all opinions should be considered.
- **Decision Trees** to map observations and conclusions about

Conceptual Examples

Customer Service and Social Outreach

Tying the Public Facing Side to Maintenance

DOT's can utilize their customer service centers to tie feedback directly into work orders and maintenance functions. Many public interactions take place on Twitter/Facebook or other Social Media outlets. Agencies can introduce ways to connect feedback and maintenance issues into the maintenance and feedback data collection systems.

Targeted Focus Group Engagement

Capital Plan Roadshows

Some agencies may decide to take their capital improvement plan and budget on-the-road. Targeting a series of town hall style public outreach sessions and/or focus groups sessions is an effective means of obtaining a regionally varied input into a transportation asset management capital program.

Insights and Value Criteria

Modern decision science and data analytics programs require more than inventories and conditions to provide long-term value. The information obtained from public and agency perception surveys provide required context to investment decisions.

Important Terminology

The following terms are used within this Section.

Decision Science:

Quantitative techniques used to inform decision-making by identifying optimal choices based on available information. Decision science seeks to make plain the scientific issues and value judgments underlying these decisions, and to identify tradeoffs that might accompany any particular action or inaction.

Associated Response Templates

Appendix B

B.4.a – Public Perception

B.4.b – Decision Maker Values

Area C – Store, Integrate, and Access Data

Structuring, integrating and providing access to data to support TAM operations, management and reporting needs.

General Area Overview

The Store, Integrate, and Access Data Area is organized into four Sections:

C.1 **Databases:** Designing TAM databases to support efficient and effective storage of and access to contained data and documentation.

C.2 **Asset Life-Cycle Data Integration Workflows:** Efficient exchange of information across various business processes, tools, and systems involved in the complete asset life-cycle, from project planning through delivery and ongoing asset management and operation.

C.3 **Other Data Integration Workflows:** Efficient exchange of information between asset management and financial and other supporting business systems and practices.

C.4 **Data Access:** Ability of agency field staff and the general public to efficiently and securely access TAM information.

Improvements in this Area are aimed at managing asset data in an efficient manner and integrating data across systems supporting different assets and different asset life-cycle phases and agency business processes.

Implementation Support

Organizational Practices
Chapter 5

Case Studies
Chapter 5

C.1 Databases

Making data available across the enterprise while eliminating redundant information is critical to driving efficiency and reliability.

Moving from paper based data to fully integrated databases requires planning and critical thinking about how and where data will be stored, and how different databases will be linked to each other.

Data Storage Management

Data retention, backup, and disaster recovery are essential to the sustainability of agency asset databases and the continuity of critical, data-informed TAM business processes. Examine and quantify risks and select tiered data storage solutions that align with agency risk tolerance and budget.

Conceptual examples of key components of a disaster recovery plan are provided on the following page.

Source Systems and Master Data

Identify and designate source systems for essential agency business information (such as agency assets, financials, contracts, or employees). Create master data from source data to provide a single source of truth for reporting. Protect source data integrity and ensure that changes to source data are reflected in replicated or derivative data sets.

Asset Identifiers and Linear Referencing for Data Linkages

Asset identification and linear referencing schemes are vital to agency database integration. New and existing TAM databases should be structured to provide these standardized data linkages. This practice will enable integration of asset and non asset data for TAM analysis and decision-making.

Establishing these data linkages typically requires programming, however more and more commercial software tools are providing end user utilities to help automate development, decreasing reliance on specialized skillsets and staff.

Data Warehousing

Across the enterprise, asset and non-asset data are commonly stored in different systems. A data warehouse is a central repository of integrated data that supports efficient reporting and analysis. Data is typically loaded into a data warehouse through automated routines that run on a set frequency based on end user requirements.

Important Terminology

The following terms are used within this Section.

Linear Referencing System:

A linear referencing system is a method of spatial referencing the locations of physical features along a linear element. The features are described in terms of measurements from a fixed point, such as a mile marker or station along a road. Each feature is located by either a point (e.g. a signpost) or a line (e.g. a no-passing zone). A well governed LRS helps ensure spatial relationships between assets held in different databases can be viewed and analyzed.

Conceptual Examples

Components of a Disaster Recovery Plan

Executive Summary

A few pages that cover the most important steps of the plan and key contacts.

Scope and Purpose

An introduction that describes the purpose of the plan and the scope for which is covers along with documentation of authority and approvals and frequency of review and updates required for the plan.

Roles and Responsibilities

Descriptions of the key roles and responsibilities of each member of the disaster recovery team and any limitations based on governance and approval thresholds.

Response Procedures

Documented processes to be initiated and followed including assessment of the situation, any damages and notifications required based on severity.

Documentation Requirements

Clear direction on the documentation of activities that must occur if the plan is activated.

Data Lake:

A data lake is a single repository of different databases in native form, typically used for data exploration, rather than routine analysis. Consider the end use and such details as storage, security, agility and end user sophistication when implementing a data lake.

Disaster Recovery:

A disaster recovery plan documents a set of policies and procedures that support the recovery of data and data infrastructure in the event of a natural or human-made disaster. In the context of asset management, the disaster recovery plan should consider necessary access to data related to "life line" assets such as evacuation routes, utilities and communications.

Cloud Storage:

Cloud storage has emerged as a useful tool to address rapidly growing data storage needs. In the cloud storage model, physical data storage is managed by external service providers (e.g. Amazon Web Services or Microsoft Azure). Cloud storage often provides lower cost and less maintenance but requires additional data access and security considerations that must be addressed.

Associated Response Templates

Appendix C

C.1.a – Efficient Storage

C.1.b – Database Linkages

C.1.c – Document Linkages

C.1.d – Data Storage Capacity

C.2 Asset Life-Cycle Data Integration Workflows

Through technology advancement, it is now possible for data to persist across the asset life cycle – from planning through to design and delivery and ultimately through to operations and maintenance.

Integrating workflows between phases of the asset life cycle is critical to unlocking the value that is amassed through these phases.

Asset Life Cycle and BIM

Building Information Modeling (BIM) for Transportation has emerged as a process that supports asset life-cycle data integration. As technology has evolved to be more and more interoperable, industry is seeing the advantages of leveraging BIM and a common data environment to support the asset life cycle from end to end.

Asset information developed during project planning and design can seamlessly flow through to the construction and operations phases, generating efficiencies in each project phase and yielding a detailed asset information model to inform asset operation and maintenance.

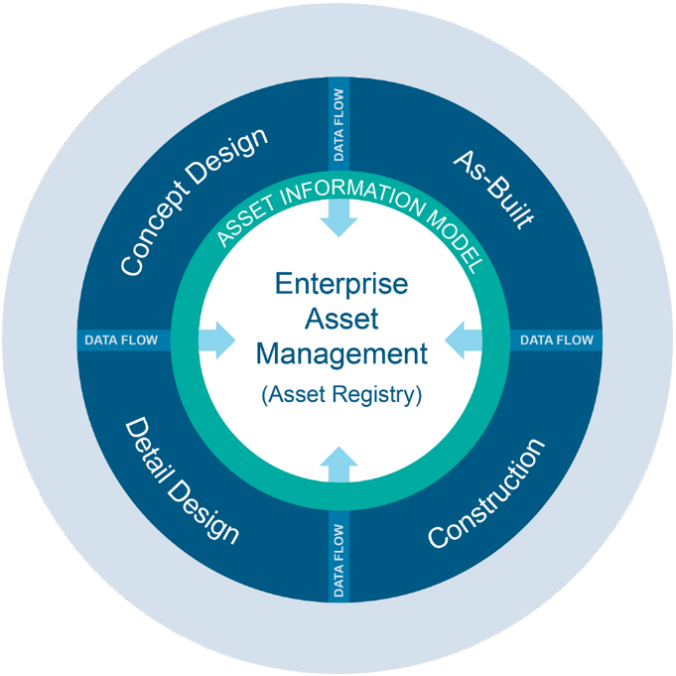


Figure 3-6. Example Data and Information Flow Supporting Asset Registry Development and Maintenance

Project Planning

During project planning key decisions are made regarding site location, constructability, and regulatory requirements. Assets within the project limits may inform planning decisions. For example, Federal project requirements may dictate that safety assets (e.g. guardrail) are evaluated and brought to current standards during the project. By integrating existing asset information into project planning systems, these activities can be streamlined and planning outcomes are improved.

Geospatial information systems (GIS) databases and tools are customarily used during planning. GIS data collected and generated during planning regarding boundary constraints, material considerations, or site conditions are key inputs to the Project Delivery. Ensure that data workflows from Planning to Development consider how these data are passed on to create efficiencies in future phases.

Project Development

Project development includes the financing and design aspects of an infrastructure project. Schematic and detailed designs progress the project plan into a constructible state. Designs typically include asset location, size, material, type or standard, and other asset information. These can be coded in the model to meet the owner's specification and then leveraged during project delivery.

Conceptual Examples

Data Integration across Life-Cycle Stages

Project Planning to Project Development

Most planning activity occurs in the 2D space using tools like GIS. These include site selection, alignment alternatives, and environmental constraints analysis. Interoperability between GIS and design tools is affording new efficiencies that eliminate needs for exporting/importing data to inform design (e.g. Esri's Autodesk Connector for ArcGIS). Through these tools, planning data can be shared directly with designers to inform decision-making. For example, soil information can influence material selections or placement of pilings.

Project Development to Project Delivery

Current DOT practices typically involve disconnected processes where the design model is discarded and the contractor defines a model optimized for their delivery purpose. These inefficiencies ultimately translate to additional costs for the owner. Alternative delivery methods are creating new efficiencies, but infrastructure owners can take responsibility for defining model requirements throughout the phases of design-bid-build projects.

Project Delivery to Asset Inventory/Condition & Work Orders

When model specifications are defined contractually, the as-built plans can be delivered digitally as as-built models. With model specifications directly aligned with the asset information model, the assets defined in the as-built model can be imported to supplement the asset inventory. Valuable as-built condition information – such as location, photos, manufacturer recommended maintenance schedules, warranties, etc. – can be retained for use in maintenance works ordering, warrantee claims, and general asset management and operation.

Project Delivery

Project delivery represents the physical construction of the new asset. During this phase information contained in the design model can be carried forward to inform and optimize the construction phase. As-built information can also be captured during project delivery.

Handover/Handoff

At the completion of construction, the asset is handed over for management and maintenance. At this stage, asset life-cycle data integration workflows yield the most significant benefit. Data developed and evolved through the project phases can be transferred directly into the owner's asset data model and be subsequently maintained through the owner/operator asset management systems, providing updated asset inventory, condition, and work history.

Important Terminology

The following terms are used within this Section.

Asset Life-Cycle:

The asset life cycle is broken down into phases representing key milestones in the development of the asset – starting with planning, then development, then delivery, and ultimately operation and maintenance.

Data Transformation:

The process of converting data from one format to another, often required to support data integration workflows, particularly when different technologies are employed by different users or stakeholders over the asset life-cycle.

Batch Processing/Transfer:

Mature data integration workflows are often supported by batch processing. Batch processing allows for certain data transformation tasks to be performed according to a routine, frequently without human intervention.

Performance Targets:

Based on performance measurements intended to provide evidence or give indication of an assets level of service or performance, performance targets can be directly imposed by regulators or set based on strategic objectives of an organization. Targets can be established to meet a minimum level of service committed to the users of that asset (e.g. smoothness of pavement) or aspirational if an organization is trying to enhance the level of service to encourage use or thwart competition (e.g. lower congestion levels on managed lanes).

Associated Response Templates

Appendix C

C.2.a – Asset Management Data to Project or Work Order

C.2.b – Project Planning to Project Development

C.2.c – Project Development to Project Delivery

C.2.d – Project Delivery to Asset Management Data

C.3 Other Data Integration Workflows

Information contained in agency financial, traffic monitoring, transportation modeling, and environmental systems support asset risk analysis and prioritization, and improve TAM treatment selection and decision-making.

Demand and Utilization

Traffic monitoring and traffic and demand modeling data help TAM practitioners understand the current and forecasted level of service required of existing or proposed roadway assets. This information is highly valuable in asset management decision making, particularly to inform prioritization, selection, and scoping of projects and maintenance work.

By establishing a means to integrate demand (measured or modeled) with your asset data, an organization can:

- **Better plan and optimize funding** to coincide with current and forecasted levels of services required to meet user needs.
- **Improve design** of new or reconstructed assets based on existing demand, reducing future TAM needs.
- **Improve maintenance treatment selection** to account for known or modeled demand.
- **Prioritize decision-making** to deliver maximum value for the public and other TAM stakeholders.

Environmental Modeling

Environmental systems contain data valuable in understanding asset deterioration, environmental impacts of assets and regulatory requirements applicable to individual projects and maintenance actions.

Environmental data is often managed in GIS. Geo-processing tools can efficiently combining GIS information with the associated assets based on their geolocation.

Financial Register vs Operational Register

A financial asset register is used to produce financial statements and support long term financial planning and budgeting. In contrast the operational asset register, typically stored in the asset data model of an asset management system, supports the ability to associate and track work orders and maintenance.

It is important to establish a tie between the financial asset register and the operational asset register to support accurate financial reporting and to leverage asset work order and maintenance history to support financial forecasting and planning.

Important Terminology

The following terms are used within this Section.

Two-Way Data Exchange:

Bi-directional reading and/or writing of data between two databases.

Non-Asset Data:

Non-asset data is data that is contextual to the asset but not directly about the asset. For example, the soil type in the area of a buried utility pipe is not data explicitly about the asset but is highly relevant to how the asset will perform.

Conceptual Examples

Other Data Integrations

Use of Demand Modeling Data in Asset Management

Traffic demand modeling provides roadway asset owners with forecasted traffic volumes. Forecasted traffic volumes are used in prioritizing work programs and capital projects. Database considerations to support linking demand models to asset inventory is the key to unlocking integration efficiencies (for example, by using common location referencing or roadway section identifiers).

Use of Environmental Data in Asset Management

Flooding risk is a key environmental factor considered in TAM. With accurate spatial location referencing for asset data, analysis of the impact and risks posed by flooding events can be conducted. Analysis results inform prioritization of maintenance procedures, treatment selection, asset designs decisions, and at times, influence new development decisions.

Conceptual Examples

Two-Way Data Exchange

Exchange between Financial and Operational Asset Registries

A two-way data exchange between an operational asset registry and a financial asset registry may occur when a new asset is constructed.

In one direction, the asset value may need to be exchanged from the operational asset registry to the financial asset registry.

In the other direction, the acquisition cost of an asset, stored in the financial asset registry, may need to be exchanged to the operational asset registry to support life-cycle cost analysis.

Data Transformation:

The process of converting data from one format to another, data transformation is often required to support data integration workflows, particularly when different technologies are employed by different users and stakeholders throughout the project phases.

Batch Processing/Transfer:

Typical of mature data integration workflows, batch processing allows for certain data transformation tasks to be performed according to a routine, frequently without human intervention.

Associated Response Templates

Appendix C

C.3.a – Revenue, Budget, and Expenditure Data

C.3.b – Demand and/or Utilization Data

C.3.c – Environmental Data

C.4 Data Access

Data access must be carefully planned to balance agency business needs and public accountability with the need to protect data integrity and mitigate risks of data misuse or misinterpretation.

Connected and Disconnected Editing

Field maintenance staff need the ability to access, update, or input data in both connected and disconnected environments.

Connected editing requires an internet connection through cellular or Wi-Fi to be able to read or write data back to a database. In a connected environment, field data collection can be made available immediately upon collection, allowing efficient coordination with office staff or other stakeholders who are not in the field.

Field staff can also access information that is otherwise unavailable without advanced planning (e.g. detailed design files from previous projects or comprehensive asset work histories). This improves field decision-making and generates significant efficiencies by avoiding unnecessary travel time between field and office locations.

Disconnected editing allows a user to download and store data locally on the mobile device (in the office or at another location with a reliable internet connection). The user can then write to the local data and upload updates back to the main database once an internet connection is reestablished.

If field work requires users to retrieve or collect data in remote areas, disconnected editing options will be required to support these activities.

Access Levels and Data Security

Data access and security is more easily managed early in system development, when the system and associated data models can be structured to support assignment and enforcement of data

access or security levels. With proper consideration, data access and security can be controlled at the system level, the application level, or even the database level. Sample questions to aid in determining data access levels are provided in the supporting example.

Mobile Access

Mobile devices, such as laptops, phones, or tablets, provide handy means to access data when away from the primary office environment.

When evaluating mobile access, consider:

- Security protocols and technical programming that are required to make data and/or tools available.
- Data required in the field versus desired or useful only in office.
- Agency policy and practice relating to mobile device procurement and personal cell phone use.

The proliferation of mobile technologies offers a perception of ease and convenience, but having too much data or overcomplicated tools can reduce efficiency and create adoption challenges. Industry trends are toward making mobile tools targeted for niche functions and employing responsive web design (RWD) on primary applications that make web pages render well on a variety of devices and window or screen sizes to avoid costly additional programming to support mobile device use.

Conceptual Examples

Data Access and Security

Database Access Qualifying Questions

Determining who should have access to different data sets can be a daunting task. Key questions that can serve as a guide include:

- Why does the user need to access the data?
- How will the data be used?
- Is the data being accessed sensitive (i.e. would release of the data pose risks)
- Does the user need read only access or will they need to update the data as part of their task?

Role Based Data Access

Role base data access is an approach to granting or denying access to users based on their designated role in an organization. By defining roles and responsibilities, the appropriate levels of data access can be granted across enterprise wide systems.

Data governance programs commonly define such roles and implement oversight to monitor and manage the roles and responsibilities so that they can evolve over time to support the changing data and systems environment of the organization.

Story Boards and Dashboards

Story boards and dashboards have emerged as key data visualization and communication tools. The ability to use illustrations, maps, charts and other graphics is critical effective communication of the complex

messages of a DOT asset management program.

For example, Esri GIS story boards with embedded maps and charts communicate critical asset risk areas or forecasted network-level asset condition far more powerfully than presenting the same data in written reports and spreadsheets.

Tools such as Microsoft Power BI and Tableau make it easy to mine and present trends for historical asset condition values or projected savings based on different project prioritization schemes to support funding approvals. These tools also allow a DOT to provide curated access to agency data, which is particularly useful when engaging non-expert or external stakeholders.

Important Terminology

The following terms are used within this Section.

Firewall:

An information technology security system that monitors and controls incoming and outgoing network traffic, screening what is and is not let through based on predetermined security rules. It is essentially a barrier between trusted sources and untrusted sources. Adjustments may be required in firewall security protocols to account for new means of access (such as mobile or third-party access to agency systems).

Single Sign On:

Technology facilitating ease of data access across different enterprise applications and network resources, through an authentication process allowing access to multiple applications with one set of login credentials. This eliminates the need for users to maintain different user names and passwords for different systems.

Associated Response Templates

Appendix C

C.4.a – Field Access to Data

C.4.b – Public Access to Data

C.4.c – Access Security

Area D – Analyze Data

Establish decision-support tools, techniques, and practices to develop actionable information and insights to support decision-making.

General Area Overview

The Analyze Data Area is organized into two Sections:

D.1 **Data Exploration, Reporting, and Visualization:** Addressing the analytical environment, practices, and tools used within the agency data analysis practice.

D.2 **Modeling:** Presenting specific asset performance prediction and TAM investment optimization and prioritization methodologies which can be supported through data analysis.

Improvements in this Area are aimed at advancing practices for transforming raw data into information that can support decision making.

D.1 Data Exploration, Reporting, and Visualization

Transforming raw data to actionable information requires establishing consolidated data processing, analysis, and reporting environments and tools, as well as standardized reporting procedures and training to support effective data analysis

Data Analysis Environment

A centralized data analysis environment offers significant time savings, improved analysis quality and trust, and a common platform around which to standardize reporting, visualization, and analysis tool, techniques, and practices.

Populate this environment with authoritative, curated datasets and develop standardized data transformations needed to support routine TAM data analysis needs. Provide standardized capabilities and solutions to address ad-hoc analysis requirements (for example, use of a data lake to temporarily expose data for time-bound data exploration activities).

TAM Data Visualization Practices

Standardized data reports and visualizations are effective communication and information sharing tools. Common visualization techniques include:

- **Straight Line Diagraming Tools:** Simplify the representation of the roadway in order to provide location referencing context.
- **Performance Dashboards:** Track and represent agency goals, objectives, and performance measures to guide daily asset management work activities and decisions.
- **Data Marts and Interactive Reporting Tools:** Provide highly usable, ad-hoc reporting functions.

Associated Response Templates

Appendix D

D.1.a – Analysis Environment

D.1.b – Analysis Practices

D.1.c – Analysis Tools

TAM Data Analysis Practices

Many DOTs are developing specialized data analysis and data science programs to support TAM and other business areas. Analytical techniques commonly leveraged to support TAM include are provided in the conceptual examples.

Important Terminology

The following terms are used within this Section.

Big Data:

Data that is too large and complex to be dealt with through traditional data processing applications and methods.

Business Intelligence:

Systems, applications, and process that change raw data into useful business information.

Data Science:

The use of scientific methods, processes, algorithms, and systems to extract knowledge and insights from structured and unstructured data.

Data Mart:

A scaled down version of a data warehouse, meeting a particular analytical, reporting, or decision-support need.

Conceptual Examples

Analysis Techniques Supporting TAM

Geo-processing

Use geospatial information to integrate and compile disparate datasets useful for TAM analysis.

Data, Text, and Process Mining

Provide techniques to identify anomalies, patterns, and correlations within the large datasets available to TAM practitioners.

Temporal Analysis

Enable examination or modeling of a variable within a data set over time, useful for applications such as asset deterioration modeling, performance trend analysis, investment scenario analysis, and asset work history or use evaluation.

Trade-Off Analysis

Facilitate the comparison of investment priorities with fiscal constraints (both within a given asset program, or across multiple programs).

Prescriptive Analytics

Use business analytics to find the best course of action for a given situation (e.g. selecting a TAM treatment for a specific location or asset).

Predictive Modeling

Apply business analytics to forecast future conditions (e.g. asset condition forecasting).

Predictive Analytics

Use data mining, statistics, modeling, machine learning, artificial intelligence, or other techniques to make predictions about unknown future events. These techniques are emerging in DOT practice.

Decision Science

Score projects and optimize of selection for programming based on benefits, costs, and other measures to assign relative importance. Seen in multi-objective project prioritization and decision-analysis applications.

D.2 Modeling

Agencies are implementing increasingly powerful asset performance models and investment prioritization and optimization techniques to support asset life-cycle planning, project prioritization, and network-level resource allocation.

Asset Performance Models

Support condition- or performance-based management strategies through the development of models to forecast asset performance over time. Use modeling outcomes to improve asset life-cycle planning strategies selection and TAM investment and resource allocation decisions.

Common asset performance models include:

- **Improvement Benefit Models** which anticipate future asset condition and/or performance for a given TAM investment.
- **Asset Deterioration Models** which forecast future condition or performance of the asset, assuming no TAM investment.

Development of these models is ideally based upon statistical analysis of trusted work and performance history, however where trusted data is not available, expert opinion can be used to develop or refine asset performance models.

In combination, these models form the backbone of TAM investment optimization and prioritization analysis.

Conceptual Examples

Modeling Techniques

Deterministic Modeling

A relatively simple and commonly used modeling approach in TAM. Deterministic modeling applies regression analysis to develop "best-fit" equations to characterize asset performance change over time or based on TAM investment.

Probabilistic Modeling

Useful to incorporate uncertainty by provide a distribution of possible strategies. In TAM application, probabilistic models are most applicable to network-level analysis (such as setting funding expectations or needs).

TAM Optimization and Prioritization Analysis

DOT asset management systems are often used to conduct network-level optimization analysis of potential investment strategies or treatment options.

Key inputs to these analysis are:

- **Current Inventory and Condition** necessary to baseline the analysis and establish the potential investment options.
- **Asset Performance Models** which are discussed in detail above.
- **Treatment Rules and Costs** defining the conditions under which a specific TAM treatment may be applied (e.g. triggering conditions) and the costs of those interventions.
- **Analysis Parameters** including the:
  - **Analysis Horizon**, or the number of years to analyzed.
  - **Analysis Objective**, for example, to maximize benefit, or minimize treatment cost.
  - **Analysis Constraints**, such as minimum performance expectations or maximum funding limits.

For assets where condition or performance-based management is not available, age-based or reactive management techniques can be useful. These approaches can still rely upon network-level analysis to prioritize investment options based on available asset information, associated prioritization factors, and existing funding and resources.

Cross-Asset Resource Analysis

Output from asset-specific investment optimizations can be combined and analyzed to identify optimal distribution of resources across asset and program areas. In this approach, a DOT must relate performance outcomes from individual asset programs, to a common benefit or value (typically based on overaching agency goals and objectives). With these relationships established, trade-off analysis can be completed to optimized the total agency benefit or value based on asset-specific outcomes modeled at various potential investment levels.

Important Terminology

The following terms are used within this Section.

Investment Optimization:

Analysis techniques applied to select ideal TAM investments for a given analysis horizon, objective, and set of constraints.

Investment Prioritization:

Screening and ranking techniques used to establish TAM investment priorities.

Associated Response Templates

Appendix D

D.2.a – Asset Performance Prediction

D.2.b – Optimization and Prioritization

Analysis Parameters:

Key inputs to agency asset management or investment optimization analysis, such as asset deterioration rates, treatment condition reset values, treatment unit costs, or analysis time horizons.

Area E – Act Informed by Data

Application of data and information systems, processes, tools, and techniques to TAM decision-making, including performance targeting and prioritization programs, project-level scoping and design, as well as infrastructure and equipment maintenance practices.

General Area Overview

The Act Informed by Data Area is organized into three Sections:

E.1 **Resource Allocation and Prioritization:** Addressing how data is applied within TAM performance targeting and project prioritization.

E.2 **Project Planning, Scoping, and Design:** Presenting how project planning and scoping, as well as design are informed by data.

E.3 **Maintenance:** Capturing how available data is incorporated into agency infrastructure and equipment maintenance practices.

Improvements in this Area are aimed at better integrating use of data and information within TAM processes including network-level investment decision-making, project-level prioritization and development, and routine maintenance decisions.

E.1 Resource Allocation and Prioritization

Optimizing allocation of scarce resources is one of the essential goals of a TAM program. As data and analysis methods improve, agencies are able to prioritize projects and allocate resources based on a firmer, more defensible foundation.

Performance Targeting

Asset performance targets should be:

1. **Aligned** with TAM goals, objectives, performance measures and analysis.
2. **Achievable** through existing practices
3. **Integrated** meaningfully into actual TAM decision-making

Project Prioritization

Project-level investment decision-making should be aligned with stated agency goals and objectives.

There are a variety of techniques employed to support informed maintenance, rehabilitation, and replacement project selection.

Conceptual Examples

Performance Target Incorporation into TAM Decision-Making

Agency Strategic Plans

Reflect agency TAM goals, objectives, measures, and targets. Document funding expectations, key asset life-cycle practices, and roles and responsibilities. Raise TAM awareness and establish agency direction, priorities, and strategy.

TAM Resource Allocation and Budgeting

Ensure alignment of TAM resources with established targets. Adjust available resources and budgets or targeted performance as appropriate and necessary.

Performance Dashboards

Guide decision-makers by reporting progress and supporting course correction. For this purpose, output measures (e.g. miles paved, bridges rehabilitated) may be correlated to more difficult to monitor outcome measures (e.g. % good pavement, # deficient bridges).

Continual Improvement

Identify roles with responsibility and accountability for achieving TAM performance targets. Routinely evaluate to support continual improvement of TAM decision-making business processes.

- **Simple Asset Information Summaries:** Expose trends in asset allocations, inventory, condition, and/or performance through business intelligence tools (ideally as formal performance dashboards). By promoting visibility of performance outcomes, TAM practitioners and management will be encouraged to evaluate and improve existing project selection practices.
- **Network Screening Tools.** Evaluate available data, such as asset inventory, condition, utilization, risk, or other factors, to identify ideal TAM investments for individual assets or locations.
- **Multi-Objective Decision Analysis** techniques can be employed to objectively evaluate project costs with respect to anticipated benefit to agency goals or objectives. Evaluation results should be formally be incorporated into decision-making through well-documented procedures that are routinely evaluated against agency priorities.

Important Terminology

The following terms are used within the assessment and improvement identification materials associated with this Section.

Cross Asset Metrics:

Metrics that allow comparison and evaluation of agency performance across multiple asset areas and programs, for example in terms of asset need, value, or benefit.

Cross-Asset Resource Allocation:

A resource allocation technique where potential investment strategies across multiple asset and/or program areas are evaluated to identify an investment program which best meets overarching agency priorities.

Multi-Objective Decision Analysis:

A decision-making process utilized to make the best decision against a complex set of competing criteria and priorities. When used by DOTs, multi-objective decision analysis (MODA) is typically used in capital project selection.

Utilizing an established objective hierarchy and defined value function (based on agency goals and objectives), the DOT completes detailed, project-level data collection and analysis to score potential projects and identify those with the highest returns on investment. These projects are then prioritized in programming of available funds.

Associated Response Templates

Appendix E

E.1.a – Performance Targeting

E.1.b – Project Prioritization

E.2 Project Planning, Scoping, and Design

Asset inventory, condition, work history, and treatment recommendation data can be used to support efficient project development, as well as selection of optimal design features to meet maintenance and operational needs.

Project Planning and Scoping

DOT policies often recommend (or even require) certain asset maintenance, repair, or replacement activities be incorporated within planned capital projects. These requirements are often based on existing field conditions, however DOTs often have limited formal tools to support informed decision-making.

Typically, simple checklists are developed to support these processes; however, DOTs should seek to improve scoping by integrating available asset inventory, condition, and performance information directly into project planning.

Incorporatation of Optimization and Prioritization Analysis

DOT asset management systems are often used to conduct network-level optimization analysis of potential investment strategies or treatment options (further detailed in **Chapter 3, Area D** support materials).

DOTs are often challenged to meaningfully incorporate outcomes from network-level TAM optimization analysis into project-level decision making. Policy, procedures, and tools are necessary to overcome these challenges, however these must be balanced with the reality that project-specific field conditions cannot fully accounted for in network-level analysis. Therefore, appropriate flexibility should be offered to field decision-makers.

Optimization and Prioritization Analysis

Area D – Analyze Data
Chapter 3

Field Performance Verification

Monitor asset condition and performance after project delivery to validate actual versus predicted outcomes. If significant descrepencies are observed, determine if design or construction practices can be improved or if asset performance models should be adjusted. Continual monitoring and improvement improves design and construction practices, project-level decision-making, and network-level TAM analysis.

Important Terminology

The following terms are used within this Section.

Project Scoping Templates:

Developed for common project types, these can be pre-populated with TAM analysis outcomes and asset inventory and condition information as the basis for field project scoping. These templates provide efficiencies in scoping activities and encourage investment decisions aligned with TAM priorities.

Evidence-Based Design and Construction:

Use of a scientific methodology and statistical techniques to evaluate project design decisions and construction practices in order to achieve the best possible outcomes. Useful to TAM programs in identifying changes to design standards and processes supporting improved asset management and operations outcomes.

Conceptual Examples

TAM Analysis Incorporation in Project-Level Decision-Making

Treatment Selection Screening

Prescriptive decision-analysis techniques can be applied to individual assets or potential investment locations to establish acceptable treatment categories. These are very useful in preventive maintenance scoping, where certain field conditions may be known to result in low performance benefits (e.g. application of preventive maintenance seal coats to pavements exhibiting fatigue or “alligator” cracking).

Network-Level “Best Mix of Fixes”

Predictive modeling and analytics can provide optimized TAM investment strategies. Rather than applying these directly to the specific locations selected in the analysis (based on network-level information), aggregate outcomes by treatment or activity type. Then, communicate these as investment targets to field decision-makers, allowing field selection of the specific locations and detailed TAM treatments or activities.

This approach balances optimal strategies with field realities that are not accounted for in the network-level analysis. This can also be paired with treatment selection screening to ensure field selected treatments are appropriate to the specific locations selected.

Associated Response Templates

Appendix E

E.2.a – Data-Driven Project Planning and Scoping

E.2.b – Data-Driven Project Design

E.3 Maintenance

Asset life-cycle modeling techniques can be used to develop effective routine, preventive, and reactive maintenance programs for transportation infrastructure and equipment.

Common Maintenance Practices

Most DOT equipment and many transportation assets have well documented standards for routine and preventative maintenance. Equipment manufacturers recommend regular preventive maintenance cycles (for example oil changes or tune-ups) and many DOTs, other transportation asset owners, or industry representatives have recommendations for when various transportation assets should be inspected or receive preventive care.

These practices can be incorporated into DOT life-cycle models and maintenance programs. By investing in these activities, even on a defined, interval-based methodology, the DOT can expect to generate long term savings through improved performance and extended service life.

Conceptual Examples

Promoting Awareness

Standard Operating Procedures

Identify targeted routine and preventive maintenance activities and document clear standard operating procedures for maintenance staff. Share this documentation in an easily accessible location, and advertise its availability. For complex activities, consider establishing formal training courses to ensure proper application.

Targeted Communication and Outreach

Organize regular meetings with field maintainers and promote preventive and routine maintenance expectations and opportunities. Share anticipated outcomes and benefits to the agency.

Performance Targets

Using life-cycle modeling, interval-based methods, or available funding, establish and track preventive maintenance targets. Validate that maintenance is being targeted to appropriate candidates (as preventive maintenance is typically only useful to extend the life of an asset that is still in good condition).

Automated Work Ordering

Where asset management and work ordering systems can be integrated, implement tools to automatically screen the asset inventory for routine, preventive, and reactive maintenance candidates. When assets are identified, automatically generate and assign work orders to trigger necessary maintenance activities.

Important Terminology

The following terms are used within this Section.

Automated Work Ordering:

An automated process that generates maintenance work orders, typically based on asset use, age, maintenance or work logs, inspection results, observed defects, or condition ratings.

Preventive Maintenance:

Programs or activities employing network level, long-term strategy that enhances asset performance or extends asset life through a set of proactive, cost-effective practices.

Routine Maintenance:

Recurring maintenance activities that are regularly employed over the life of an asset, such as cyclical inspection, servicing, or replacement of components.

Associated Response Templates

Appendix E

E.3.a – Infrastructure Maintenance

E.3.b – Equipment Maintenance

4. Evaluation and Summary of Results

This chapter provides guidance for evaluating candidate improvements and communicating information about recommended improvements to build support and secure resources for implementation.

4.1 Practice Summary, Improvement Evaluation and Result Communication

At this stage of the process, you will have a list of candidate improvements to close gaps between where you are now and where you want to be.

The next important step is to evaluate these candidate improvements. The purpose of the evaluation is to set priorities and build an understanding of the likely implementation challenges you will face.

The result of this step is a summary of the gaps to be closed, and the recommended improvements for closing them. These materials can be used to make a case for resourcing improvements.

Current and Desired State Summary

Users of the guidebook will establish the current and desired state of practice for each assessed Area, Section, and Element of the framework. This will provide a clear picture of where there are gaps in current practice, exposing opportunities for potential improvement.

While element-level response templates provided in the print guidebook are available to complete a pen and paper assessment, use of the TAM Data Assistant will facilitate summary and communication of the assessment results.

Visual summary and presentation of current and desired practice benchmarking is the most effective means of communicating assessment outcomes. "Spider web" or "radar" charts are best used for this communication (example provided in **Figure 4-1** on the following page). Due to the number of individual elements, individual summary charts should be developed for each assessed Area within the guidance framework.

These charts will provide a compelling, visual representation of where current performance is high or low, as well as where there are gaps between current and desired performance. Using these charts will clearly identify priorities for advancement, and support improvement evaluation and prioritization.

TAM Data Assistant

The TAM Data Assistant simplifies the summary of assessment outcomes by automatically generating these charts from the detailed assessment data.

Additional Recommendations

Summary and review of assessment results can generate new insights from the assessment team and allow for broader engagement beyond those involved in the initial assessment process.

Use the assessment summary materials to iteratively refine the assessment details and generate more meaningful assessment results and improvement priorities.

TAM Data Assistant

Reference Materials

General Uses
Chapter 2

Assessment Facilitation Uses
Appendix H

User Quick Reference Guide
Appendix I

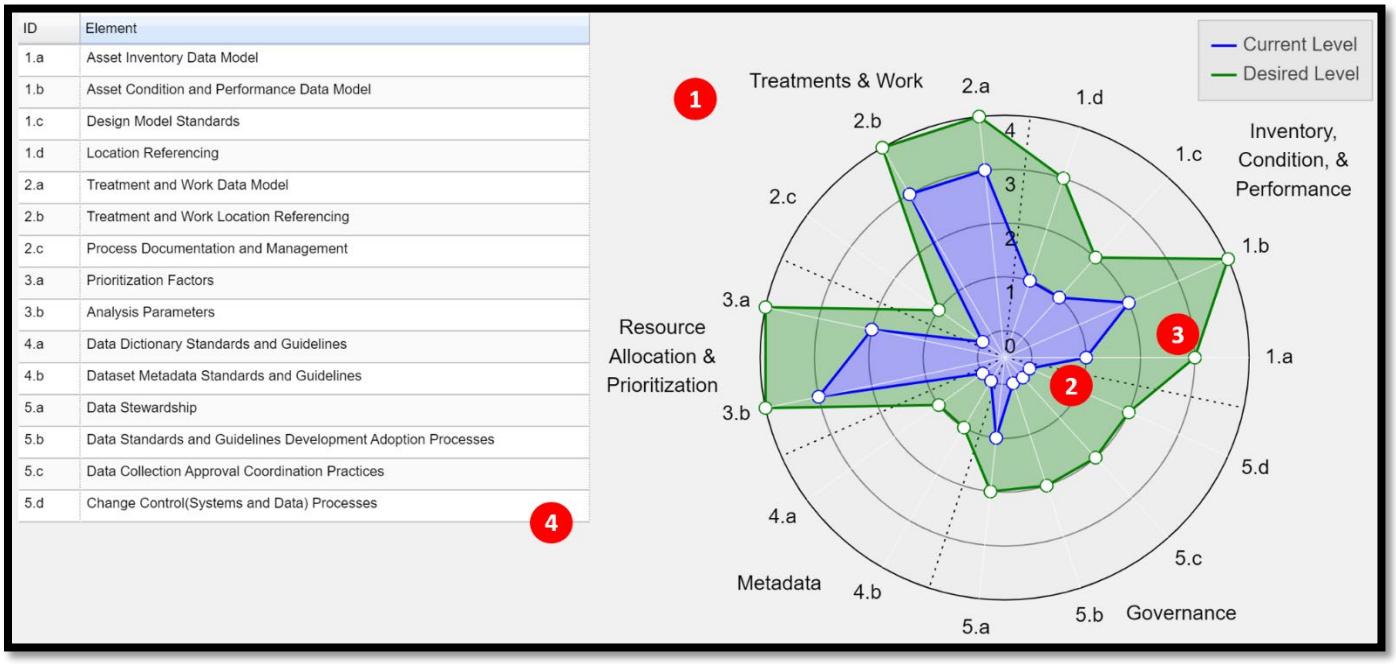


Figure 4-1: TAM Data Assistant Assessment Summary Example

Explanation of Recommended Summary Charting

The figure above exemplifies the recommended approach to visualizing the current and desired state captured through the assessment process. Highlighted are four key elements of this visualization:

1. **The "spider web" or "radar" chart** itself, including each assessed Element within the Area, organized by Section, and representing each possible level of performance (from benchmark level 0 to benchmark level 4).
2. **The current performance**, highlighted in blue. This is provided for each assessed element within the targeted Area.
3. **The desired performance**, highlighted in green. This is provided for each assessed Element within the targeted Area.
4. **The element identifier and name** for each assessment Element represented in the summary chart.

Use of Recommended Summary Charting

Identification of Low- and High-Performing Sections and Elements: In the example above, Governance and Metadata practices are easily identified as low performing, whereas Treatment and Work Data Standards are relatively high performing.

Low performing areas may become obstacles to ongoing advancement and may need to be prioritized for improvement, even if these capabilities are not specifically an area of

focus for the agency. In the example above, without advancing Governance and Metadata capabilities, the ability to efficiently and effectively collect, integrate, or analyze TAM data may be compromised due to lack of understanding of and compliance with data standards as business needs and practices change.

Gaps in Current and Desired Performance: In the example above, all assessed Elements had a gap between current and desired performance, however certain elements had larger gaps than others. Governance elements typically were two levels lower than desired, and will require significant investment and potentially face substantial institutional hurdles and organizational challenges to implement.

Based on this summary, a long-term governance implementation initiative should be considered. Communication to decision-makers should highlight the significant gap in current practices with respect to the desired state and the value and benefits of investment in advancing governance practice.

Detailed Analysis

Detailed assessment data can be exported from the TAM Data Assistant to an Excel spreadsheet.

The export file can be used to readily list, filter, sort, and apply calculations which may be helpful in communicating the current practice, desired state, or practice gaps. The user can also readily create a "radar" or "spider web" chart from the export file (though the tool does this automatically for each framework area).

The assessment information can also be combined with detailed improvement evaluation outcomes (also included within the export file) to relate current and desired practice to individual improvement opportunities (as is discussed further in the Improvement Evaluation section of this Chapter).

TAM Data Assistant Quick Reference Guide

For more detailed information on the tool's functions and use, see the TAM Data Assistant Quick Reference Guide provided in **Appendix I**.

Improvement Evaluation

After candidate improvements are identified, the next step is to evaluate them, understand effort versus likely payoff, and anticipate implementation challenges. This evaluation step is important for setting priorities and developing a comprehensive improvement strategy.

The TAM Data Assistant allows you to sort, filter, and review a list of improvement identified during the assessment process. Through this interface, you can track evaluation results based on the criteria described below.

Each improvement should be evaluated in the context of other selected improvements, allowing the relative impact, effort, and priority of each improvement to be established (as High, Medium, or Low) with respect to the other identified options. Improvement specific challenges can also be identified for consideration during strategy development.

Impact is characterized by the extent to which new or existing practices will transform TAM related business practices.

Effort is characterized by the level of resources and staff time required and the extent to which those can be incorporated into the responsibilities and budgets of existing business units.

Priority is established on the basis of when that improvement would be targeted for implementation, ranging from immediate action to being recognized for future, unplanned action.

Challenges can be categorized as into distinct categories of Time, Resource, Expertise, Coordination, Change, or Other.

Conceptual examples illustrating the application of these evaluation factors are provided on the following pages.

Conceptual Examples

Impact Evaluation

High Impact

Transforms current business in a way that addresses major process pain points, is likely to extend to multiple business units, and adds value to multiple business processes.

Medium Impact

Makes existing business processes significantly more efficient and effective, however may be within a limited area of business (e.g. a specific business function or process area).

Low Impact

Contributes a minor adjustment to an existing business process, but will not significantly change the business. In general, these improvement may already be informally in place, but are simply being formalized or being made clearer in the context of the program at large.

Effort Evaluation

High Effort

Requires a major commitment of resources and staff time, typically across multiple business units. Examples would include a major IT application, a statewide technology deployment, etc.

Medium Effort

May be incorporated within typical budgets and resources but would require planning and coordination, typically limited to a specific business function or process area.

Low Effort

Can be included within the routine responsibilities of a business unit or working group and typically able to be completed within a short timeframe.

Priority Evaluation

High Priority

Targeted for immediate action.

Medium Priority

Desired to begin within the next several investment or planning cycles (e.g. 1-2 years).

Low Priority

Recognized, but not anticipated for action within the near future and unlikely to be incorporated into near term planning activities.

Conceptual Examples

Challenge Categorization

Time

Recommended when the time available is limited for the extent of the effort.

Resources

Recommended when level of resources or staff time would require executive approval.

Expertise

Recommended when the expertise required is not available to the DOT without specialized support.

Coordination

Recommended when engagement and agreement is required across many different areas of business within the DOT, particularly when many of the impacted business units do not typically work together as part of the routine business of the agency.

Change

Recommended when the improvement will significantly transform current business across multiple business units and processes, requiring extensive process reengineering and/or training to those impacted.

TAM Data Assistant Uses

The TAM Data Assistant provides functionality for recording ratings of impact, effort, priority and challenges for each selected candidate improvement.

Additional Recommendations

An iterative approach to improvement evaluation is recommended. To the extent practical, this process should also involve external stakeholders and external planning processes. For example, the goals and objectives stated in agency strategic plans should be incorporated into prioritization of improvement action.

The availability, workload, and resources of impacted business units should also be considered, as well as the engagement and enthusiasm for change found in potential project sponsors and business leads. Without stakeholder engagement, it is unlikely that a data or information system improvement will be successfully and sustainably implemented within routine business.

TAM Data Assistant

Digital Tool Overview
Chapter 2

Improvement Evaluation Uses
Chapter 4

Result Summary and Executive Communication
Chapter 4

Assessment Facilitation
Appendix H

Tool Quick Reference Guide
Appendix I

Improvement Evaluation Tools

The figure below demonstrates the TAM Data Assistant functionality supporting improvement evaluation. Highlighted are five key aspects of this interface:

1. **Sort and Display Functionality** – organize improvements identified during the self-assessment process
2. **Filter Functionality** – apply criteria to filter the improvements based on Area, Challenge, Priority, Effort, Impact, as well as other factors.
3. **Individual Improvement Details** – see details for each selected improvement
4. **Evaluation Criteria** – establish the improvement's impact vs. effort, priority, and associated challenges.
5. **Assessment Information** – review the current and desired state of the associated element, as well as provide a link to quickly return to, and adjust, the associated assessment information.

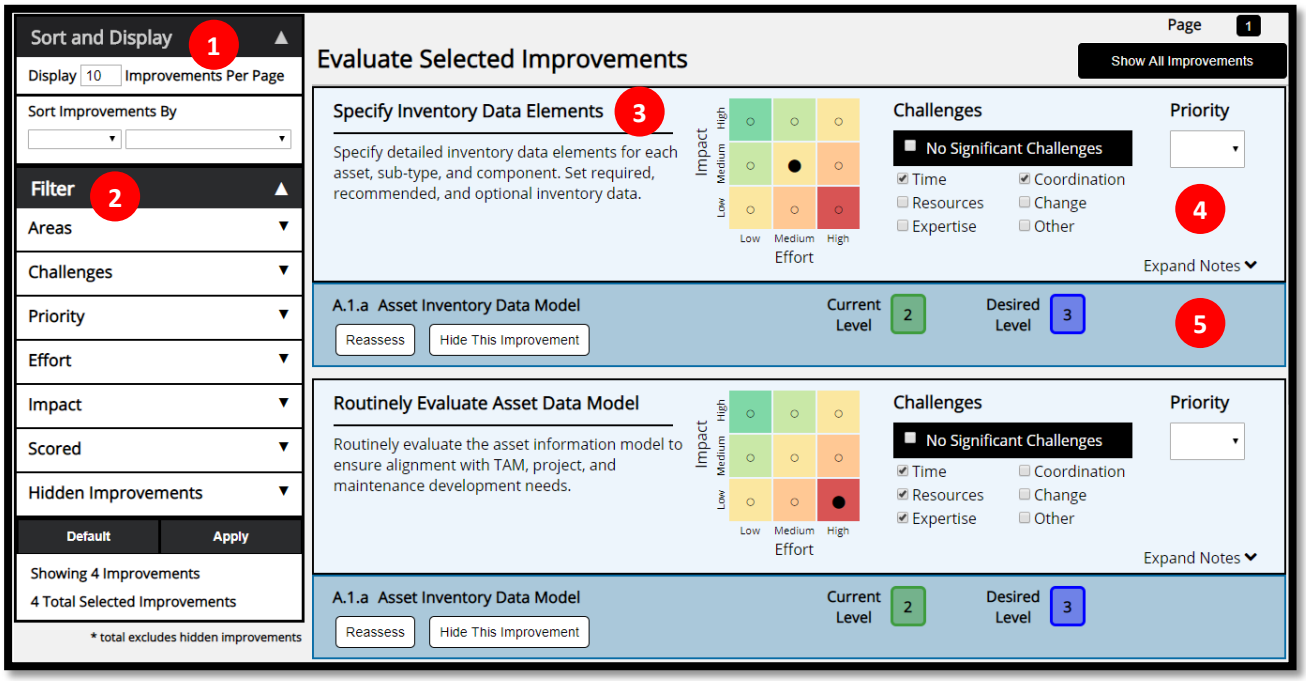


Figure 4-2: TAM Data Assistant Use to Evaluate Selected Improvements

- **Priority:** The Low, Medium, High priority value assigned to the improvement.
- **Impact:** The Low, Medium, High impact value assigned to the improvement.
- **Effort:** The Low, Medium, High impact value assigned to the improvement.
- **Time Challenge:** An indicator of whether a time challenge was identified for the improvement (0 = no challenge was identified, 1 = a challenge was identified).

- **Resource Challenge:** An indicator of whether a resource challenge was identified for the improvement (0 = no challenge was identified, 1 = a challenge was identified)
- **Expertise Challenge:** An indicator of whether an expertise challenge was identified for the improvement (0 = no challenge was identified, 1 = a challenge was identified)
- **Coordination Challenge:** An indicator of whether a coordination challenge was identified for the improvement (0 = no challenge was identified, 1 = a challenge was identified)
- **Change Challenge:** An indicator of whether a change challenge was identified for the improvement (0 = no challenge was identified, 1 = a challenge was identified)
- **Other Challenge:** An indicator of whether another type of challenge was identified for the improvement (0 = no challenge was identified, 1 = a challenge was identified)
- **Status:** An indicator of whether the improvement was or was not selected for improvement.
- **Evaluation Notes:** Improvement notes captured during the self-assessment activity.

The export file can be used to readily list, filter, sort, and apply calculations which may be helpful in communicating the priorities for improvement. By joining these results with the detailed assessment information, the user can further refine the priorities for improvement.

Conceptual Examples

Detailed Result Evaluation

High Impact, Low Effort Improvements

Filter for High Impact, Low Effort improvements. Consider improvement opportunities which deliver significant value without substantial effort. Where practical for immediate investment, communicate these "low hanging fruit" to decision-makers as easy wins.

Combine Assessment and Improvement Information

Combine assessment and improvement information using the Element ID field. Use this to improve communication of improvement priorities by also relating current or desired performance.

Improvement of Low Performing Elements

Use the combined assessment and improvement information to sort the improvement list for low performing elements ("increasing" by assessment current level). Identify improvements to lowest performing elements.

A low performing element may not always stand on its own as a priority of the organization, but also consider the interrelated nature of performance within the framework. Lagging performance in one aspect of performance can impact ability to be successful in other areas.

Improvement of Elements with Large Performance Gaps

Use the combined assessment and improvement information to sort the improvement list based on performance gaps ("decreasing" by the different between desired and current level). Identify improvements in the high performance gap elements.

Consider whether initial improvements in these areas should be prioritized, given that multiple improvements over an extended period of time will likely need to be implemented.

TAM Data Assistant Quick Reference Guide

For more detailed information on the TAM Data Assitant's functions and use, see the TAM Data Assistant Quick Reference Guide provided in **Appendix I**.

Executive Communication

Clear, concise communication of current practices, the desired state, key performance gaps, and priority improvements are essential to securing support for implementation.

The assessment facilitator, project sponsor, and other key team members should be involved in development of executive communication materials.

Digital Output and Uses

"Radar" charts, individual improvement evaluation data entry, as well as summary improvement "impact vs. benefit" charting can be directly used in decision-maker communication.

These pre-developed communication materials should be selectively used within externally developed executive briefing and summary materials designed to speak to the specific needs and interests of the targeted decision-makers.

Detailed export output should be used as the basis for any non-standard communication materials. This will ensure that these are easily maintained or updated in the event that the assessment results are revisited at a future date.

Recommendations for effective executive communication include:

1. **Present the assessment focus and context** emphasizing the motivation, desired value in selecting the focus, and the cross-functional nature of the assessment team.

2. **Communicate current and desired state** quickly demonstrating where performance is low, where it is high, and were improvement is most necessary. Provide practical examples of impacts that low performance is having on current TAM business.

3. **Share a clear set of implementation priorities** that address gaps in current practices. Emphasize these are the agreed upon priorities of the cross-functional team.

4 **Acknowledge challenges** that will be faced and outline organizational practices and real-world case studies that will support successful implementation.

Implementation Support Materials

Organizational Practices
Chapter 5

Case Studies
Chapter 5

5. Implementation Support

This chapter references supplemental materials provided in the guidebook appendices that can be used to support implementation planning for data and information improvements.

These materials provide background on organizational practices as well as DOT case studies highlighting implementation experience.

5.1 Organizational Practices

Making meaningful changes to how data are managed, shared, and used within and across a DOT TAM program requires much more than procuring new tools and technologies.

Agencies must ensure that they have the necessary workforce capabilities to successfully use and integrate new technologies – and that they are able to adapt to new processes for creating and using information.

Four key types of organizational practices can be employed to support implementation of TAM data and information improvements:

- **Strategic Management**
- **Initiative Management**
- **Talent Management**
- **Knowledge Management**

Organizational Practice Use

Large organizations, like DOTs, will face institutional challenges to sustained improvement. Many of these challenges can be addressed through deliberate application of the identified organizational practices.

Implementation Challenge Overview

Improvement of DOT data and information systems and related TAM business practices requires:

- **Time and Resources** for technical work and review and revision cycles;
- The right kinds of **Expertise** needed to create workable standards and facilitate review and negotiation processes;
- **Coordination** to get agreement among different business and IT stakeholders – and potentially with outside vendors and partner agencies; and
- **Changes** to data collection processes, IT systems, and business processes for collecting, entering, reporting and using data.

Assembling needed time, resources and expertise; and navigating coordination and change management needs can be more challenging than conducting the actual technical work for improvement.

Some organizational strategies that can be used to overcome these challenges are highlighted below.

Time and resource challenges can be addressed through:

- **Strategic Planning** – increase agency direction and support for data and information system related improvement and initiatives.

Time and Resource Challenges

Appendix F

Strategic Planning

Governance

Portfolio Management

Expertise Challenges

Appendix F

Workforce Planning, Branding, Employee Development

Succession Management

Knowledge Capture and Dissemination

- **Governance** – establish decision-making structures and prioritized investment in activities to develop enterprise data standards.
- **Portfolio Management** – offer techniques to identify and advocate for the business value and return-on-investment from data and information system and TAM investments.

Expertise challenges can be addressed through:

- **Workforce Planning, Branding, and Employee Development** – provide techniques to identify job skills and develop associated recruitment and training necessary to build specialized technical skill (e.g. data modeling) and soft skills (e.g. group facilitation and engagement) necessary to develop and implement meaningful data and information system practices.
- **Knowledge Capture and Dissemination** – establish a common resource base for individuals involved in data and information system related efforts and TAM business processes.

Coordination challenges can be addressed through:

- **Collaboration and Peer-to-Peer Learning** – create opportunities for collaboration between business and IT professionals and create cross-functional work groups to work on data and information-system related improvements.

Change challenges can be addressed through:

- **Change Management** – develop approaches to communicate the purpose, build awareness, and facilitate adoption of new data standards, information systems, and related TAM business practices to individual staff, business units, and the organization at large.
- **Performance Management** – set objectives and performance measures that promote awareness and compliance with new data-informed business practices.
- **Enterprise Architecture** – establish a reference for existing or proposed business processes.

Coordination Challenges

Appendix F

Collaboration and Peer-to-Peer Learning

Change Challenges

Appendix F

Change Management

Performance Management

Enterprise Architecture

Organizational Practice Guidance Format and Content

Information on the four practice areas is provided in Appendix F. For each practice area, a brief practice overview is provided, typical strategies are detailed and related to specific challenges that are addressed through the strategy's application, and additional, external references are shared for further examination.

Overview

This introductory material provides the essential concepts pertaining to the organizational practices and recognizes each of the typical strategies that are subsequently documented.

Typical Strategy Documentation

Individual strategies are identified and documented within each practice area. These strategies are not meant to be comprehensive, but are identified as they address institutional and organizational challenges that may be faced by a DOT as they advance their data and information system related practices supporting their TAM programs.

For each strategy, specific, but high-level, guidance is shared relating to its execution at the DOT. This is intended to provide a base understanding of how the DOT can pursue application of the strategy to address identified challenges.

References

Given the focus of this guidebook, it is not practical to provide comprehensive guidance for application of each practice area, even within the specific context of supporting DOT TAM programs.

Recognizing the critical role these organizational capabilities will play in sustained improvement in DOT practices, following the practice area overview and typical strategy documentation, additional, external reference materials are provided.

5.2 Case Studies

The case studies provide practical examples of real projects completed by state DOTs that can serve as best practice references.

These references can be used in conjunction with improvement recommendations to support projects and initiatives to enhance data management maturity in accordance with this guidebook.

Case Study Format and Content

The interpretation and application of the improvement recommendations will vary amongst DOTs based on size, organizational structure, leadership objectives, and other factors.

However, by complementing improvement recommendations with real project examples aligned with various areas of the assessment, DOTs will be able to see how others have approached similar challenges, how those challenges were addressed and how desired outcomes were achieved.

Each case study is is provided in a consistent format. This format provides the reader a concise and clear description of why the project was undertaken, the approach applied, the value delivered, and the key challenges faced. Supporting graphics are included with each case study to provide visual context in the form of charts, workflows, screen captures or other artifacts.

Motivation

The motivation section of the case study is designed to create a relatable position for why a DOT would undertake such a project. The goal of the motivation description is to help the reader identify with the originating challenge or opportunity and related it to a similar challenge or opportunity within their own organization.

Approach

The approach is intended to provide a high-level walkthrough of the key steps the DOT took to execute the project or initiative. Specific step, actions, tactics and engagement strategies employed by the DOT are detailed as applicable.

Value Delivered

In the value delivered section, the outcome of the project or initiative is described in qualitative or quantitative fashion. By providing the outcome

value information the reader can infer similar outcome value propositions for improvements that they are considering that might be associated with the particular case study.

Key Challenges Faced

Each case study highlights key organizational requirements and challenges faced during implementation. Each case study categorizes these challenges by time, resources, expertise, coordination, and change.

Supporting Graphics and Context

In order to bring the project or initiative to life, select images are provided to support the textural portion of the case study. These images may be photographs, screen shots or applications, charts, or other representative graphics to help illustrate motivation, approach, value or challenges.

Case Study Overview

Case study selection is guided by an understanding of some of the more challenging and progressive areas of the guidance. Each case study is aligned to an assessment area with a single case study potentially covering more than one area or element.

Below are listed the case studies organized by assessment area, section and/or element references identified.

A brief case study description outlines how the case study provides a useful example of practice and how it is linked to the assessment and improvement framework.

Detailed case study materials are found in **Appendix G**.

Establishing and Applying a Governance Framework

Area: Specify and Standardize (A)

Section: Governance (A.5)

Element: All (A.5a – A.5.d)

Organization: Ohio DOT

Project: Establishing and Applying a Data Governance Framework

Description: This project illustrates the criticality of stewardship and formal oversight for data standards within an organization. The case study reveals the necessity to engage across all levels of the organization to ensure that there is investment to provide a comprehensive, sustainable governance structure established by policy.

This case study demonstrates how a specific DOT could advance governance elements from practice level 1 or 2 up to practice level 3, by implementing improvements for stewardship roles and governance structures, data management maturity self-assessments, and data and integration through process mapping.

Statewide Vehicle-Based Data Collection

Area: Collect (B)

Section: Inventory, Condition, and Performance Collection (B.1)

Elements:

Detailed Case Study Material

Appendix G

- Coverage (B.1.a, B.2.a, B.3.a)
- Automation (B.1.b, B.2.b, B.3.b)

Organization: Utah DOT

Project: Statewide Mobile LiDAR Data Collection

Description: This project demonstrates establishing enterprise standards and driving consistency so that statewide inventory can be collected uniformly. This project also illustrates the careful analysis of determine data value to guide investment decisions on how much data to collect and when dealing with large data sets the importance of automating processing steps to create efficiencies.

This case study demonstrates how a specific DOT could advance these elements from practice level 2 to practice level 3, by implementing improvements for manual data collection automation and collection tools and methods consolidation.

Data Collection Quality Management Plan Implementation

Area: Collect (B)

Section: Inventory condition and performance (B.1)

Elements: Quality (B.1.c, B.2.c, B.3.c)

Organization: Colorado DOT

Project: Pavement Data Quality Management Plan

Description: This project showcases the ability to leverage Federal requirements as an impetus to addressing a larger and more complex issue. Additionally, this project reveals the importance of change management and careful attention to understanding in entirety:

- the business process,
- what will change, and
- how it will affect the stakeholders.

The training and certification aspects of the case study illustrate a method to support sustained change.

This case study demonstrates how a specific DOT could advance these elements from practice level 1 to practice level 2 or 3, by implementing improvements for data quality collection plan.

Mobile Field Data Collection Implementation

Area: Collect (B)

Sections:

- Inventory, Condition, and Performance Collection (B.1),
- Project Information (B.2),
- Maintenance Information (B.3)

Element: Quality (B.1.c, B.2.c, B.3.c)

Organization: Virginia DOT

Project: Mobile Field Data Collection of Maintenance Work Accomplishments

Description: This project showcases the value of defining data collection standards and data capture strategies that allow for consistency field data collection. These are foundational to development of mobile field data collection tools and downstream analysis tasks. Also highlighted in this project is the cost benefit analysis that must be made with respect to software customization decisions.

This case study demonstrates how a specific DOT could advance these elements from practice level 3 to practice level 4, by implementing improvements for automated data quality collection audits.

Mobile LiDAR and BIM/CADD Integration

Area: Store, Integrate and Access (C)

Section: Asset life cycle data integration workflows (C.2)

Elements:

- Project development to project delivery (C.2.b)

Organization: Utah DOT

Project: Integration of 3D Modeling Data to Support Asset Management

Description: This project exemplifies the value of leveraging asset inventory and condition data into the project delivery phase. This project also shows that investments in one asset life-cycle stage can pay dividends in another, the additional returns on investment by looking at the larger life cycle viewpoint can be considered to aid justification of new data and digitalization projects.

This case study demonstrates how a specific DOT could advance this element from practice level 3 to practice level 4, by implementing improvements for asset life-cycle data transfers automation.

Multi-Objective Project Prioritization Program Implementation

Area: Act (E)

Section: Project Planning, Scoping, and Design (E.2)

Element: Data-Driven Project Planning and Scoping (E.2.a)

Organization: Ohio DOT

Project: Transportation Asset Management Decision Support Tool (TAMDST)

Description: The project illustrates the accumulated value and derived benefits from normalizing ratings and metrics to support cross asset planning. This work further demonstrates the value of dashboards and visualization techniques

to support decision making as well as making those decisions on prioritization defensible.

This case study demonstrates how a specific DOT could advance this element from practice level 2 to practice level 3, by implementing improvements for network-level performance monitoring programs.

Appendix A: Specify and Standardize Data Element-Level Response Templates

This Appendix offers element-level response templates for Area A: Specify and Standardize Data.

Note: Use of the TAM Data Assistant is recommended however these templates are provided for informal use or pen and paper assessment.

Date: **Participating Members:** **Assessment Context:**

A-Specify and Standardize Data
1-Inventory, Condition, and Performance

A.1.a – Asset Inventory Data Model

Element Description Standardized asset categories, component breakdowns and core attributes, providing the foundation for asset inventory information tracking, integration, summary, and reporting.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
There are no commonly adopted definitions or methodologies for tracking inventory information for a given asset or asset type.	The asset has been defined, and the approach for asset inventory has been established – e.g. sampling versus full inventory; itemize each asset versus counts.	An asset breakdown structure has been established to define various asset subtypes and components. There are clear criteria for assigning sub-types and identifying components.	A minimum set of required inventory attributes have been identified (e.g. unique identifier, location, install date, asset subtype, size/measure). Additional recommended and optional data elements have been identified. The desired extent of collection has been established.	A detailed asset information model has been defined that supports direct integration with project and maintenance information, contracts and/or design files.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Define the "asset" and determine how the asset inventory should be recorded to support current/desired practice.	☐ Develop the "asset breakdown structure", providing clear criteria for identifying various asset "sub-types" and "components".	☐ Specify detailed inventory data elements for each asset, sub-type, and component. Set required, recommended, and optional inventory data.	☐ Document a detailed asset information model facilitating direct integration of asset inventory with maintenance work orders and project files.	
☐ Coordinate with field and office staff to identify current inventory data collection practices and standards.	☐ Evaluate existing inventory standards to identify gaps or inconsistencies in current standards for improvement.	☐ Specify minimum levels of inventory data coverage to meet decision-making, communication, and reporting needs.	☐ Routinely evaluate the asset information model to ensure alignment with TAM, project, and maintenance development needs.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

A-Specify and Standardize Data
1-Inventory, Condition, and Performance

A.1.b – Asset Condition and/or Performance Data Model

Element Description Standardized asset condition and performance data types, detailed attributes, and summary indices, ratings, or scores that are useful in asset related decision-making and communication.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
Condition or performance data elements and collection methods have not yet been defined for the asset or asset type.	General condition or performance data elements have been defined for the asset or asset type.	General condition or performance categories and/or ratings have been defined for the asset or asset type.	Specific data attributes related to the condition or performance measures have been established (e.g. observation date, detailed data attributes, overall rating).	A methodology has been defined to evaluate asset specific condition or performance information against a common, cross asset performance metric (typically associated with net benefit, value, contribution, or need based on the agency's overarching strategic framework.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Define the various condition and performance data types and associated/anticipated collection methodologies.	☐ Document general condition or performance groupings and general criteria (e.g. condition ranges) for these groupings.	☐ Specify detailed data elements for each condition or performance rating or categorization. Set required, recommended, and optional data elements.	☐ Establish detailed methodology to evaluate asset condition, performance, or contribution to overarching agency strategic priorities.	
☐ Coordinate with field and office staff to identify current condition and performance data collection practices and standards.	☐ Evaluate existing condition or performance standards to identify gaps or inconsistencies in current standards for improvement.	☐ Specify minimum levels of condition or performance data coverage to meet decision-making, communication, and reporting needs.	☐ Routinely evaluate the condition and performance standards to ensure alignment with TAM business needs.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

A-Specify and Standardize Data
1-Inventory, Condition, and Performance

A.1.c – Design Model Standards

Element Description CADD standards consistent with asset inventory standards (asset categories and component breakdowns) to support linkage and data exchange with project information with asset inventory and management systems

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
CADD standards are not defined for the asset.	CADD standards are defined for the asset, however they are not related to established asset categories or components.	CADD standards are defined with base objects aligned with asset categories and components in a manner that allows for extraction of asset information from project files with a project specific, manual effort to reconcile differences.	CADD standards are defined with base objects aligned with asset categories and components, in a manner that allows for extraction of asset information from project files through standardized processes.	Data exchange protocols are defined for the asset, allowing direct integration of project files and asset inventory and/or management systems.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Establish uniform standards and procedures for development of electronic design and survey plans	☐ Define CADD standards that align based objects with asset types, sub-types and components	☐ Define a detailed project information model that contains detailed asset attribution needed for asset management.	☐ Define detailed data exchange protocols which support transformation of asset information into CADD design files, and vice versa.	
☐ Develop training to communicate design standards.	☐ Develop training to communicate CADD standard alignment with asset information.	☐ Develop training to communicate detailed project information model and uses in asset management.	☐ Develop training to raise awareness of data exchange protocols and requirements.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

Specify and Standardize Data
Inventory, Condition, and Performance

A.1.d – Location Referencing

Element Description Standardized location referencing for asset inventory and condition data to enable mapping and integration with other agency data for analysis.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
Location referencing methods and data standards for the asset have not been defined.	Location referencing methods and data standards have been established for the asset, but they cannot be readily transformed to the established enterprise location referencing standard.	Location referencing methods and data standards have been established for the asset and can be readily transformed to the agency's enterprise location referencing standard.	Location referencing methods and data standards have been established for the asset and are consistent with the agency's enterprise location referencing standard.	Location referencing of asset information is kept up-to-date in (near) real time as the enterprise location referencing definitions are updated.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Evaluate agency enterprise location referencing standards and identify a method(s) which best support asset needs.	☐ Standardize location referencing in a manner that can be transformed to the agency enterprise standard.	☐ Standardize location referencing in a manner that is consistent with the agency's enterprise standard.	☐ Fully integrate asset data systems, tools, and records with the agency's enterprise location referencing system.	
☐ Examine current inventory, condition, and performance data standards to identify various location referencing methodologies in current use.	☐ Document clear processes and business requirements for transformation of any location references not meeting the enterprise standard.	☐ Develop specifications for tools to support accurate identification of location based on current enterprise location referencing system definitions.	☐ Routinely evaluate the agency location referencing systems to ensure alignment with TAM business needs.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

A-Specify and Standardize Data
2-Treatments and Work

A.2.a – Treatment and Work Data Model

Element Description Standardized asset treatment/work categories and attribution to enable information collection, integration, and consistent reporting.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
There are no consistently defined treatment/work categories for the asset.	Treatment and work categories impacting asset condition or performance have been defined (e.g. replacement, corrective maintenance, preventive maintenance).	Specific treatment types and work activities have been identified for the asset, and classified according to established categories. Standard methods for tracking work accomplishments are in place.	A standard set of minimum attributes for tracking maintenance activities and projects (e.g. work completion date, cost, location) have been established. Required, recommended, and optional fields have been identified for various treatments and work types.	Impacts of projects affecting multiple assets are tracked for each individual asset. Asset treatment and work data models are periodically adjusted to reflect changes in project delivery methods.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Define what are considered “work accomplishments” for the asset.	☐ Develop lists of standard activities and project types, providing criteria for grouping specific work into these activity and project types.	☐ Specify detailed treatment and work data elements for various project and activity types. Establish required, recommended, and optional data elements.	☐ Integrate methods for tracking impacts of projects affecting multiple assets (e.g. pavement projects that upgrade guardrails) into the treatment and work data models to capture information needed for the assessed asset.	
☐ Coordinate with field and office staff to identify current project types and maintenance activities impacting the asset.	☐ Evaluate existing treatment and work data standards to identify gaps or inconsistencies for improvement.	☐ Determine minimum levels of treatment and work data coverage to meet decision-making, reporting, and communication needs.	☐ Establish a program to routinely evaluate asset treatment and work data models to ensure they continue to meet agency needs.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

A-Specify and Standardize Data
2-Treatments and Work

A.2.b – Treatment and Work Location Referencing

Element Description Standardized location referencing for planned and completed work to enable accurate collection, mapping, and integration with other agency data for analysis.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
Treatment or work data associated with the asset do not include location references and are not mappable.	Some treatment or work types are tracked with location referencing but location referencing methods are not consistent across work types or over time.	Consistent standards for location referencing are established for the asset's project or maintenance treatment data types (where applicable), however these standards cannot be readily transformed to the established enterprise location referencing standard.	Consistent standards for location referencing are established for the asset's project or maintenance treatment data types (where applicable) in a manner that can be readily transformed to the agency's enterprise location referencing standard.	The agency's enterprise location referencing standards are in place for all the asset's project and maintenance treatment data types (where applicable).
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Evaluate agency enterprise location referencing standards, identifying methods that best support asset work tracking needs.	☐ Standardize location referencing in a manner that is transformable to the agency enterprise standard.	☐ Standardize location referencing in a manner that is consistent with the agency's enterprise standard.	☐ Integrate asset work tracking data systems, tools, and records with the agency enterprise location referencing system.	
☐ Examine current work accomplishment tracking data standards to identify location referencing methodologies in current use.	☐ Document clear processes and business requirements for transformation of any location referencing methodologies not meeting the enterprise standard.	☐ Develop specifications for useful tools to support accurate identification of location based on current location referencing system definitions.	☐ Routinely evaluate the agency location referencing systems to ensure alignment with treatment and work tracking needs.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

A-Specify and Standardize Data
2-Treatments and Work

A.2.c – Process Documentation and Management

Element Description Established and documented responsibilities and business processes for updating asset information as assets are installed, maintained, upgraded, and replaced or removed.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
Business processes for updating asset inventory, condition and work history information are ad-hoc and undocumented.	Business processes for updating asset information are established but not yet documented.	Business processes for updating asset information are documented in a general fashion based on a standard practice. Documentation is not shared in a consistent, highly visible and accessible place.	Business processes for updating asset information are documented in detail and include explicit information on when and how different data entities are created, updated, and deleted or archived. Documentation is stored in a highly visible, accessible place.	Business process documentation for updating asset information includes detailed business rules suitable for monitoring and/or automating data updates and exchange.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Coordinate with field and office staff to identify current asset data updates based on asset work accomplishment.	☐ Develop standard operating procedures relating to primary asset maintenance activities and project types. Include steps for asset data updates.	☐ Augment standard operating procedures to include detailed responsibilities and instructions for asset data updates reflecting work accomplishment.	☐ Document detailed business rules for how individual asset data elements are adjusted based on work data. Establish metrics that can be used to evaluate process execution.	
☐ Coordinate with field and office staff to identify various business practices relating to asset work accomplishment tracking.	☐ Evaluate current business practices to identify where there are significant gaps in asset data updates relating to work accomplishment.	☐ Develop detailed process documentation identifying when various asset data entities are or should be created, updated, deleted, or archived.	☐ Define detailed exchange protocols facilitating automation of asset data updates based on capture of work accomplishment information.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

A-Specify and Standardize Data
3-Resource Allocation and Prioritization

A.3.a – Prioritization Factors

Element Description Use of asset tiers, condition or performance levels, work types or other prioritization factors to support high-level decision-making.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
Investment prioritization factors are not defined for this asset.	General investment prioritization factors have been established for the asset (e.g. functional classification) but do not include key factors of concern to asset managers.	Specific Investment prioritization factors have been established for the asset that address key factors of concern to asset managers. However, they don't address concerns of other key stakeholders or other agency business processes (e.g. safety planning).	Investment prioritization factors have been established that address factors of concern to asset managers as well as concerns of other key stakeholders and other agency business processes.	Investment prioritization factors have been distinguished for both internal asset level decision-making as well as cross-asset or cross-program investment prioritization.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Identify basic geographical, organizational or network information useful in determining how to prioritize needed work on assets.	☐ Expand prioritization factors to include asset specific information such as asset type, utilization, condition category.	☐ Expand prioritization factors to include stakeholder input such as asset performance requirements, or risks, impacts and/or need in other asset or business areas.	☐ Expand prioritization factors to include individual asset contributions to agency goals or objectives (e.g. safety).	
☐ Communicate general expectations for what information should be considered in deciding how work is to be prioritized.	☐ Document a methodology for prioritization factor use in distribution of asset-related resources.	☐ Update resource distribution methodology as appropriate. Document factor use in external investment decisions (e.g. when an asset must/should be included in an unrelated asset improvement or project).	☐ Develop a methodology for calculating prioritization factors that can be used across different programs.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

A-Specify and Standardize Data
3-Resource Allocation and Prioritization

A.3.b – Analysis Parameters

Element Description Established analysis parameters (e.g. asset deterioration and treatment benefit models, treatment unit costs, analysis time horizons) supporting resource allocation analysis and decision-making.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
Analysis is ad-hoc and therefore there is no recognized need for standardizing analysis parameters.	Simple analysis parameters (e.g. unit costs or service life) are standardized to support asset decision-making and resource allocation. These are only useful for general, network-level analysis.	Condition or performance-based analysis parameters (e.g. improvement benefits of various treatment types or asset deterioration models) are standardized to support asset decision-making and resource allocation. These are typically only useful for network-level analysis or rough project-level estimates.	Condition or performance-based analysis parameters are standardized to support asset decision-making and resource allocation. These are useful for both network- and project-level analysis.	Analysis parameters are defined consistently across assets, supporting cross-asset resource allocation analysis.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Identify base parameters supporting estimation of annual needs (e.g. asset service life, typical treatment unit costs, or annual life-cycle maintenance costs).	☐ Expand parameters to support condition or performance based forecasting (e.g. asset deterioration and improvement benefit models).	☐ Work with field asset managers to expand analysis parameters to support individual asset level needs assessment and investment optimization.	☐ Expand analysis parameters to include asset specific contributions to agency goals or objective areas.	
☐ Communicate general expectations for asset-related needs or investment analysis.	☐ Document a methodology for asset needs forecasting.	☐ Document a methodology for application of network-level analysis for project-level, field decisions.	☐ Examine analysis methodologies across different assets and develop a consistent approach to analysis parameter definition (e.g. service life) to enable cross-asset analysis.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

A-Specify and Standardize Data
4-Metadata

A.4.a – Data Dictionary Standards and Guidelines

Element Description Standardized data dictionaries documenting data element definitions, calculation methods, formats and value domains.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
There are no requirements or standards for data dictionaries to document data element definitions.	Data dictionaries may be required for new systems, but data dictionary elements are not standardized beyond those required for technical database design (e.g. field name, data type, format).	Data dictionaries requirements are defined and specifications for key content (field description, allowable values), are defined.	Guidance, training and quality assurance processes are in place to ensure that data dictionaries contain useful information for both business and IT staff and that they are maintained in a known, designated location.	Policies or guidelines for creating and maintaining data dictionaries ensure update as changes to databases are made. They are stored and managed at enterprise level, enabling identification of similar data elements across databases.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Establish basic scope, elements and needs for development of data dictionary content.	☐ Document metadata policy for new IT projects or system enhancements. Define a standard format and required, recommended, and optional fields.	☐ Develop guidance and training to ensure metadata standards meet business and IT needs.	☐ Develop standard operating procedures for maintaining metadata.	
☐ Work with IT and business owners to document data dictionary content for critical asset data.	☐ Work with IT and business owners to document data dictionary content for remaining asset data.	☐ Develop requirements for and implement a standardized metadata repository to store, manage, and provide access to agency metadata.	☐ Improve functionality of metadata repository, enhancing data search and identification functionality.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

A-Specify and Standardize Data
4-Metadata

A.4.b – Dataset Metadata Standards and Guidelines

Element Description Standardized dataset-level metadata documenting dataset contents, collection methods, coverage, and limitations.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
There are no requirements or standards for dataset level metadata documenting dataset contents, collection methods, coverage and limitations.	Dataset-level metadata requirements are defined, however detailed standards for content are not in place or are not consistently defined.	Dataset-level metadata requirements are defined and specifications for key metadata elements are defined.	Guidelines, training and quality assurance processes ensure that dataset level metadata contain useful information for both business and IT staff and that they are maintained in a known, designated location.	Processes are in place to ensure updates to dataset metadata as changes occur. Dataset metadata are stored and managed at enterprise level, supporting creation of data catalogs and data search capabilities.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Establish basic scope, elements and needs for development of dataset level metadata content.	☐ Document dataset metadata policy for new IT projects or system enhancements. Define a standard format and required, recommended, & optional fields.	☐ Develop guidance, training and quality assurance processes to ensure that metadata meets business and IT needs.	☐ Develop metadata standard operating procedures.	
☐ Work with IT and business owners to document dataset level metadata for critical asset datasets.	☐ Work with IT and business owners to document dataset level metadata content for remaining asset datasets.	☐ Develop requirements for and implement a standardized metadata repository to store, manage, and provide access to agency metadata.	☐ Develop easily navigated, searchable data catalogs for the asset and key asset related business processes.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

A-Specify and Standardize Data
5-Governance

A.5.a – Data Stewardship

Element Description Established data governance structures and data stewardship roles.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
No formal data governance structures or specified data stewardship roles and responsibilities for asset data.	Contact people for data related to different assets are generally known, but roles and responsibilities have not been explicitly defined or formalized.	Steering committees or similar structures formed to manage enterprise data systems (e.g. GIS or data warehouses); data stewards with responsibility for asset data in these systems have been designated.	One or more agency data governance bodies has been formed with responsibility for establishing governance processes and stewardship roles. Stewardship roles may have been defined but are not yet implemented.	Data governance bodies are well-established and are actively working to strengthen data management practices in the agency. Data stewards have been designated and are performing their intended functions.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Define base concepts and organization of governance structures, roles, and responsibilities.	☐ Engage business experts and leaders to participate in the governance program.	☐ Define governance bodies with stewardship responsibilities (e.g. data quality accountability, developing curated master data).	☐ Identify an asset steward and system owners. Document clear responsibilities for strengthening governance and data management.	
☐ Engage executives and business management in discussion of governance functions and implementation.	☐ Complete self-assessment and, action planning exercises to identify gaps and prioritize action. Periodically reevaluate.	☐ Establish communities of interest in priority business areas and functions. Capture business needs, terminology, rules, etc.	☐ Implement enterprise systems to manage and provide access to governance products (e.g. a rules engine or glossary repository).	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

A-Specify and Standardize Data
5-Governance

A.5.b – Data Standards & Guidelines Development/Adoption Processes

Element Description Formal processes for the development, review, improvement and adoption of new data standards and guidelines.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
The agency has no data standards or practices for standardizing data elements.	Existing external data standards are considered for new system development, and some internal agency data elements adhere to "de-facto" standards.	Data standardization initiatives have been undertaken and results of these efforts have been disseminated. However, a formal adoption process has not been established.	A formal process for nominating, adopting, and publishing data standards has been established.	Roles, responsibilities and processes have been established to ensure that data standards are being followed and facilitate updates to standards based on experience.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Define processes and formats for creating data standards.	☐ Undertake a pilot effort to create a data standard for a high priority data element (e.g. project ID or location reference).	☐ Define formal processes for nominating, adopting, and publishing data standards.	☐ Incorporate responsibilities for established processes within new or existing governance bodies.	
☐ Document existing external (e.g. federal) data standards and internally used formats and definitions for priority data elements.	☐ Complete self-assessment and, action planning exercises to identify gaps and prioritize action. Periodically reevaluate.	☐ Advance initiatives to create standards for priority data elements.	☐ Organize communities of interest around established standards to ensure they are maintained and implemented.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

A-Specify and Standardize Data
5-Governance

A.5.c – Data Collection Approval / Coordination Practices

Element Description Formal processes for the evaluation, approval, and coordination of new data collection processes - to reduce or eliminate duplicate data collection and ensure that the value of new data collection is maximized.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
Decisions about data collection are made independently by individual business units with little or no coordination.	Decisions about data collection are made independently by individual business units but some level of informal communication and coordination occurs to avoid duplication.	Guidelines for data collection have been created or adopted and disseminated to promote following best practices.	A formal process has been established to evaluate and approve new data collection or acquisition. This process has been applied on a limited basis.	A formal process for evaluating and approving new data collection or acquisition efforts is in place and is being followed.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Establish guidance for data collection decision-making which include coordination to avoid duplication and identify potential added value.	☐ Engage business experts and leaders to participate in data collection best practice initiatives.	☐ Define formal processes for evaluating new data collection or acquisition.	☐ Incorporate responsibilities for established processes within new or existing governance bodies.	
☐ Encourage informal data collection collaboration between business units.	☐ Complete self-assessment and, action planning exercises to identify gaps and prioritize action. Periodically reevaluate.	☐ Provide training to key data collection decision-makers regarding formal processes for new data collection evaluation.	☐ Organize communities of interest around key data collection to ensure the data meet agency needs.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

A-Specify and Standardize Data
5-Governance

A.5.d – Change Control (Systems and Data) Processes

Element Description Formal processes to manage change in data and information systems to ensure that limited resources are effectively leveraged and reduce unanticipated impacts to downstream systems and users.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
Communication about planned or actual changes to data and information systems is limited and downstream consequences of these changes on reports or other systems are not anticipated or planned for.	Communication about changes generally occurs but is not formalized.	Data change management guidelines have been documented but are not always consistently followed.	Formal change control committees are in place and consistently follow established procedures to minimize downstream impacts of database changes.	Change control processes are periodically reviewed and improved based on stakeholder feedback.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Establish guidance for communication regarding planned or actual data or information system changes.	☐ Document policy for communication regarding planned or actual data or information system changes.	☐ Define formal processes for proactively evaluating proposed system or data changes with known stakeholders.	☐ Organize communities of interest around key data and systems. Include change control as recurring topic of discussion.	
☐ Identify primary users of current asset related data and systems.	☐ Identify extended and/or downstream users of current asset related data and systems.	☐ Incorporate responsibilities for established processes within new or existing governance bodies.	☐ Integrate change control processes with a formal, enterprise change management program.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Appendix B: Collect Data Element-Level Response Templates

This Appendix offers element-level response templates for Area B: Collect Data.

Note: Use of the TAM Data Assistant is recommended however these templates are provided for informal use or pen and paper assessment.

Date: **Participating Members:** **Assessment Context:**

B-Collect Data
1-Inventory, Condition, and Performance

B.1.a – Inventory, Condition, & Performance Coverage

Element Description Coverage and level of detail for asset inventory, condition, and/or performance data aligned with current and anticipated business needs and established data models.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
Data are not collected.	Inventory, condition and/or performance data collected to meet a one-time need and not aligned with ongoing data needs.	Established inventory, condition and/or performance data collection practices, but not fully in line with business needs (coverage is either insufficient or overly detailed) and/or not aligned with the established data model.	Established inventory, condition and/or performance data collection practices in line with current business needs and data model.	Regular strategic planning process to anticipate emerging needs and adjustment of data collection scope to meet these new needs.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Determine whether asset inventory, condition, and/or performance data collection is warranted (establish the business case).	☐ Work with stakeholders to understand data requirements to meet decision support needs.	☐ Review existing data collection plans and assess whether the data are being used as intended and providing value and whether there are remaining gaps to consider. Confirm the business case and value of new data collection with key stakeholders.	☐ Conduct an annual or bi-annual review of data collection plans to ensure alignment with current and emerging business needs.	
☐ Examine existing data and data collection programs for potential efficiencies.	☐ Confirm the business case for new data collection and establish a “best practical” collection scope based on current capabilities and funding.	☐ Review existing data collection plans for consistency with established data model. Consider modifications to achieve consistency.	☐ Examine opportunities to “optimize” collection scope. If warranted, engage stakeholders to adjust data model for future needs.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

B-Collect Data
1-Inventory, Condition, and Performance

B.1.b – Inventory, Condition, and Performance Automation

Element Description Efficient and effective use of technology for asset data collection (such as sensing technology, video, LiDAR, field collection tools)

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
Primarily pen/paper collection.	Collection in digital form but through largely manual processes that could be further automated (e.g. stand-alone, electronic forms or spreadsheets).	Data collection using primarily automated/semi-automated techniques. (e.g. custom applications with GPS location detection, voice recognition, bar codes / QR codes)	Data collection using primarily automated / semi-automated techniques with capabilities to efficiently adapt tools to meet varied data collection requirements across multiple data collection business processes or asset types.	Application of state-of-the-art computer vision and change-detection techniques for data extraction and efficient updating.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Document business cases for automation through internal practice, peer agency, and best practice reviews.	☐ Pilot and implement a vehicle-based data collection solution for individual assets (e.g. video imagery extraction)	☐ Pilot and implement vehicle-based data collection solutions for multiple assets (e.g. video image collection / LiDAR)	☐ Use change detection to automate and/or focus collection. Leverage changes in base inventory, work accomplishments, condition forecasting, and other techniques to eliminate or reduce collection in low value areas.	
☐ Implement simple solutions to move away from pen & paper collection (e.g. digital forms or spreadsheet tools)	☐ Pilot and implement semi-automated field collection tools (e.g. mobile data collection applications)	☐ Pilot and implement field collection tools useful for multiple data collections (e.g. standardized apps or enterprise asset management system tools)	☐ Conduct periodic evaluation and pilot testing of cutting-edge applications or capabilities to asset data collection programs. Implement identified collection solutions as appropriate.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

B-Collect Data
1-Inventory, Condition, and Performance

B.1.c – Inventory, Condition, and Performance Quality

Element Description Established processes to assess and improve asset inventory, condition and performance data quality.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
Quality is not defined.	Expectations for data accuracy, valid values and completeness are established.	A plan has been produced including activities and roles for data quality management before, during and after data collection.	Formal data collector certification and data acceptance criteria and processes are in place.	Data collection and quality management processes are regularly reviewed and revised based on prior experience.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Establish general data collection requirements (e.g. conditions appropriate for collection)	☐ Develop a data quality management plan, including documented quality management activities and roles.	☐ Establish formal data collection training and collector certification processes.	☐ Automate data quality checks to streamline quality management process and ensure consistency of quality review.	
☐ Document business rules for evaluation of accuracy, completeness, and validity of collected data.	☐ Evaluate data collection best practices and lessons learned from other internal and external data collection programs.	☐ Document a comprehensive collection business process with clear data acceptance criteria and error resolution procedures.	☐ Incorporate outcomes from quality control and assurance processes and routine evaluation of lessons learned to prevent systemic errors and improve ongoing collection processes.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

B-Collect Data
2-Project Information

B.2.a – Project Information Coverage

Element Description Processes to capture project work accomplishment information in a manner consistent with the project data model and with sufficient coverage to meet asset management analysis, decision-making, reporting, and communications needs.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
Project work accomplishment data is not available in a useful form for asset management.	Project work accomplishment data is collected to support non-asset management purposes (e.g. contract payment) in a manner that is only useful to asset management for aggregate, network-level summary reporting.	Project work accomplishment data is collected in a manner that provides an understanding of what types of work have been completed at particular locations.	Project work accomplishment data collection includes associated asset information in a format that is useful to management and upkeep of the asset inventory or condition history.	Project work accomplishment data collection includes detailed asset related information (e.g. products / component models or standards, specific treatment materials) useful for detailed asset management decision-making and project design improvement.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Evaluate and implement opportunities to summarize general project information useful to high-level asset decision-making or reporting (e.g. annual investment levels or quantities).	☐ Implement a data collection plan to capture project locations and general activities performed within those limits (e.g. preventative maintenance, rehabilitation, or replacement).	☐ Implement a data collection plan to capture individual asset locations/IDs and associated work activities, accomplishments and results.	☐ Implement a data collection plan which captures detailed asset information from work activities / accomplishments (e.g. specific materials, products, or applications).	
☐ Document general asset management use cases for project information.	☐ Establish a "best practical" collection scope based on current capabilities and funding.	☐ Examine current practices to "right size" collection scope to meet current needs and established data model.	☐ Examine best practices to "optimize" collection scope. If warranted, engage stakeholders to adjust data model for future needs.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

B-Collect Data
2-Project Information

B.2.b – Project Information Automation

Element Description Processes and technologies used to automate collection and processing of project work accomplishment data.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
Pen/paper collection	Stand-alone, standardized electronic forms or spreadsheets are used to facilitate collection. Data are not automatically populated into the source system of record.	Data collection using primarily automated/semi-automated techniques through specialized solutions (e.g. custom applications with GPS location detection, voice recognition, bar codes / QR codes).	Data collection using primarily automated / semi-automated techniques with capabilities to efficiently adapt tools to meet varied data collection requirements across multiple data collection business processes or asset types.	Application of state-of-the-art computer vision and change-detection techniques for data extraction and efficient updating.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Document business cases for project data collection automation through internal practice, peer agency, and best practice reviews.	☐ Pilot and implement semi-automated field collection tools (e.g. mobile data collection applications) for project data.	☐ Pilot and implement field collection tools useful for multiple data collections (e.g. standardized apps or enterprise asset management system tools)	☐ Use change detection to automate and/or focus collection of project work accomplishment data	
☐ Implement simple solutions to move away from pen & paper collection of project data (e.g. digital forms or spreadsheet tools).	☐ Evaluate opportunities to pre-populate high-level activity or asset information based on contract or design information.	☐ Evaluate opportunities to pre-populate detail asset or work accomplishment data based on contract or design information.	☐ Conduct periodic evaluation and pilot testing of cutting edge project data collection applications or capabilities. Implement solutions as appropriate.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

B-Collect Data
2-Project Information

B.2.c – Project Information Quality

Element Description Established processes to assess and improve project data quality

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
Quality is not defined.	Expectations for data accuracy, valid values and completeness are established.	A plan has been produced including activities and roles for data quality management before, during and after data collection.	Formal data collector certification and data acceptance criteria and processes are in place.	Data collection and quality management processes are regularly reviewed and revised based on prior experience.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Establish general project data collection requirements (e.g. conditions appropriate for collection).	☐ Develop a data quality management plan, including documented quality management activities and roles for project data.	☐ Establish formal project data collection training and collector certification processes.	☐ Automate data quality checks to streamline quality management process and ensure consistency of quality review of project data.	
☐ Document business rules for evaluation of accuracy, completeness, and validity of collected project data.	☐ Evaluate project data collection best practices and lessons learned from other internal and external data collection programs.	☐ Document comprehensive collection business processes with clear data acceptance criteria and error resolution procedures for project data.	☐ Incorporate outcomes from quality control and assurance processes and routine evaluation of lessons learned to prevent systemic errors and improve ongoing collection processes.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

B-Collect Data
3-Maintenance Information

B.3.a – Maintenance Information Coverage

Element Description Processes to capture maintenance activity information in a manner consistent with the work order data model and with sufficient coverage to meet asset management analysis, decision-making, reporting, and communications needs.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
Data on work orders is not consistently available and/or is not collected in a standardized fashion.	Work order and maintenance contract data are collected to support non-asset management purposes (e.g. contract payment) in a manner that is only useful to asset management for aggregate, network-level summary reporting.	Work order and maintenance contract data are collected in a manner supporting understanding of activities performed at individual work locations.	Work order and maintenance contract data collection includes associated asset information in a format that is useful to management and upkeep of the asset inventory or condition history.	Work order and maintenance contract data collection includes detailed asset related information (e.g. products / component models or standards, specific treatment materials) useful for detailed asset management decision-making and project design improvement.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Evaluate and implement opportunities to summarize work order information useful to high-level asset decision-making or reporting (e.g. annual investment levels or quantities).	☐ Implement a data collection plan to capture work order locations and general activities performed within those limits (e.g. preventive maintenance, minor repairs)	☐ Implement a data collection plan which captures individual asset locations/IDs and associated work activities and accomplishments.	☐ Implement a data collection plan which captures detailed asset information from work activities / accomplishments (e.g. specific materials, products, or applications).	
☐ Document general needs and uses for work order information.	☐ Establish a "best practical" collection scope based on current capabilities and funding for work order collection.	☐ Examine current practices to "right size" collection scope to meet current needs and established data model.	☐ Examine best practices to "optimize" work order collection scope. If warranted, engage stakeholders to adjust data model for future needs.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

B-Collect Data
3- Maintenance Information

B.3.b – Maintenance Information Automation

Element Description Processes and technologies used to automate collection and processing of maintenance activities, work orders, and work accomplishment data.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
Pen/paper collection	Stand-alone, standardized electronic forms or spreadsheets are used to facilitate collection. Data are not automatically populated into the source system of record.	Data collection using primarily automated/semi-automated techniques through specialized solutions (e.g. custom applications with GPS location detection voice recognition, bar codes / QR codes).	Data collection using primarily automated / semi-automated techniques with capabilities to efficiently adapt tools to meet varied data collection requirements across multiple data collection business processes or asset types.	Application of state-of-the-art computer vision and change-detection techniques for data extraction and efficient updating.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Document business cases for automation of work order data collection through internal practice, peer agency, and best practice reviews.	☐ Pilot and implement semi-automated field collection tools (e.g. mobile data collection applications) for work order data collection.	☐ Pilot and implement field collection tools useful for multiple data collections (e.g. standardized apps or enterprise asset management system tools).	☐ Use change detection to automate and/or focus collection of work order and/or maintenance work accomplishment data.	
☐ Implement simple solutions to move away from pen & paper collection (e.g. digital forms or spreadsheet tools) for work order data collection.	☐ Evaluate opportunities to pre-populate high-level activity or asset information based on work order or contract/task information.	☐ Evaluate opportunities to pre-populate detailed asset or work accomplishment data based on work order or contract/task information.	☐ Conduct periodic evaluation and pilot testing of cutting-edge data collection applications or capabilities. Implement solutions as appropriate.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

B-Collect Data
3-Maintenance Information

B.3.c – Maintenance Information Quality

Element Description Processes to assess and improve maintenance activity and cost data quality.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
Quality is not defined.	Expectations for data accuracy, valid values and completeness are established.	A plan has been produced including activities and roles for data quality management before, during and after data collection.	Formal data collector certification and data acceptance criteria and processes are in place.	Data collection and quality management processes are regularly reviewed and revised based on prior experience.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Establish general data collection requirements (e.g. conditions appropriate for collection) for maintenance.	☐ Develop a data quality management plan, including documented quality management activities and roles for maintenance data.	☐ Establish formal data collection training and collector certification processes for maintenance data.	☐ Automate data quality checks to streamline quality management process and ensure consistency of quality review of maintenance data.	
☐ Document business rules for evaluation of accuracy, completeness, and validity of collected maintenance data.	☐ Evaluate maintenance data collection best practices and lessons learned from other internal and external data collection programs.	☐ Document a comprehensive collection business process with clear data acceptance criteria and error resolution procedures for maintenance data.	☐ Incorporate outcomes from quality control and assurance processes and routine evaluation of lessons learned to prevent systemic errors and improve ongoing collection processes.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

B-Collect Data
4-Priority Criteria and Values

B.4.a – Public Perception

Element Description Capture and use of information about how the public perceives different conditions, treatment options, or other TAM related factors.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
Public perception data is not captured.	Public perception is generally evaluated against internal thresholds established through expert opinion (e.g. minimum program or service standards set based on internal DOT input).	Customer complaints or requests related to asset condition and service are compiled, but there is no specific guidance on how this information should be used.	Public perception information is gathered through proactive methods, and there are clear expectations for how this input will be used.	Public perception information is gathered through proactive methods that are coordinated across assets and program areas. Processes for considering and resolving conflicting perspectives are in place.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Define customer-oriented service levels and minimum expectations for asset related programs and services through expert opinion.	☐ Implement a data collection plan to track complaints, work requests, or other reactive metrics of public perception.	☐ Implement a data collection plan to use proactive methods of gathering general public perceptions of asset condition and service (e.g. surveys or opinion polls.)	☐ Implement a data collection plan to capture detailed information (e.g. thru focus groups) to expand upon general public perception data.	
☐ Evaluate asset related program and service levels against expectations. Flag if minimum levels are not met.	☐ Develop agency or program-level guidance on approaches to capturing public perceptions to support asset-related decision-making.	☐ Define how public perception data will be incorporated into asset-related decision-making.	☐ Document processes to resolve conflicting perspectives or input received through public engagement.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

B-Collect Data
4-Priority Criteria and Values

B.4.b – Decision Maker Values

Element Description Capture and use of information about how DOT decision-makers (at both program and executive levels) perceive and value different asset performance levels, management strategies, or other factors.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
DOT asset program managers and executives don't engage in discussions about the impacts of different asset performance levels.	DOT asset program managers and executives informally discuss impacts of different asset performance levels.	DOT asset program managers and executives have regular (annual or quarterly) meetings to review current and projected asset performance levels and discuss funding priorities.	DOT asset program manager and executive values and preferences are captured in a quantitative fashion (e.g. through stated preference or scoring methods).	Decision-maker values are captured in a quantitative fashion that supports cross-asset / cross-program resource distribution and/or investment prioritization.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Organize informal meetings to discuss impacts of different asset performance levels.	☐ Set up regular meetings to review asset performance and discuss priorities.	☐ Research alternative methods for quantifying decision maker values and preferences.	☐ Research alternative methods for cross-asset / cross program resource allocation or investment prioritization.	
☐ Identify and document key decision maker concerns and tradeoffs.	☐ Compile data that helps decision makers assess the implications of different performance levels (e.g. pavement roughness impacts on vehicle operating costs)	☐ Set up peer-to-peer discussions with agencies that have successfully applied methods for quantifying decision maker values and preferences.	☐ Pilot test available tools for cross-asset /cross-program resource allocation or investment prioritization.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Appendix C: Store, Integrate, and Access Data Element-Level Response Templates

This Appendix offers element-level response templates for Area C: Store, Integrate, and Access Data

Note: Use of the TAM Data Assistant is recommended however these templates are provided for informal use or pen and paper assessment.

Date: **Participating Members:** **Assessment Context:**

C-Store, Integrate, and Access Data
1-Databases

C.1.a – Efficient Storage

Element Description Data storage methods that enable and facilitate efficient data access, analysis and transformation.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
Asset inventory, condition and work information are primarily in paper form - not digitized.	Asset inventory, condition and work information is digital but stored in disparate database types and locations.	Most databases with asset inventory, condition and work information are stored on a server and can be accessed and managed centrally.	Materialized views and automated transformations are used to provide efficient access to data of interest.	Information is stored for efficient access by leveraging cloud-based options (as appropriate).
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Work with information technology staff to examine current practices and identify database solutions aligned with business need and agency recommended practices.	☐ Identify and implement source systems of record for storage of asset inventory, condition, and work data.	☐ Eliminate duplicate data by providing curated authoritative data for analysis and reporting.	☐ Work with information technology staff to identify needs and solutions for cloud-based data storage.	
☐ Migrate asset data from paper to simple database formats. Store locally or on central servers if no formal system of record is available.	☐ Develop and execute a migration plan for paper, decentralized, and/or locally stored data desired for ongoing retention and use.	☐ Work with information technology staff to incorporate anticipated future asset data, systems, and analysis tools in the enterprise architecture.	☐ Implement cloud data storage solutions as appropriate to provide optimized and efficient access for internal and external users.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

C-Store, Integrate, and Access Data
1-Databases

C.1.b – Database Linkages

Element Description Data integration to facilitate analysis and reporting requiring use of multiple data sources.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
There are no established linkages across different databases that store asset information.	Data across different databases can be linked based on standard location references.	Data across different databases can be linked based on shared asset, project, and/or work order identifiers.	Processes are in place to update location references and IDs as changes occur to the agency's authoritative sources for these data elements.	Roles and responsibilities have been established to ensure that databases are designed to enable efficient integration to support analysis and reporting.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Standardize location referencing within asset databases.	☐ Review existing location, asset, project, and work order identifiers with asset SMEs. Flag inconsistences across programs and processes.	☐ Integrate authoritative sources for location, asset, project, and work order information with asset databases.	☐ Assign roles and responsibilities for identifying and updating integration requirements for asset databases, systems, and tools.	
☐ Review existing location, asset, project, and work order identifiers with asset subject matter experts (SMEs). Flag inconsistencies within individual programs or processes.	☐ Standardize use of asset, project, and work order unique identifiers within asset databases.	☐ Develop processes to ensure location referencing and unique identifiers are maintained against authoritative data sources.	☐ Proactively identify asset management business needs for data integration and translate these needs into data, application and technology architecture requirements.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

C-Store, Integrate, and Access Data
1-Databases

C.1.c – Document Linkages

Element Description Processes and technologies for linking documents to assets, projects, and locations.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
Documents related to specific assets or projects may be filed in folders for the asset or project but are not directly linked through metadata or other methods.	Selected document types can be linked to associated assets, projects, and locations. Approaches may vary across document types or systems.	Standardized approaches are used to connect documents to assets, projects, locations but there are no established business processes or roles to ensure execution.	An electronic document management system is integrated with asset management, project management, location referencing systems and tools. Business processes and roles for document management are documented, but may not be monitored.	An electronic document management system is integrated with asset management, project management, location referencing systems and tools. Business processes are documented and monitored to ensure application.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Review existing document standards and metadata with asset Subject Matter Experts (SMEs). Flag opportunities to incorporate linkages to assets, projects and locations within individual processes.	☐ Review existing document standards and metadata with asset SMEs. Flag opportunities to incorporate linkages across processes and programs.	☐ Develop an electronic document management system with defined metadata providing linkages for priority documentation.	☐ Document and apply detailed document metadata business rules useful in flagging documentation that has been improperly tagged.	
☐ Take advantage of available document management systems to establish metadata elements for asset ID, project ID and location.	☐ Standardize use of asset, project, work order unique identifiers and location referencing within key asset related documentation.	☐ Document business processes, roles and responsibilities for applying standard metadata during document creation and/or update.	☐ Routinely evaluate document metadata practices to ensure they are meeting business needs.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

C-Store, Integrate, and Access Data
1-Databases

C.1.d – Data Storage Capacity

Element Description Processes to provide sufficient storage capacity to meet current and likely future needs, considering collection of imagery, LiDAR, backups, archiving, and other data storage requirements.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
Data storage needs are not systematically assessed, and requests for additional storage are not reliably met.	Data storage requirements are evaluated as part of new information system development processes, but space requirements are not routinely reassessed after initial system deployment.	A process exists for business areas to request additional storage to meet needs related to growth in data or new data collection efforts.	The organization has a data storage management strategy that includes considerations of retention, backup requirements, structured and unstructured data, disaster recovery, etc. based on current needs.	The organization has a forward-looking data storage management strategy that includes considerations of retention, backup requirements, structured and unstructured data, disaster recovery, etc. based on current and future needs. Strategy includes tactics to manage costs in alignment with needs (e.g. tiered storage, appropriate use of cloud vs. on premise). Strategy is aligned with and actively managed in coordination with the business.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Establish requirements for data storage requirement evaluation as part of new IT system planning & development.	☐ Establish process for system owners and/or business leads to request additional storage capacity.	☐ Create a five year, forward looking data storage plan in collaboration with IT and business leads.	☐ Develop a data storage management strategy that examines and quantifies risks and identifies data storage solutions aligned with risk tolerance and budget.	
☐ Examine and document IT process for securing additional storage capacity.	☐ Communicate lead time required for IT to reliable meet legitimate requests for additional data storage.	☐ Investigate and incorporate targeted cloud storage applications.	☐ Document a comprehensive cloud storage policy and associated storage solutions. Integrate cloud storage tactics in broader strategy.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

C-Store, Integrate, and Access Data
2-Asset Life-Cycle Data Integration Workflows

C.2.a – Asset Management Data to Project or Work Order

Element Description Established data flows from asset management systems to maintenance work order systems or project development systems.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
No defined data flow between asset management systems and/or scoping and project development.	Data views are defined to facilitate access to, and review of, asset inventory, condition, and analysis information. This data is presented in a manner intended for use in downstream project scoping activities.	Simple data flows are implemented, allowing pre-population of key administrative and project-level information (e.g. asset identifiers, recommended project/activity, project limits) into base project scoping documents.	More detailed data flows are implemented, allowing individual assets and/or activity details to be pre-populated into the project scoping documents.	Asset management system information automatically flows into maintenance management/ project planning systems.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Develop standard views or reports to expose asset inventory, condition, and analysis information for use in project scoping processes.	☐ Transform key data stored in asset systems to support direct integration of information into project scoping products.	☐ Transform detailed data stored in asset systems to support direct integration of asset and activity details into project scoping products.	☐ Transform detail data stored in asset systems to support direct and complete integration into project scoping products.	
☐ Engage Subject Matter Experts (SMEs) from asset management and project planning and scoping to identify opportunities for improved coordination.	☐ Pilot test and implement simple, manual or semi-automated data integrations. Provide quality assessment tools to support informed data use.	☐ Pilot test and implement batch processes to transfer data. Integrate quality assessment tools to ensure appropriate data use.	☐ Pilot test and implement fully automated processes to transfer data. Integrate quality assessment tools to ensure appropriate data use.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

C-Store, Integrate, and Access Data
2-Asset Life-Cycle Data Integration Workflows

C.2.b – Project Planning to Project Development

Element Description Established data flows from project planning (scoping) to project development. Consider both maintenance/operations activities and construction projects.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
No defined data flow between project planning and/or scoping and project development.	Data views are defined to facilitate access to, and review of, planning and scoping information. This data is presented in a manner intended for use in downstream design and/or project development activities.	Simple data flows are implemented, allowing pre-population of key administrative and project-level information (e.g. project identifiers, project/activity type, project limits) into base project, work order, or design documents.	More detailed data flows are implemented, allowing individual assets and/or activity details (such as work location, scope, estimated cost, and schedule milestones) to be pre-populated into the project, work order, and/or design documents.	Planning/scoping information automatically populates contract and design documents. Project development activities, participants, and/or documentation are automatically populated as appropriate to the scope.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Develop standard views or reports to expose planning and scoping information for use in project development activities.	☐ Transform key data stored in scoping and planning systems to support integration of data into project development products.	☐ Transform detailed data stored in scoping and planning systems to support integration of information into project development products.	☐ Assess and refine existing data flows to include additional detail (or reduce detail). Develop specifications for direct and complete integration of planning / scoping details into project development products.	
☐ Engage Subject Matter Experts (SMEs) from planning and development to identify opportunities for improved coordination.	☐ Pilot test and implement simple, manual or semi-automated data integrations. Provide quality assessment tools to support informed data use.	☐ Pilot test and implement batch processes to transfer data. Integrate quality assessment tools to ensure appropriate data use.	☐ Pilot test and implement fully automated processes to transfer data. Integrate quality assessment tools to ensure appropriate data use.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

C-Store, Integrate, and Access Data
2-Asset Life-Cycle Data Integration Workflows

C.2.c – Project Development to Project Delivery

Element Description Established data flows from project development to project delivery. Consider both maintenance/operations activities and construction projects.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
No defined data flow between project development and project delivery/construction.	Data views are defined to facilitate access to, and review of, project development information. This data is presented in a manner intended for use in downstream project delivery / construction activities.	Simple data flows are implemented, allowing pre-population of key administrative and project-level information (e.g. project identifiers and limits, bid items and charge codes, general work activities) into base project delivery tools and systems.	More detailed data flows are implemented, allowing individual assets and/or activity details to be pre-populated into the project delivery tools and systems, including asset acceptance inspection systems and work accomplishment tracking tools.	Design information automatically populates delivery/construction information. Work accomplishment information is largely pre-populated based on design documents to facilitate direct acceptance or modification with limited data entry.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Develop standard views or reports to expose design information for use in project delivery (e.g. acceptance inspection or payment).	☐ Transform key data stored in design systems/documents to support integration into project delivery processes.	☐ Transform detailed data stored in design systems/documents to support integration into project delivery processes.	☐ Assess and refine existing data flows to include additional detail (or reduce detail). Develop specifications for direct and complete integration into project delivery processes.	
☐ Engage Subject Matter Experts (SMEs) from project development and delivery to identify opportunities for improved coordination.	☐ Pilot test and implement simple, manual or semi-automated data integrations. Provide quality assessment tools to support informed data use.	☐ Pilot test and implement batch processes to transfer data. Integrate quality assessment tools to ensure appropriate data use.	☐ Pilot test and implement fully automated processes to transfer data. Integrate quality assessment tools to ensure appropriate data use.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Data and Information Systems for Transportation Asset Management

Assessment Notes:	Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

C-Store, Integrate, and Access Data
2-Asset Life-Cycle Data Integration Workflows

C.2.d Project Delivery to Asset Management Data

Element Description Established data flows from project delivery to asset management systems to ensure up-to-date, accurate inventory, condition, and work history information. Consider both maintenance/operations activities and construction projects.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
No defined data flow between project delivery/construction and asset inventory, condition, performance and work history databases.	Data views are defined to facilitate access to, and review of, as-built or inspection information. This data is presented in a manner intended for easier review and update into asset management systems and/or databases.	Simple data flows are implemented, allowing pre-population of key administrative and project-level information (e.g. project identifiers and limits, asset identifiers, general work activities) into asset databases for more detailed attribution or update.	More detailed data flows are implemented, allowing individual assets and/or activity details to be pre-populated into the asset databases, allowing most data to be pre-populated prior to finalization.	Delivery/construction information automatically flows to asset management systems.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Develop standard views or reports to expose project delivery (e.g. acceptance inspection) information for review in asset data update.	☐ Transform key data stored in as-built or inspection systems / documents to support integration into asset databases.	☐ Transform detailed data stored in as-built or inspection systems / documents to support integration into asset databases.	☐ Assess and refine existing data flows to include additional detail (or reduce detail). Develop specifications for direct and complete integration into asset databases.	
☐ Engage Subject Matter Experts (SMEs) from project delivery and asset management to identify opportunities for improved coordination.	☐ Pilot test and implement simple, manual or semi-automated data integrations. Provide quality assessment tools to support informed data use.	☐ Pilot test and implement batch processes to transfer data. Integrate quality assessment tools to ensure appropriate data use.	☐ Pilot test and implement fully automated processes to transfer data. Integrate quality assessment tools to ensure appropriate data use.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

C-Store, Integrate, and Access Data
3-Other Data Integration Workflows

C.3.a – Financial (Revenue, Budget, Expenditure) Data

Element Description Established data flows from financial systems to systems used for asset management, work planning and tracking.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
No defined data flow between asset management systems and financial systems.	Data views are defined to facilitate access to, and review of, financial data supporting asset management decision-making. This data is presented in a manner intended for use in asset improvement optimization and selection, work planning and tracking.	Simple data flows are implemented, allowing pre-population of current budget limits into asset management optimization analysis and/or work planning tools.	More detailed data flows are implemented, allowing current budget limits, total expenditures, remaining funds, and future funding forecasts to be pre-populated by discrete fund, project, or work categories into asset management optimization analysis and/or work planning tools.	Budget and expenditure information automatically flows to systems used for asset management, work planning and tracking. Updated information is available in real time or updated on a daily basis.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Develop standard views or reports to expose financial data for use in asset management processes.	☐ Summarize data stored in financial systems to support integration into optimization and work planning tools.	☐ Transform detailed financial system data to support integration into optimization and work planning tools.	☐ Assess existing data flows and identify refinements to include additional detail (or reduce detail). Develop specifications for direct integration into optimization and work planning tools.	
☐ Engage Subject Matter Experts (SMEs) from asset management and financial business units to identify opportunities for improved coordination.	☐ Pilot test and implement simple, manual or semi-automated financial data integrations. Provide quality assessment tools to support informed data use.	☐ Pilot test and implement batch processes to transfer financial data. Integrate quality assessment tools to ensure appropriate data use.	☐ Pilot test and implement fully automated processes to transfer financial data. Integrate quality assessment tools to ensure appropriate data use.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

C-Store, Integrate, and Access Data
3-Other Data Integration Workflows

C.3.b – Demand and/or Utilization Data

Element Description Established data flows from travel demand, travel monitoring systems, or other systems quantifying demand or utilization to systems used for asset management decision support.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
No defined data flow between asset management systems and travel demand or utilization data systems.	Data views are defined to facilitate access to, and review of, demand/utilization data supporting asset management decision-making. This data is presented in a manner intended for use in asset improvement optimization, prioritization, and planning, and asset communication and reporting.	Simple data flows are implemented, allowing processing of current demand or utilization against specific assets or network segments.	More detailed data flows are implemented, facilitating useful prioritization and/or risk evaluation within asset management decision-making systems, tools, and analysis.	Travel demand and utilization information automatically flows to systems used for asset management decision support.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Identify travel demand or facility/service utilization data useful to asset management. Develop standard views or reports.	☐ Summarize demand and/or utilization data to support asset prioritization and improvement decision. Directly integrate these into asset systems / tools.	☐ Examine asset risk and prioritization evaluation needs. Transform key demand / utilization data and directly integrate for these purposes.	☐ Examine real-time decision-making priorities and needs. Transform detailed demand / utilization data and directly integrate for these purposes.	
☐ Engage Subject Matter Experts (SMEs) from asset management and travel demand or facility / service utilization data producers to identify opportunities for improved coordination.	☐ Pilot test and implement manual or semi-automated demand data / utilization integrations. Provide quality assessment tools to support informed data use.	☐ Pilot test and implement batch processes to transfer demand / utilization data. Integrate quality assessment tools to ensure appropriate data use.	☐ Pilot test and implement fully automated processes to transfer demand / utilization data. Integrate quality assessment tools to ensure appropriate data use.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

C-Store, Integrate, and Access Data
3-Other Data Integration Workflows

C.3.c – Environmental Data

Element Description Established data flows from environmental information systems to systems used for asset management decision support

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
No defined data flow from environmental data systems to asset management and project development systems.	Data views are defined to facilitate access to, and review of, environmental data supporting asset management and project development. Data is presented for use in asset improvement optimization and selection, work planning, and project scoping and development.	Simple data flows are implemented, allowing processing of available environmental data against specific assets or network segments in a manner that is useful to asset improvement selection and/or project scoping and development.	More detailed data flows are implemented, facilitating prioritization and/or risk evaluation within asset management decision-making systems, tools, and analysis.	Detailed environmental data automatically flows to systems used for asset management and/or project scoping and development.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Identify environmental data useful to asset management. Develop standard views or reports.	☐ Summarize environmental data to support improvement selection and project development. Directly integrate into asset systems / tools.	☐ Examine detailed project development and asset management process and risk evaluation needs. Transform key environmental and directly integrate for this purposes.	☐ Examine real-time decision-making priorities and needs. Transform detailed environmental data and directly integrate for these purposes.	
☐ Engage Subject Matter Experts (SMEs) from asset management, project development, and environmental units to identify opportunities for improved coordination.	☐ Pilot test and implement manual or semi-automated environmental data integrations. Provide quality assessment tools to support informed data use.	☐ Pilot test and implement batch processes to transfer environmental data. Integrate quality assessment tools to ensure appropriate data use.	☐ Pilot test and implement fully automated processes to transfer environmental data. Integrate quality assessment tools to ensure appropriate data use.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

C-Store, Integrate, and Access Data
4-Data Access

C.4.a – Field Access to Data

Element Description Technologies, data structures and processes to enable access to agency asset and work management system data from the field.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
Field staff are not equipped with mobile technology.	Field staff are equipped with laptops and can bring copies of needed files to the field - no data connectivity.	Field staff are equipped with mobile devices with data connections capable of retrieval only.	Field staff are equipped with mobile devices capable of two-way connectivity with the ability to retrieve and send information to office systems.	Next generation technology is used in field business processes. Examples include tools allowing hands free retrieval and sending of data, real-time remote assistance, 3D/4D/5D visualization of data, or visualization as part of an Augmented or Virtual Reality (AR/VR) experience.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Provide basic computer and internet access at base field offices or locations.	☐ Identify positions requiring mobile computing. Provide smart phones, tablets, and/or laptops (consider mobile data plans as appropriate).	☐ Identify positions requiring mobile computing with data connectivity. Provide smart phones, tablets, and/or laptops (include mobile data plans, if data connectivity is needed).	☐ Provide seamless access across firewall and in the field for all asset (and related) data, systems, and tools.	
☐ Develop budget for supplying mobile devices to field staff. Consider Bring-Your-Own-Device (BYOD) policies.	☐ Develop mobile friendly views of key asset information (e.g. asset inventory, work recommendations or history).	☐ Develop comprehensive mobile solutions for key systems, tools, analysis, and information. Support real-time field data update and creation.	☐ Explore and pilot next generation mobile tools that can support asset business processes. Implement as appropriate.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

C-Store, Integrate, and Access Data
4-Data Access

C.4.b – Public Access to Data

Element Description Technologies, data structures and processes to enable public access to agency condition and asset performance information and planned projects.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
A publicly accessible repository of asset/project information does not exist.	A website is available with contact information.	A website is available with summary data and some downloadable data, reports, or reference materials.	A website with a dashboard is available to reflect project level performance metrics and comparison to project goals, updated periodically.	A website with a dashboard is available to reflect performance metrics and comparison to organization goals, updated in near real time.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Develop public facing website providing general overview of asset related programs and contacts.	☐ Provide access to public facing data, reports, and supporting materials through program website(s).	☐ Develop and share asset performance metrics, targets, and other information through a public facing dashboard.	☐ Implement data and system integrations to provide near real time updates of asset data shared in the public dashboard.	
☐ Examine agency public facing website and identify appropriate locations to share or link asset specific website(s).	☐ Develop a public data portal where curated data and reports can be uploaded for public access.	☐ Develop messaging and materials to share context for asset performance with public. Upload to public website(s).	☐ Develop messaging and materials to relate asset performance with overarching organization goals. Upload to public website(s).	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

C-Store, Integrate, and Access Data
4-Data Access

C.4.c – Access Security

Element Description Management of access to asset and project data to ensure data security and the proper flow of information.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
Available digital data is not access-restricted.	Access is managed on an ad-hoc, basis, with no designated responsibilities or accountability.	Roles and accountabilities for granting access have been established, but without clear policies or guidance.	Access is managed based on established roles and documented policies and protocols.	Access is managed using role-based authentication within business systems. Single sign on is used to minimize separate logins and centralize management of credentials.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Audit access controls in place for key asset data, systems, and tools. Identify system improvements.	☐ Document general processes and procedures for authorizing access to key asset data, systems, and tools.	☐ Document clear procedures and associated responsibilities for authorizing access to asset data, systems, and tools.	☐ Develop an access request / management system to support efficient processing and tracking of access requests.	
☐ Conduct a risk assessment to prioritize implementation of access controls.	☐ Identify typical system roles and users. Document general roles and responsibilities for authorizing access.	☐ Designate and train individuals who will be responsible for managing access.	☐ Provide single sign on functionality for asset related data, systems, and tools.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Appendix D: Analyze Data Element-Level Response Templates

This Appendix offers element-level response templates for Area D: Analyze Data.

Note: Use of the TAM Data Assistant is recommended however these templates are provided for informal use or pen and paper assessment.

Date: **Participating Members:** **Assessment Context:**

D-Analyze Data
1-Data Exploration, Reporting and Visualization

D.1.a – Analysis Environment

Element Description Creation and maintenance of data processing, analysis and reporting environments (e.g. staging areas, data warehouses, data marts, data lakes).

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
No central data analysis environments have been set up.	Data from different sources is brought together into a central platform for access; with little or no transformation or summarization.	Data are transformed in a limited fashion and made available for analysis; additional data manipulation is required to meet specific analysis needs.	Data are transformed, summarized and made available in a convenient form to meet the most common analysis and reporting needs; data are structured and documented to support more specialized queries.	A "big data" environment is available supporting sophisticated exploration, cleansing, visualization and analysis of large, heterogeneous datasets.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Create a data warehouse to make data centrally available for analysis.	☐ Apply basic data transformations supporting data exploration, reporting, and visualization needs.	☐ Apply more complex and/or additional data transformations needed to meet specialized analysis needs.	☐ Provide a "big data" environment with data profiling tools – include functions to generate random sampling of large data sets, provide graphical insight into data distributions and outlier values.	
☐ Identify initial priority datasets supporting asset analysis and reporting needs to make available within a central data warehouse.	☐ Provide standard analysis and reporting views combining data from different sources for asset related analysis.	☐ Develop data marts meeting specific asset related business analysis and reporting needs.	☐ Develop user capability to share data and analysis products through the environment.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

D-Analyze Data
1-Data Exploration, Reporting and Visualization

D.1.b – Analysis Practices

Element Description Procedures, standard reports, templates, and training to ensure valid and productive analysis of current data.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
No standard reports or agency reporting procedures have been established.	Limited standard reports are available within the agency's individual asset management systems. Reports are produced on request.	A regular process has been established to produce and make available standard reports.	A regular process of data exploration and analysis has been established to identify patterns in the data, explore hypotheses and derive actionable information. Staff conducting this analysis receive appropriate training in statistics and data analysis techniques.	Based on inputs from data analysts, data and analysis environments are continually improved to enhance the agency's ability to derive valuable insights from data.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Configure agency asset management systems and tools to provide standard reporting for asset SMEs.	☐ Put standard operating procedures in place to develop reporting commonly needed outside the asset area.	☐ Integrate data science practices within asset related analysis.	☐ Develop a data science program to share and develop techniques to generate quantifiable, data-drive insights among data scientists and analysts.	
☐ Identify ad-hoc data exploration, reporting, and visualization practices in use in asset related business.	☐ Document and promote useful analysis techniques to deliver on common needs.	☐ Document and promote useful techniques to communicate complex asset management analysis results.	☐ Develop training plans for data analysis and data science practices and applications. Routinely evaluate to ensure alignment with staff needs.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

D-Analyze Data
1-Data Exploration, Reporting and Visualization

D.1.c – Analysis Tools

Element Description Tools supporting productive analysis and reporting practices (e.g. GIS, charting, reporting, dashboards)

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
No tools exist.	Tools for data exploration, reporting, and visualization are available in the agency but they are geared to expert users and requests for reports, dashboards or maps involve a request process with substantial lead time for service.	Limited tools are procured by individual business units that can be used to meet basic reporting and mapping needs. There is no training (or support for training) on proper application of these tools.	A variety of tools for data exploration, reporting, and visualization are available for use, and training is available to ensure that the capabilities of these tools is fully leveraged.	Standard tools for data exploration, reporting, and visualization are available across the agency, and meet the needs of asset management staff. The agency provides training and support for these tools and undertakes periodic improvements / upgrades to ensure they evolve with changing business and technology.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Develop agreements and/or process for use of analysis tools and/or expert analysts in support of priority analysis needs.	☐ Implement analysis tools allowing internal asset program staff to meet basic reporting and mapping needs.	☐ Transition existing analysis to standard business intelligence/analysis tools.	☐ Implement data profiling tools supporting random sampling of large datasets and provide graphical insights into data distributions and outlier values.	
☐ Inventory in-house asset management, reporting, business intelligence, dashboarding and other tools useful to asset related analysis.	☐ Document simple user instructions for available analysis tools.	☐ Develop training materials supporting application of standard tools to individual program analysis, reporting, and mapping needs.	☐ Develop detailed training plans for analysis tool uses and applications. Routinely evaluate to ensure alignment with staff needs.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

D-Analyze Data
2-Modeling

D.2.a – Asset Performance Prediction

Element Description Capabilities for development and application of asset performance models.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
Asset performance models have not been developed.	Predictive models have been developed for key asset condition or performance measures. There is limited confidence in these models for applications outside of network-level performance prediction or needs analysis.	Predictive models have been developed for key condition or performance measures. These models are generally trusted and applied in project-level decision-making. However, these models are not routinely validated and/or evaluated for improvement.	Predictive models have been developed for key condition or performance measures. These models are trusted, integrated into project-level decision-making and are periodically validated and improved using project-level and/or asset specific information.	Prediction and model building leverage asset component and/or very specific location or asset information. Available information is used to tailor model input to the specific asset, with built in methodologies to revert to network level models when asset specific data is not available or trusted. Models and assumptions are regularly validated.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Develop predictive models for key condition or performance data using historical data and/or expert opinion.	☐ Improve predictive modeling through evaluation of available condition or performance data, reducing reliance on expert opinion as a key input to the models.	☐ Improve predictive modeling through integration of data sources beyond condition or performance data (e.g. utilization/environmental data).	☐ Develop performance modeling based on data collected for a specific asset or location.	
☐ Develop methodology for use of predictive models in forecasting network-level needs.	☐ Develop methodology for use of predictive models in project-level investment decision-making. Document processes for use.	☐ Validate and improve methodology for use of models in project-level decision-making. Document processes for use.	☐ Develop analytical tools to identify discrepancies between actual and anticipated performance.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

D-Analyze Data
2-Modeling

D.2.b – Optimization / Prioritization

Element Description Capabilities for development and application of prioritization and optimization techniques.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
Asset investment prioritization is not conducted.	Investment prioritization / optimization methodology exists for individual assets. This methodology does not use information on work history and planned work.	Investment prioritization / optimization methodology exists for individual assets and uses information on work history and planned work.	Results from individual asset investment optimizations are used to discuss investment tradeoffs across assets, however there is no quantitative approach to cross-asset optimization.	A quantitative approach to cross-asset resource optimization is in use.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Develop treatment selection criteria, associated improvement benefit and cost models, and methodology for investment optimization and prioritization.	☐ Improve treatment selection criteria, benefit and cost models, and prioritization through analysis of historical data and expert opinion.	☐ Improve treatment selection, benefit and cost models, and prioritization with non-asset data (e.g. utilization / environmental data).	☐ Develop method to tie asset investments to overarching “benefit” or “value” against agency objectives, supporting a quantitative cross-asset resource optimization approach.	
☐ Document key factors input as constraints to optimization analysis (e.g. performance constraints, available funding). Identify values / data sources.	☐ Identify data sources for planned work and define method for incorporating this data into existing investment analysis.	☐ Produce asset specific investment optimization / prioritization analysis results in a format useful in an overarching investment optimization and prioritization decision process.	☐ Develop analytical tools to identify where discrepancies are identified between actual and anticipated performance of asset investments and improvements.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Appendix E: Act Informed by Data Element-Level Response Templates

This Appendix offers element-level response templates for Area E: Act Informed by Data.

Note: Use of the TAM Data Assistant is recommended however these templates are provided for informal use or pen and paper assessment.

Date: **Participating Members:** **Assessment Context:**

E-Act Informed by Data
1-Resource Allocation and Prioritization

E.1.a – Performance Targeting

Element Description Processes for establishing performance targets and aligning asset investment decisions with targets.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
No consideration of asset performance/condition in resource allocation.	Asset performance/ condition is considered as a part of resource allocation decisions.	Asset performance / condition targets are set based on review of trend data, and resources are allocated to achieve established targets. However, resource allocations are not adjusted based on monitoring of actual performance.	An annual monitoring and adjustment process is in place to keep targets and resource allocations in line with observed performance.	Processes for performance target setting, resource allocation, and monitoring are periodically reviewed and improved.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Develop basic summaries of asset information (e.g. trends in asset allocations, inventory, condition, or performance) to inform resource allocation decisions.	☐ Establish targets for asset condition or performance. Allocate available funding based on needs to meet targets.	☐ Incorporate information about asset life cycles into resource allocation processes. Monitor field investments against recommendations.	☐ Integrate asset specific allocation decisions into a cross-asset resource allocation program. Optimize allocations across all areas against agency goals and objectives.	
☐ Initiate a process of reviewing asset condition or performance trends as part of resource allocation business processes.	☐ Document resource allocation decision-making processes, including methods for considering needs or targets in fund distribution.	☐ Document desired and expected condition and/or performance outcomes based on fund distribution.	☐ Develop a dashboard to communicate resource allocation targets and decisions. Flag where decisions are not aligned with expectations.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

E-Act Informed by Data
1-Resource Allocation and Prioritization

E.1.b – Project Prioritization

Element Description Use of a data-driven prioritization methodology to select asset maintenance, rehabilitation and replacement projects for funding.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
No formal approach to project prioritization; design making criteria are not transparent.	Formal criteria and methodologies for project prioritization are established based on the primary asset. Prioritization is primarily based on qualitative factors. Limited or no consideration of impacts to other assets or projects.	Formal criteria and methodologies for project prioritization are established based on the primary asset using data on unit costs, exposure (e.g. traffic or ridership), and predicted condition improvement.	Formal criteria and methodologies for project prioritization are established based on agency goals and objectives and the project scope. Approaches support tracking of aggregate work accomplishment and performance targets.	Formal criteria and methodologies for project prioritization are established and support comprehensive evaluation against agency goals and objectives. Targets for project development, work accomplishment, and performance outcomes are managed by formal procedures that involve input from cross-functional business and management teams.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Develop simple summaries of asset information (e.g. trends in asset allocations, inventory, condition, or performance) to inform project selection.	☐ Apply funding, treatment benefit and cost models and other factors to constrain project selection to identified priorities.	☐ Incorporate life-cycle planning analysis outcomes into project selection. Monitor field investments against recommendations.	☐ Integrate asset specific project priorities a multi-objective project prioritization program. Optimize project selection in all areas against agency goals and objectives.	
☐ Establish criteria for identifying and prioritizing candidate projects based on current asset or external information.	☐ Document project prioritization and selection decision-making practices.	☐ Document desired and expected condition and/or performance outcomes based on planned projects.	☐ Develop a dashboard to communicate project priorities and investment decisions. Flag where decisions are not aligned with expectations.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

E-Act Informed by Data
2-Project Planning, Scoping, and Design

E.2.a – Data-Driven Project Planning and Scoping

Element Description Use of asset inventory, condition, work history and treatment recommendation data to inform project planning and scoping.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
Project planning and scoping are performed with little or no consideration of asset inventory, condition, work history or treatment recommendation information.	Project planning and scoping are based on field observation of asset inventory and condition information.	Project planning and scoping considers selected asset inventory and condition information available within the agency's business systems.	Project planning and scoping is conducted based on documented procedures for use of asset inventory, condition, work history, and treatment recommendations.	Templates for project scopes are developed and tailored to common asset life-cycle conditions and analysis recommendations. These are managed in a library that supports reuse and continuous improvement to project scoping and planning outcomes.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Develop checklists or standard forms to gather field observations of asset inventory and condition during project planning and scoping.	☐ Develop guidance for project scoping/planning based on available asset inventory and condition.	☐ Incorporate available asset life-cycle and/or utilization data and analysis into project planning and scoping processes.	☐ Develop project scoping/planning templates tailored to life-cycle analysis outcomes and scoping requirements and practice.	
☐ Document best practices for using asset data for project planning and scoping. Develop materials (e.g. case studies) to illustrate and share these practices.	☐ Promote awareness of project scoping/planning expectations through targeted outreach and communication.	☐ Develop and implement a training program and materials for asset data-informed project planning and scoping.	☐ Provide a formal repository to store project scoping/planning templates, supporting integration with life-cycle analysis outcomes.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

E-Act Informed by Data
2-Project Planning, Scoping, and Design

E.2.b – Data-Driven Project Design

Element Description Selection of materials and design features based on observed performance and maintenance / operational needs.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
Asset performance and cost information is not considered in the design process.	Anecdotal (qualitative) information about asset performance and cost information is considered in the design process.	Selected quantitative asset performance information (e.g. material performance) is available to designers but use of this information is not a formally established part of the design process.	There are established, documented design procedures for use of asset performance data. Field performance is verified by experimentation, and proper statistical practices are followed (e.g. minimum sample size, etc.).	There are automated processes for retrieval of relevant performance data from business systems at design inception. Performance data gathered via sensor or similar technology is analyzed and used to optimize material selection and other design elements.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Document expert opinion regarding benefits and best uses of design alternatives. Summarize typical costs.	☐ Perform statistical evaluation of design outcomes using asset information. Document high and low performing options.	☐ Institute routine evaluation of project-level performance outcomes. Incorporate findings into design process / decisions.	☐ Implement monitoring tools to capture detailed performance data that can inform future design improvement.	
☐ Document agency best practices relating to asset data use in project design. Develop communication materials (e.g. case studies) to share practice.	☐ Promote awareness of project design expectations through targeted outreach and communication.	☐ Develop and implement a training program and materials for asset data-informed design decision-making and processes.	☐ Establish a formal program for evidence-based design and construction practice improvement.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

E-Act Informed by Data
3-Maintenance

E.3.a – Infrastructure Maintenance

Element Description Infrastructure maintenance program informed by asset life cycle modeling and analysis.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
No regular preventive or scheduled maintenance program.	Limited maintenance based on industry standards or norms.	Limited maintenance informed by life cycle analysis.	Regular maintenance programs with dedicated funding based on analysis of life cycle costs and benefits. Tracking of costs and benefits is established but may not yet be producing usable information.	Maintenance program is based on life cycle analysis with adjustments based on data-driven assessment of program costs and benefits, for example through asset-specific modeling or through incorporation of contracting and/or programming efficiencies.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Document maintenance practices among peer agencies. Develop simple policy/guidance for field staff.	☐ Develop network screening protocol/tools that support identification of maintenance opportunities.	☐ Establish formal maintenance programs. Use life-cycle analysis to establish funding and targets and associated reporting.	☐ Expand/improve decision-making through collection of detailed performance and reliability information.	
☐ Develop simple check lists, time-based protocol, or other tools to improve proactive maintenance decisions.	☐ Promote awareness of maintenance expectations through targeted outreach and communication.	☐ Track and examine costs and benefits of preventive and other maintenance treatment alternatives.	☐ Track and examine benefits of strategies to improve programming efficiencies (e.g. coordinated investment across multiple assets or programs).	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Date: **Participating Members:** **Assessment Context:**

E-Act Informed by Data
3-Maintenance

E.3.b – Equipment Maintenance

Element Description Use of equipment life cycle, maintenance history and cost information to inform planning and budgeting for equipment maintenance.

Benchmark Level 0	Benchmark Level 1	Benchmark Level 2	Benchmark Level 3	Benchmark Level 4
No regular equipment preventive or scheduled maintenance program.	Equipment maintenance is performed based on age, a prescribed frequency or cycle, or manufacturer recommendations.	Equipment maintenance costs and reliability are tracked and considered in planning for equipment maintenance and replacement for *selected high-risk assets*.	Equipment maintenance costs and reliability are tracked and considered in planning for equipment maintenance and replacement for *all essential equipment assets*.	Maintenance and replacement cycles are based on data about Individual pieces of equipment gathered in an automated fashion.
Current: ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐	**Current:** ☐ **Desired:** ☐
☐ Establish proactive equipment maintenance policy based on manufacturer recommendations.	☐ Track service history and use information to identify low reliability equipment for replacement.	☐ Expand equipment history tracking to include maintenance costs and productivity. Use this data for maintenance and replacement decisions.	☐ Expand/improve decision-making through collection of detailed performance and reliability information.	
☐ Develop simple checklists, time-based protocol, or other tools to improve proactive maintenance decisions.	☐ Implement an equipment inventory and maintenance history tracking system.	☐ Establish a formal preventive/routine equipment maintenance program. Set funding, responsibilities, targets, and associated reporting.	☐ Implement automated work ordering tools to automatically generate work orders based on established practices.	
☐ Other:	☐ Other:	☐ Other:	☐ Other:	

Assessment Notes:

Improvement Notes:

Appendix F: Detailed Organizational Practices

This Appendix offers supplementary materials on organizational practices to support implementation of TAM data and information improvements.

Strategic Management

Strategic management is an umbrella term covering strategic planning and decision-making structures and processes that are used to set priorities and allocate resources (including time, funding, staff capacity and capabilities).

Strategic management practices provide a way to establish alignment across different business units and tools reinforcing organizational priorities and tracking progress towards established objectives. Additionally, these practices provide a means to evaluate organizational structures and roles to ensure they remain aligned with changing expectations and requirements.

Typical strategic management strategies include:

Strategic Planning

Creating agency business plans to guide development and investment. Useful for addressing time, resource, expertise, coordination, and change challenges.

Performance Management

Establishing objectives and measures at the agency, business unit, and employee level and a tool to provide focus and guide improvements. Most valuable for coordination and change challenges.

Enterprise Architecture

Providing an integrated view of agency business process, data, application, and information technology infrastructure that will support the agency's desired level of integration and standardization. Applicable to time, resource, coordination and change challenges.

Enterprise Risk Management

Instituting systematic practices to control uncertainty and variability on strategic objectives by managing risks at enterprise, program, project, and activity levels. Helpful for time, resource, coordination, and change challenges.

Strategic Governance

Forming the decision-making structures, roles, and responsibilities used to make enterprise level decisions within the agency business, information technology, and management programs. Very useful in addressing time, resource, coordination, and change challenges.

Typical Strategy Details

Strategic Planning

Agency and IT strategic planning are useful to assess the current state of the organization and develop strategies to move forward, tracking progress towards a desired state.

Agency Strategic Planning

Utilize agency strategic planning to understand the current situation and future outlook. Identify strategic issues to address, seek input from stakeholders, customers, and employees, and synthesize current strengths, weakness, opportunities, and threats (SWOT). Then create or update the agency's mission, values, vision, goals, and objectives. Develop agency wide strategies to achieve the objectives and cascade these down to the Division and Program levels. Set Key Performance Indicators (KPIs) to measure progress and establish a schedule for monitoring and updating the plan. Communicate the plan across the agency.

IT Strategic Planning

Develop an IT strategic plan following a similar process as described for agency strategic planning, building off of those outcomes. Assess the current state, identify issues and trends affecting future needs, and establish goals, objectives, and supporting strategies and tactics. The IT strategic plan should identify categories of investment needed to achieve objectives and provide guidance for project selection – it should not be a fixed project list. An IT strategic plan may also address workforce capacity building needed to successfully meet future needs.

Typical Strategy Details (continued)

Performance Management

Develop performance measures, targets, and management plans, and track and communicate KPIs indicating progress towards performance goals.

Transportation Asset Management Plans

As a part of (or in addition to) creating federally required Transportation Asset Management Plans, agencies may establish a TAM policy or strategic to set priorities for investment, identify key infrastructure management and service delivery processes, define roles and responsibilities, and set direction for continuous improvement of TAM practices.

Performance Dashboards

Create performance dashboard communicating KPIs that can be reasonably measured and tracked to provide a meaningful indication of progress towards agency strategic goals and plans. Consider using a balanced scorecard approach to include multiple perspectives on performance: financial, customer/stakeholder, internal process efficiency and quality, and organizational capacity, learning, and growth. Establish a desired reporting interval and put in place measurement and reporting processes. Acquire or build tools automating data processes, and provide online access. Communicate how and why the dashboard was created and how it should be used.

Enterprise Architecture

Clarify the desired level of business process integration and standardization across the agency (the Operating Model) and use this to drive identification of core business and supporting IT capabilities. Use these capabilities to guide prioritization and selection of strategic initiatives to strength the agency's foundation for execution. Train and integrate architects within the project teams. Create models of as-is and to-be business capabilities, processes, data, applications and technology infrastructure to support transition from the current to desired future state.

Enterprise Risk Management

Define responsibilities and processes for identifying, tracking, and mitigating risks at the agency, program, project, and activity levels. Use an established risk management framework (e.g. ISOP 31000) to establish standard risk management processes, including risk identification, risk analysis (identify root causes and assess likelihood and consequences), risk evaluation (ranking), taking appropriate action (mitigation, termination, acceptance, transfer, and communication and monitoring.

Strategic Governance

Establish agency decision-making bodies, roles, and responsibilities. Develop charters to ensure clear process and procedures for reaching consensus and mechanisms for escalation where consensus cannot be reached. Engage stakeholders to ensure informed participation and decision-making, and regularly evaluate decision-making authority to ensure it is meeting current agency needs and is aligned with strategic vision and enterprise

Strategic Management References

Below are key references available if a deeper understanding or application of strategic management is needed.

- **NCHRP Report 331:** Strategic Planning and Management Guideline for Transportation Agencies
- **NCHRP Synthesis 326:** Strategic Planning and Decision Making in State DOTs
- **TCRP Synthesis 59:** Strategic Planning and Management in Transit Agencies
- **NCHRP Project 20-24(83):** Alternative DOT Organizational Models for Delivering Service
- **NCHRP Report 08-93:** Managing Risk Across the Enterprise: A Guide for State DOTs
- **NCDOT Research Report:** Adopting a Culture for Performance Management at the Nevada DOT
- **FHWA Noteworthy Practices:** North Carolina Refining a Performance Management System
- **Harvard Business Review Press:** Enterprise Architecture as a Strategy: Creating a Foundation for Business Execution

Talent Management

Talent management incorporates workforce planning, recruiting and retention, succession planning, and employee development practices which help organization identify, hire, and develop the skilled staff needed to design, deploy, and integrate these improvements into the complex systems, tools, and associated business practices of the DOT.

As new technologies, tools, and practices are implemented, the skills required by the TAM workforce will change, requiring techniques to identify changing staff and job requirements as well as provide the training necessary to develop these capabilities in existing staff.

Typical strategic management strategies include:

Workforce Planning

Identifying workforce composition based on retirements, hiring, and other organizational and environmental trends. Best for expertise, coordination, and change challenges.

Talent Acquisition and Retention

Creating hiring and retention practices and a corporate image that successfully attracts and retains the interest of target employees. Best for expertise and change challenges.

Succession Management

Proactively planning for successors to existing senior employees, and, where allowed, pursuing dual incumbency to ensure critical positions remain filled. Best for expertise and change challenges.

Employee Development

Developing onboarding, career development, organizational ladders, leadership training, and performance review practices to ensure staff have

opportunities to identify and build upon current skills and address areas needing development. Best for expertise, coordination, and change challenges.

Typical Strategy Details

Workforce Planning

Support the future sustainability and performance of the agency by anticipating workforce needs and planning to fill gaps in skills and expertise, ensuring the agency employs the right people, with the right skills, at the right time.

Start by identifying the current workforce composition of the agency, analyzing the organizational structure, composition, and rate of change (e.g. capturing number of entry level vs. upper management employees, amount of new hires vs. long term staff, and the percentage of the workforce that is likely to retire in the next 5-10 years). Next, assess the organizational trends, technology changes, and other external forces that may create gaps in skills and capabilities at the agency. Identify the current skills and capabilities that the agency must maintain in the future and the new skills and capabilities that will be needed as trends change. Based on the current workforce composition and the predicted gaps in skills, develop a plan for hiring people to fill those gaps in the coming years.

Talent Acquisition and Retention

Support the agency's workforce and mission by generating interest and enthusiasm in target employees and successfully acquiring and retaining the talent needed to effectively carry out its goals.

After developing a hiring plan to fill skills and capabilities gaps, perform a market analysis to determine the needs and desires of skilled potential and current employees. Analyze current agency policy, then determine the areas where improvement is needed to make the work environment more attractive to prospective and current employees. For example, allow for flexible work hours or remote working options, provide appealing technology options, streamline the hiring process, or work towards competitive salaries. As improvements are made, highlight these in the recruitment and retention activities.

Consider engaging local universities and provide opportunities for summer internships or part-time work during the school year. These can be either paid opportunities or for college credit. Raise awareness of jobs in transportation by attending career fairs and holding information sessions. Show the wide variety of work available in transportation and demonstrate the path toward full employment.

Additionally, evaluate the ways the agency stands out from private sector employers or other public sector agencies (e.g. benefits, work-life balance, flexible work hours, agency culture, agency mission, etc.). These should be highlighted in all recruitment activities. Develop a workplace identity/brand to appeal to employees that fit the culture of the organization. Use performance reviews to communicate progress and areas for further growth to employees.

Typical Strategy Details (continued)

Succession Management

Ensure that critical positions in the agency are filled and knowledge is transferred effectively as workers change jobs.

Identify the critical positions within the agency and develop a succession plan for these positions. Identify the skills and training required for these positions and work to build that experience in people who may be able to fill the role in the future. Succession Planning is an iterative process and the plan will change as new people fill different roles, as roles change, or as the skills required for the roles evolve.

Employee Development

Provide training and opportunities for growth to help engage employees, build skills, and prepare for the future.

Develop an onboarding training program to help new employees feel informed and prepared and also set the expectation of continued training throughout an employee's time at the agency. Offer training classes to develop new skills and highlight the career development steps needed to move up in the organization. Hold regular performance reviews to communicate progress and areas for further growth to employees.

Talent Management References

Below are key references available if a deeper understanding or application of talent management is needed.

- **Vermont Agency of Transportation:** Employee Retention and Knowledge Management
- **NCHRP Synthesis 323:** Recruiting and Retaining Individuals in State Transportation Agencies
- **TRB Special Report 275:** The Workforce Challenge
- **NCHRP Synthesis 362:** Training Programs, Policies, and Practices
- **Alaska Department of Transportation:** Serving Future Transportation Needs
- **NCHRP Report 685:** Guide to Implementing Strategies to Attract and Retain a Capable Transportation Workforce
- **Transportation Research Record:** Millennials in the Transportation Workforce
- **NCHRP 20-05 Topic 49-10:** Transportation Workforce Planning and Development Strategies (not published)

Initiative Management

Initiative management includes a range of business, process, and program management techniques which enable the organization to effectively deliver upon its priorities. This is essential as DOTs are complex organizations, with wide ranging, interdependent programs and strategic initiatives requiring planning and management for effective execution.

Establishing standard tools, techniques, processes, roles and responsibilities for documenting and delivering upon detailed business cases for program and process improvement is critical to undertaking the complex data, information system, and business improvement projects recommended in this guidance.

Typical Initiative management strategies include:

Portfolio Management

Creating processes, practices, and tools to scope, schedule, monitor, adjust, and coordinate across projects and other initiatives. Track, manage, and coordinate a set of projects and other initiatives to maximize value to the organization, manage risks, and maintain a balance between commitments and available resources. Best for time/resources, expertise, coordination, and change challenges.

Organizational Change Management

Applying processes, practices, and techniques to address employee and organizational resistance to changes. Prepare, equip, and support people in an organization to successfully adapt to changes in business processes, tools or management structures. Best for change and coordination challenges.

Process Improvements

Evaluating and improving performance of existing business processes. Modify

business processes to create more value, increase speed and efficiency and produce more consistent results. Best for time/resources, coordination, and change challenges.

Typical Strategy Details

Portfolio Management

Start by identifying the types and sizes of initiatives you want to track. For example, an agency's initiative portfolio might include IT projects, new data collection or purchases, and new program or policy implementation efforts. Then, define the information to collect and maintain for each initiative. This information should enable traceability to the need that triggered the initiative and the organizational goals and objectives it supports. It is also helpful to track resource needs, timelines, key milestones, major dependencies and risks. Create or acquire a system to manage the portfolio information. Establish responsibilities for reporting and updating information. Finally, put in place processes that use this information to prioritize candidate initiatives, improve coordination across related initiatives and balance work with available resources. Use roadmaps to gain consensus on a path forward, describe steps needed to get from the current state to the desired future state, and identify and understand dependencies across related efforts. The process of developing a roadmap is as important as the end product as it helps establish alignment across different players.

Organizational Change Management

Establish an organizational change management capability within the agency. Adopt a proven change management model such as ADKAR (Awareness, Desire, Knowledge, Ability, Reinforcement). Include a change management component within projects or other initiatives that require significant adjustments to current processes or responsibilities. Keep in mind that initiative-based change management may not be effective without ongoing attention to organizational culture and employee engagement. Be sure to provide opportunities for changes to be initiated from the bottom up, not just top down. Use roadmaps to ensure that the end goal, and the path to that goal, is clear.

Process Improvements

Develop internal agency expertise in Lean or other established business process improvement techniques or identify external resources that can be brought in for this. Increase awareness of these techniques across the organization so that managers understand their value and seek out services when they recognize opportunities for improvement. Encourage application of business process improvement techniques prior to or in conjunction with introduction of new IT applications.

Establish business analyst positions within the agency. These positions may be located within the information technology unit and/or within business units. Train and equip business analysts to perform business process modeling (e.g. flowcharts, swim-lane diagrams), business case analysis, requirements elicitation and management, use case analysis, user stories, conceptual data models, data flow diagrams, business rules analysis, test case development and other business analysis techniques. Encourage the use of RACI (Responsible-Accountable-Consulted-Informed), and similar models in conjunction with new initiatives, or in cases where roles and responsibilities are ambiguous and need clarification.

Knowledge Management

Knowledge management encompasses a range of techniques for building, leveraging and sustaining the know-how and experience of an organization's employees.

Some agencies choose to pursue knowledge management as a strategic, agency-wide practice; others implement knowledge management techniques without central coordination – as an integral part of staff management, project management, information management, or research/innovation activities.

Typical knowledge management strategies include:

Knowledge Capture and Dissemination

Identifying agency knowledge assets and gaps and creating processes to capture and document critical knowledge and organize/manage it so it can be discovered. Support planning for how to build the necessary expertise required to implement and sustain improvements and then disseminating that information throughout the organization. Best for expertise, coordination, and change challenges.

Collaboration and Peer to Peer Learning

Facilitating collaboration and learning through establishing communities and fostering connections to experts. Best for expertise and change challenges.

Knowledge Development

Building in opportunities for learning through initiatives and as a part of routine business processes. Best for expertise challenges.

Typical Strategy Details

Knowledge Capture and Dissemination

Knowledge Capture

To support building the necessary expertise required to implement and sustain improvements, capture the critical knowledge within and missing from the organization. Through interviews and surveys, perform a knowledge audit to identify current knowledge resources and gaps. Capture and document specialized or unique knowledge from experts through knowledge interviews. Create a structures questionnaire for knowledge interviews and identify and train one or more individuals to conduct the interviews. Establish criteria to help identify and prioritize situations where knowledge interviews would be beneficial, such as the pending retirement of a senior engineer.

Knowledge Dissemination

To support continuous improvement in practices for data standardization, collection, analysis, and use, create a searchable repository for documenting critical knowledge and lessons learned. Promote the use of this repository during the planning stage of new initiatives.

Collaboration and Peer to Peer Learning

Peer Collaboration

Support collaboration and learning within groups that perform similar roles but may not normally interact in the course of day to day business by defining an agency-sanctioned process for groups to come together to brainstorm, problem solve, and share experiences. Ensure that teams embarking on improvement initiatives benefit from the experience of their peers by organizing and facilitating a work-session that brings together peers to share their experiences and knowledge with a team that needs help meeting an upcoming challenge.

Expertise Directory

Support new initiatives and on-going business processes by developing an expertise directory to provide a way to recognize agency experts in specialized areas that can be consulted for advice or expert knowledge. Create a process for identifying these experts in selected topic areas and enlist their participation. Publish an online directory of these experts with contact information.

Knowledge Development

To support maintaining critical agency knowledge and addressing knowledge gaps, create a program to teach employees critical knowledge through seminars, training, and other methods and to acquire outside critical knowledge where gaps exist through hiring, outside help, or other means. When outside help is sought to address knowledge gaps, ensure access to the knowledge is properly maintained.

Appendix G: Implementation Support: Case Studies

This chapter provides practical examples of real projects completed by state DOTs that can serve as best practice references.

These references can be used in conjunction with improvement recommendations to support projects and initiatives to enhance data management maturity in accordance with this guidebook.

Ohio DOT: Establishing a Governance Framework

Specify and Standardize Data
Governance

Responding to in-house and third-party software applications with limited integration capabilities, the Ohio DOT (ODOT) developed a data governance framework to improve data management efficiencies and reduce data duplication.

This governance framework was established and applied through the following approach:

Step 1: Perform Maturity Assessment

ODOT contracted a study to measure the department's maturity in data governance. A survey was created and administered to key ODOT data business owners. Recommendations from this study were to create data a governance framework and supporting policy and standards.

Step 2: Establish Governance Framework

A data governance structure was defined with oversight by the Chief Data Officer and a Data Governance Committee.

Step 3: Create Governance Standards, Roles, and Responsibilities

The Data Governance Committee led a project to implement enterprise data standards, define governance roles and responsibilities, and establish metadata management practices.

Step 4 (Future State): Treat Data as an Asset

Through increased awareness of governance processes, make ODOT a data-driven organization emphasizing data quality, availability, integrity, and usability.

Value Delivered
Consistent quality, availability, integrity and usability of data

Leadership
Executive endorsement and vision from onset

IT collaboration and integration in project

Expertise

Technical expertise in big data and industry standards

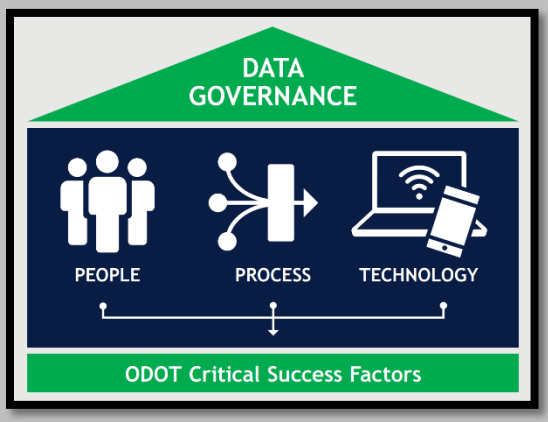
Coordination
Identify and leverage data governance champions

Cross-department communication

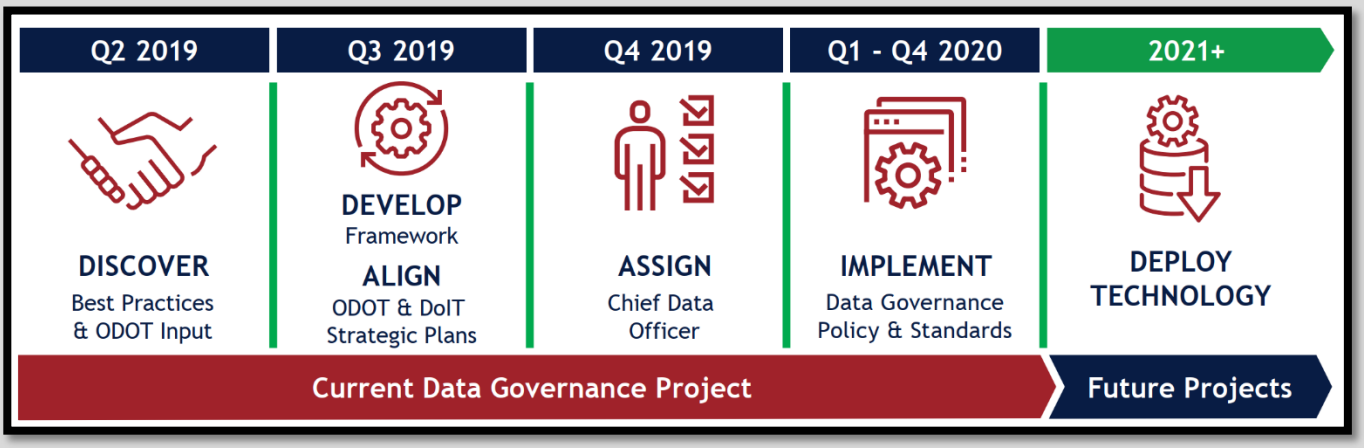
Change
Change management focus on value derived from the change

Ohio DOT: Establishing a Governance Framework

Data Governance Maturity Gap Chart – Spider diagram showing areas with lowest maturity levels to target governance needs.



Data Governance Framework - Recognizing management of data centered on People, Process and Technology – a culture change impacting nearly all ODOT staff.



Proposed implementation phases focused on a new agency-wide approach to data governance (based on calendar year).

Utah DOT: Statewide Vehicle-Based Data Collection

Collect Data

Inventory, Condition, and Performance Collection

Utah DOT (UDOT) found that many asset owners were collecting data but there was no single repository for that information. This was creating data management challenges and an inability to quantify and enterprise-wide asset inventory and value to improve data driven decisions.

To address this, UDOT determined it would collect a statewide LiDAR survey of its entire roadway system every two years.

Step 1: Inventory Assessment

UDOT engaged a service provider to collect mobile LiDAR data of its entire roadway system. During the initial phases of data collection, UDOT encountered various challenges with asset coding and the sheer scope of the data collection. UDOT addressed these challenges individually.

Step 2a: Developing a Data Dictionary

The data collection vendor did not have sufficient documentation to properly code all the assets being collected. UDOT prepared a Data Dictionary on asset coding to drive consistent, higher quality data extraction. This required bringing together individuals from across the organization to agree upon a single set of attributes for each asset.

Step 2b: Establishing Asset Tiers

With an overwhelming amount of enterprise-wide data, UDOT focused TAM decision-making, by establishing asset tiers. Tier 1 assets, such as pavements and bridges, were targeted for data-informed decision-making.

Step 3: Maintain Asset Database

UDOT is now working to complement the enterprise wide asset data collections using mobile applications in a newly procured asset management system. The new mobile tools replace pen and paper tracking, allowing UDOT to understand the real cost to maintain assets over their life cycle. These tools will also assist in maintaining a more up to date asset database by providing live asset updates instead of waiting for statewide collection every two years.

Value Delivered

Standardization and ease-of-use for asset data

Leadership

Executive endorsement and vision from onset

Division level engagement

Expertise

Technical expertise to troubleshoot and optimize workflows

Asset performance subject expertise to identify data requirements

Coordination

Cross-functional teams to make asset priority decisions

Change

New data management practices shifting to single repository for data access

Colorado DOT: Data Quality Management Plan Development

Collect Data
Inventory, Condition, and Performance Collection

The Colorado DOT (CDOT) developed a Quality Management Program (QMP) document in response to federal requirements. This document reports processes performed by CDOT and by the data collection contractor to address the quality of all data reported to the FHWA's Highway Performance Monitoring System (HPMS).

The QMP ensures collected pavement condition data is reliable, accurate, complete, and reasonable.

Step 1: Defining Information Flow

CDOT documented the information flow from raw data collection through submittal to the FHWA HPMS. They created a flowchart to visually represent the information flow and to support user understanding. They then documented the technical components of the collection program (Steps 2a-2d).

Step 2a: Standards and Protocols

CDOT documented the standards and protocols for collection and characterization of the Federal pavement condition metrics as well as other data elements collected for state pavement management purposes.

Step 2b: Training and Certification

CDOT documented the training and certification of all personnel involved in the production of data, including field data collection, data processing, and manual distress rating.

Step 2c: Collection Equipment

CDOT documented calibration procedures and quality checks conducted on data collection equipment before and during collection.

Step 2d: Collected Data

Quality checks applied Federal metrics and individual data elements and associated procedures were documented.

Step 3: Staff Accountability

As a final step, CDOT required signatures of all designated staff acknowledging acceptance and accountability for adherence to the plan.

Value Delivered
Compliance with FHWA standards

Leadership
Executive endorsement

Expertise
Data collection equipment

Data quality control and sampling

Coordination
Cross-functional teams & training

Central office, field, and support staff

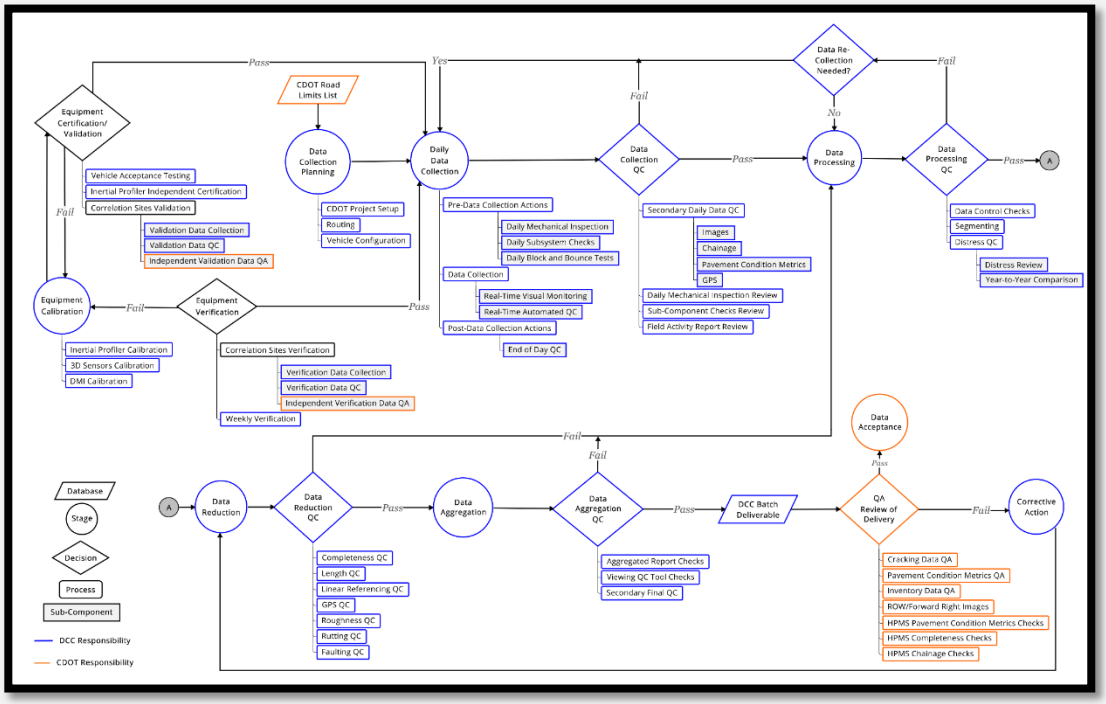
External collection contractor

Change
Governance

Impact to field collection staff workflows and processes

Data issues were exposed requiring new quality control practices

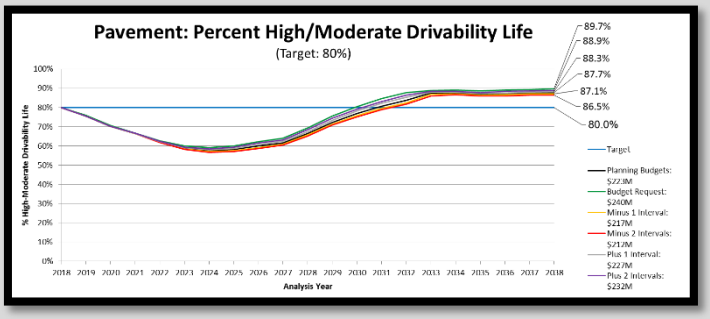
Colorado DOT: Pavement Data Quality Management Plan



A flowchart of CDOT Pavement Data QMP provides users an overall view of data flow and interdependencies.

Data Type	Percentage	Absolute Value	Units
IRI	5%	1.000	Inch per mile
Rutting	5%	0.050	Inches
Macro Texture MPD	10%	0.080	Inches
Macro Texture RMS	10%	0.050	Inches
CrossFall	5%	0.500	Percent Slope
Roll	5%	0.500	Percent Slope
Grade	5%	1.000	Percent Slope
Pitch	5%	1.000	Percent Slope
Fault Height	5%	0.039	Inches

Data certification thresholds are a critical component of the pavement data QMP and set the standards for internal and external collection requirements.



Pavement Data QMP allows for higher accuracy life cycle forecasting to support funding requests.

Virginia DOT: Mobile Field Data Collection Implementation

Collect Data
Maintenance Information Collection

Virginia DOT (VDOT) embarked on an asset management system replacement project in 2016. Among other needs, VDOT sought to support field collection of asset information, work orders, inspections, and work accomplishments.

Full procurement and implementation of a commercial off the shelf solution took approximately 3 years, but their new Highway Maintenance Management System (HMMS) was implemented statewide and across multiple departments.

With the system in place, VDOT began capturing field maintenance information in a standardized manner and using this information to better understand and communicate how much money was being spent on maintenance activities and the results that are being achieved.

Step 1: Standard Work and Life-Cycle Definitions

VDOT defined what would and would not qualify as work accomplishments. They also defined how to record these accomplishments to accurately capture desired performance metrics.

Step 2: Assign Work and Budget

VDOT assessed the quantities of each asset and used life-cycle assumptions to determine how much maintenance work (and budget) to assign to each category per year.

Step 3: Track Work in Real Time

VDOT Maintenance Division devised an approach to incorporate HMMS data entry of work "accomplishments" into routine field business practices to support real time tracking.

Step 4: Engage Stakeholders

To engage stakeholders and manage change, VDOT prepared guidance documents and job aids for data entry protocols and metric quantification methodology. VDOT also instituted monthly performance reporting.

Value Delivered
Compliance with FHWA standards

Leadership
Executive endorsement and vision from onset

Expertise
Knowledge of tools and software to support required configurations for data requirements

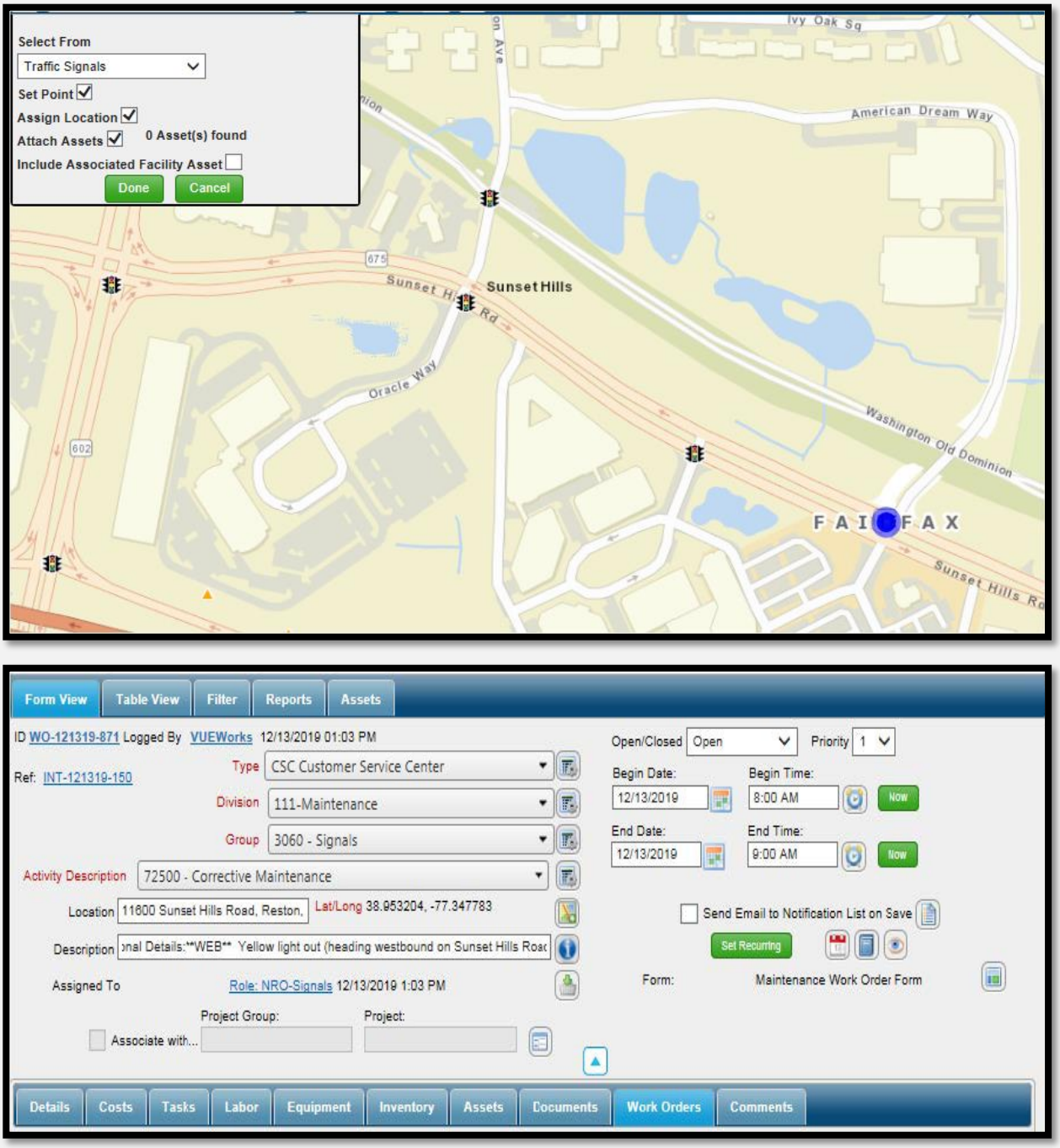
Coordination
Feedback from local offices to central office

Central office, field, and support staff

Change
New tools and processes required of field staff

Lack of awareness of statewide needs and uses for work accomplishment data

Virginia DOT: Mobile Field Data Collection Implementation Example



GPS enabled mobile devices and map-based tools support efficient collection of maintenance work accomplishment information in the field. Use of pick lists and other standardized data entry support analysis and reporting of statewide performance measures.

Utah DOT: Mobile LiDAR and BIM/CADD Integration

Store, Integrate and Access Data

Asset Management System Integration with CADD

UDOT has made significant investment in 3D design with a goal of streamlining the data flow and management from pre-construction through to maintenance.

Since 2016, UDOT has awarded 11 projects with the 3D design model as the legal document (MALD). In 2018, UDOT awarded it first MALD project without cutting sheets (which were previously included on MALD projects for information only).

UDOT is now looking to develop a repeatable process to maintain the 3D model data through construction and beyond using mobile devices in the field to capture as-built details.

Step 1: Export Data to GIS

UDOT will export the 3D model data from Bentley software using FME to bring the features and all the model attributes into a 2D GIS representation.

Step 2: Locate Asset

The model data will be loaded onto mobile field devices and utilized by field personnel to locate the asset and update attributes. If the location is not accurate, an updated features location can be collected. Mobile devices are connected via s-built Bluetooth to rovers to support the required level of location accuracy. One important consideration made by UDOT was to determine an acceptable level of tolerance for each asset type so that field personnel can make consistent judgments around whether new location collection is or is not required.

Step 3: Upload Asset Attributes

The updated, as-constructed attributes and locations, if required, will then be uploaded to the primary enterprise database in the organization's master GIS repository, UPlan, as a new layer allowing users to see the as-built asset condition. Going forward, UDOT will be able to construct 3D representations of the asset using the Z coordinates retained from the original 3D model.

Value Delivered

LiDAR data as asset baseline

3D digital representation of assets

Leadership

Executive endorsement and vision from onset

Expertise

Knowledge of tools and software to support required integration requirements

Coordination

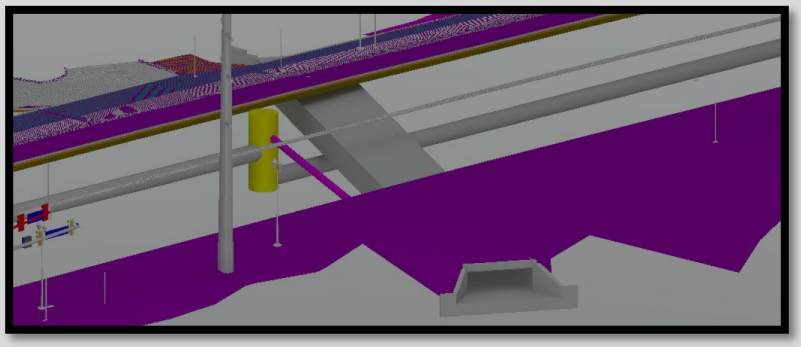
Cross-divisional coordination is required to drive consensus and understand target use

Change

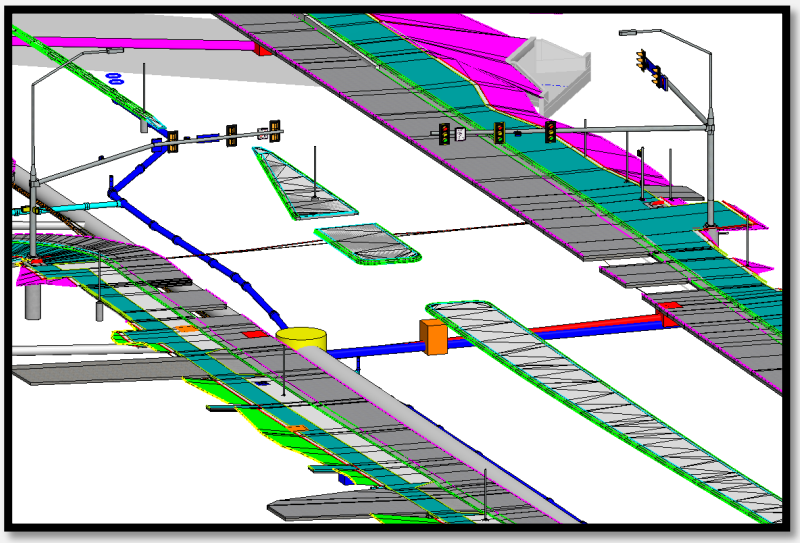
New processes for how asset data is stored, managed and accessed.

Utah Mobile LiDAR and BIM/CADD Integration Examples

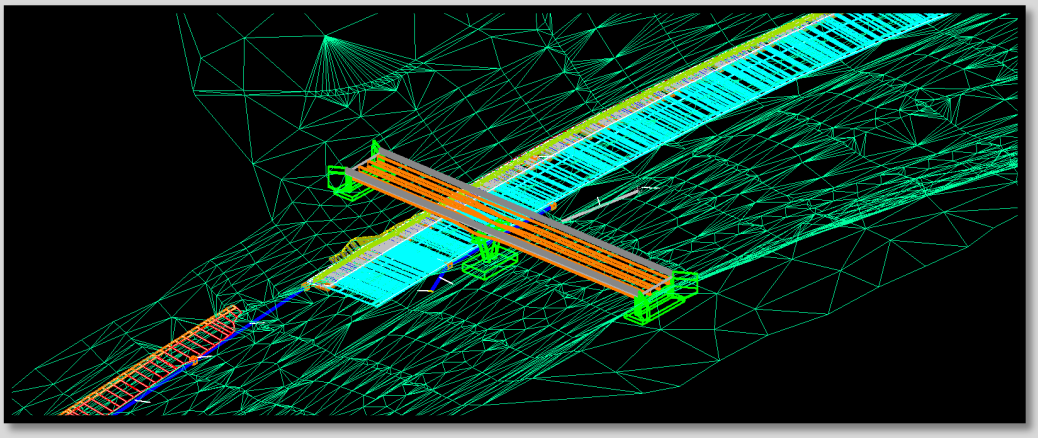
Inspectors use a rover and a tablet to collect survey data electronically.



A 3D model of underground utilities and a culvert.



A 3D model of a T intersection showing clash detection and utilities.



A 3D model showing topography and a bridge.

Ohio DOT: TAM Decision Support Tool Case Study

Act Informed by Data

Project Planning, Scoping, and Design

The Ohio DOT developed a Transportation Asset Management Decision Support Tool to provide a mechanism for ODOT managers to make decisions on adequate information for optimizing the performance and cost-effectiveness of infrastructure assets.

This tool supports investment decisions and demonstrates the return on those investments both quantitatively and qualitatively.

The tool was developed and implemented through the following approach:

Step 1: User Needs and Use Case Documentation

User needs and use cases for the proposed decision support tool were developed by a cross-functional team. Recommendations were provided through 1) a series of workshops with individual business and data subject matter experts, 2) engagement of executive management to establish decision-making values and priorities, and 3) review of tools of peer agencies.

Step 2: Develop Data Sources

Enterprise data needs were identified and associated reference and master data sets were developed from source systems.

Step 3: Configure Off-the-Shelf Business Intelligence Tools

Requirements for a configurable, off-the-shelf solution were developed to ensure long-term sustainability. A custom solution was identified as a risk.

Step 4: User Engagement and Training

Staff were allowed dedicated time away from routine business responsibilities. An agile approach was used for delivery.

Step 5: Data Quality Improvement

Integrating data and formalizing metrics exposed data quality issues. Resources and responsibilities for quality were assigned.

Value Delivered

Centralized portal for data access

Leadership

Executive endorsement and vision from onset

Expertise

Business Engagement

Data Architecture & Management

BI Software & Dashboards

Coordination

Cross-functional teams & training

Central office, field, and support staff

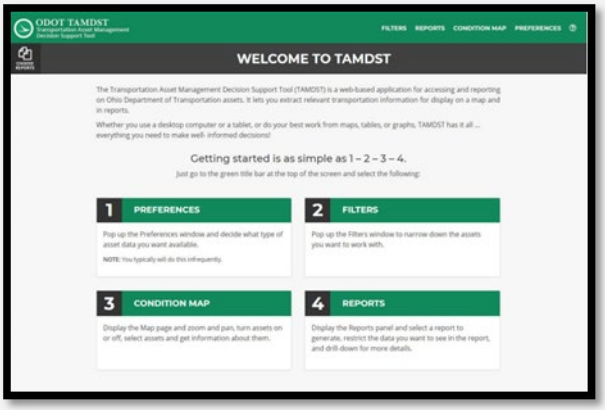
Change

Impacts to Roles and Responsibilities

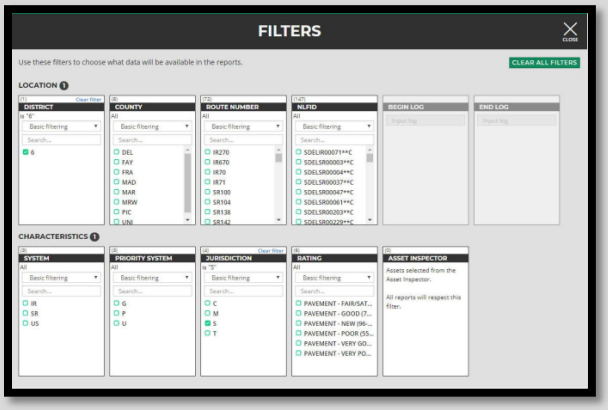
Accountability for data-informed decisions

Data Issues Exposed

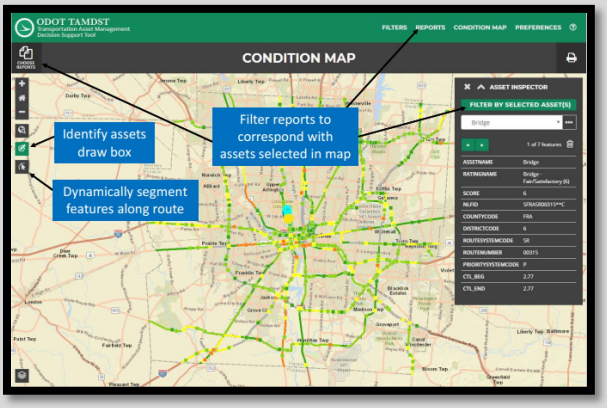
Ohio TAM Decision Support Tool Content Examples



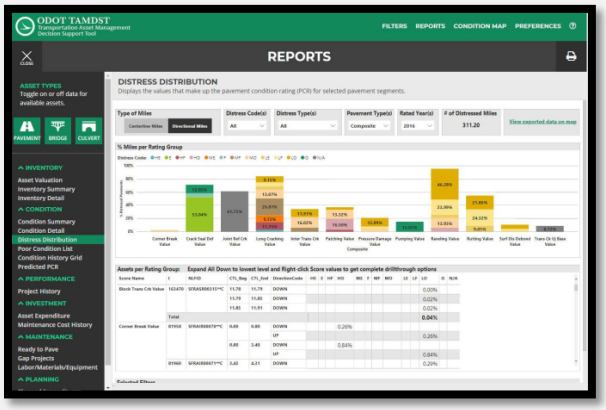
A landing page allows efficient access to data and reports, with options to filter, review maps, and generate reports.



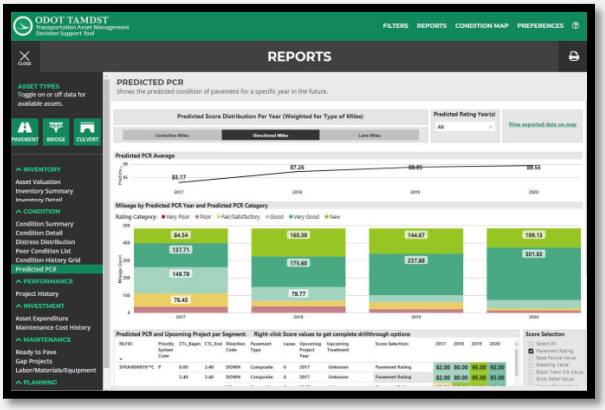
Filtering tools provide the ability to narrow the reported data by location as well as asset characteristics.



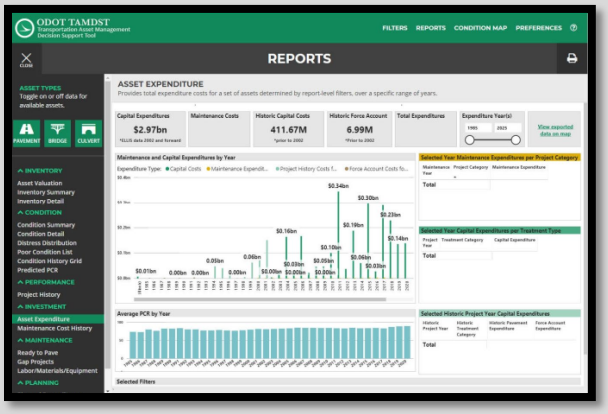
Condition maps provide network level screening based on color coded features, and to allow access to detailed asset information through an “Asset Inspector” tool.



Standard reporting is provided across a range of information areas, including inventory, condition, performance, investment, maintenance, and planning.



A report showing forecasted pavement conditions.



A report showing total expenditure by selected assets.

Appendix H: Facilitator Materials

This appendix offers supplementary materials to support the organization and preparation for formal application of the guidebook by a DOT.

Supplemental materials are organized around: Participant Engagement, Kickoff Meeting, Self-Assessment and Improvement Identification, and Improvement Evaluation.

Activity 1 – Initial Scoping

Outcome:

Focus for the process is selected and target participants identified.

Supporting Material:

Chapter 2, Use Case Selection guidance

Instructions:

The project sponsor and assessment facilitator should establish a specific scope (or focus) for improvement.

The focus should be identified based on the Chapter 2, Use Case Selection materials and the known needs and priorities of the agency or sponsoring business or technical area. Once any other interested executive and/or decision-making leadership.

Initial Scoping Preparation Materials

"Use Case Selection"
Ch. 2, Page ##

"Key Roles and Responsibilities"
Ch. 2, Page ##

Activity 2 – Participant Engagement

Outcome:

Targeted participants are informed of the need and value of their involvement.

Assessment team membership finalized.

Supporting Material:

Appendix H, Participant Engagement materials and meeting agenda

Chapter 2, Key Roles and Responsibilities guidance

Instructions:

Once a focus is selected, the facilitator must identify the desired membership of the assessment team with the input of the project sponsor.

1. **Invite targeted participants** to a preliminary engagement meeting.
2. **Deliver a preliminary engagement meeting** to share details of the commitment, answer questions, and identify any additional recommendations for team membership
3. **Secure commitment** from the participants, for the full process, including potential implementation support.

Additional Supporting Guidance:

At the preliminary engagement meeting the facilitator should:

- Communicate the specific nature of the planned assessment activities and an expectation for the level of effort involved.
- Identify the targeted focus area and anticipated value of improvements.
- Answer questions from the targeted participants (including how and why they were identified for involvement).
- Secure participant commitment and identify any additional recommendations for involvement.
- Make participants aware that they may also be asked to assist with implementation (for example, by supporting business or IT requirements development or by advocating for priority improvements impacting their business or technical area.

Before holding the preliminary meeting, the facilitator should be familiar with the guidebook process and general organization. It is important the

Participant Engagement Materials

Key Roles and Responsibilities
Chapter 2

facilitator can clearly discuss the identified need or motivation, as well as the specific process that will be followed by the team.

The facilitator should encourage any questions and discussion that might develop over the course of the meeting and also ask if any additional participants are recommended for inclusion in the team (noting that additional perspectives are always valuable, however the size of the group should be managed to allow for maximum engagement from all participants).

Activity 3 – Kickoff Meeting

Outcome:

Share context and establish a self-assessment meeting schedule with the assessment team.

Ensure participants are prepared for the upcoming self-assessment activities.

Supporting Material:

Appendix H, Kickoff Meeting Materials and Meeting Agenda

Chapter 2, Key Roles and Responsibilities guidance

Chapter 3, Detailed Technical Framework guidance

Instructions:

Once the assessment team has been engaged and the commitments of individual participants secured, hold a kickoff meeting.

The facilitator should:

1. **Provide a high-level overview** of the process and upcoming activities of the group.
2. **Detail the role of the facilitator** to
   - Guide the group activities.
   - Record, summarize, and share group consensus and notes.
3. **Explain individual roles** sharing expectations and desired perspectives from each individual participant in the team.
4. **Review key guidebook content** (such as the guidebook framework and element-level response templates) used during assessment and improvement identification activities.
5. **Share participant "homework"** will be required for detailed self-assessment and improvement identification meetings.
6. **Establish a meeting schedule** based on participant availability and the recommended meeting duration and frequency.
7. **Introduce the digital support tool** highlighting key contents, usefulness in preparation for upcoming meetings, and encouraging individual review after the meeting.

Additional Supporting Guidance:

Meetings should be kept to a maximum of 90 minutes with typically 1-2 meeting per week. This allows for sufficient

Kickoff Meeting Materials

Key Roles and Responsibilities
Chapter 2

Detailed Technical Framework
Chapter 3

Sample Kickoff Meeting Agenda and Supporting Materials
Appendix H

preparation and avoids participant fatigue.

With proper preparation and facilitation, a small group should expect to be able to complete self-assessment and improvement identification with approximately 10 minutes of discussion per element, allowing assessment of one Area in a typical meeting.

Given the wide range of perspectives on the team, the facilitator should acknowledge that, where agreement cannot be reached across all participants, the facilitator will have to make a final decision for the purposes of the effort, and that other views or perspectives will be captured in the detailed notes.

At the end of the kickoff meeting, the facilitator should identify when the first assessment meeting will be held, and communicate which guidebook sections should be reviewed in preparation for that discussion.

Activity 4 – Self-Assessment

Outcome:

Complete self-assessment activities.

Document the current and desired state of practice within the selected focus.

Identify potential improvements that close performance gaps.

Supporting Material:

Appendix H, Self-Assessment Meeting Materials and Meeting Agenda

Chapter 3, Area-Level and Section-Level Self-Assessment Guidance and Support Material

Appendix A-E, Element-Level Response Templates

Instructions:

After the kickoff meeting has completed, organize and hold self-assessment meetings.

1 **Prior to a meeting:**

- Coordinate schedules and send meeting invites.
- Communicate the Area(s) that will be the focus of individual meetings.
- Identify Chapter 3 materials that should be reviewed prior to the meeting.
- Encourage individual completion of element-level response templates prior to the meeting.

2 **During the meeting:**

- Use the TAM Data Assistant.
- Navigate the assessment framework, facilitating benchmarking and improvement selection discussion.
- Capture group consensus and any assessment or improvement specific notes and context.

3 **After the meeting:**

- Summarize and share meeting outcomes.
- Identify action items or specific clarification or context that were requested during the meeting's activities.

Assessment Guidance and Support

Area and Section-Level Assessment Support Materials
Chapter 3

Sample Self-Assessment Meeting Agenda and Support Materials
Appendix H

Element-Level Response Templates
Appendix A-E

Facilitator Tips:
Self-Assessment Meetings

Meeting Duration:
≤ 90 min.

Practical Considerations

Plan no more than 1-2 meetings per week and avoid extensive gaps between meetings.

Target Discussion

Focus on no more than two assessment areas in a meeting.

Activity 5 – Improvement Evaluation

Outcome:

Complete improvement evaluation activities.

List improvements prioritized for implementation.

Document potential implementation challenges, improvement impact and effort, and associated priority of individual improvements.

Supporting Material:

Appendix H, Improvement Evaluation Meeting Materials and Meeting Agenda

Chapter 4, Improvement Evaluation Guidance

Instructions:

Once the self-assessment activities are complete, evaluate and prioritize the selected improvements for implementation.

Organize and hold an improvement evaluation meeting.

1 **Prior to a meeting:**

- Coordinate schedules and send meeting invites.
- Highlight improvement evaluation concepts and needs
- Request individual review of the Chapter 4 materials.
- Export and share all identified improvements with participants
- Request individual review of improvements, identifying no more than five implementation priorities.
- Evaluate individual responses to identify the group's priorities and prepare to facilitate a focused improvement evaluation discussion.

Improvement Evaluation Materials

Improvement Evaluation
Chapter 4

Sample Evaluation Meeting Agenda and Supporting Materials
Appendix H

Facilitator Tips:
Improvement Evaluation

Meeting Duration:
≤ 90 min.

Practical Constraints

Focus on improvements at the current performance level, **do not** attempt to "leap frog" multiple performance levels.

Target Discussion

Use individual priorities to focus discussion. Begin priorities identified from individual responses.

Move forward with other improvements as time allows.

2 **During the meeting:**

- Use the TAM Data Assistant.
- Navigate improvements, facilitating prioritization, impact vs. effort, and challenge identification and discussion.
- Capture group consensus and evaluation notes or context.

3 **After the meeting:**

- Summarize and share meeting outcomes.
- Identify action items resulting from meeting activities.

Activity 6 – Summary and Communication

Outcome:

Executive engagement and support for implementation priorities.

Supporting Material:

Chapter 4, Current and Desired State Summary.

Chapter 4, Improvement Evaluation.

Chapter 4, Executive Communication.

Instructions:

Clear, effective communication of the current and desired state, key performance gaps, and priority improvements are essential to capturing support for improvement.

1. **Develop summary materials** that effectively communicate to the executive audience, in coordination with the Project Sponsor.
2. **Build support**, encouraging the assessment team to engage their management and stakeholders.
3. **Meet with decision-makers** sharing the process, priorities for investment, and consensus and support from cross-functional team members and stakeholders.

Additional Supporting Guidance:

If the TAM Data Assistant has been used, the facilitator can export summary charts as well as detailed assessment and improvement information in order to support these communication needs.

Further detail is provided in the guidance materials documented in Chapter 4, Evaluation and Summary of Results.

Summary and Communication Materials

Current and Desired State Summary
Chapter 4

Improvement Evaluation
Chapter 4

Executive Communication
Chapter 4

Activity 7 – Implementation Support

Outcome:

Improvement delivery.

Successful, long-term implementation.

Supporting Material:

Chapter 5, Implementation Support Guidance and Materials.

Instructions:

The Chapter 5, Implementation Support materials share organizational practices and case study materials which can be very useful in guiding agency implementation efforts.

All participants should review these materials and actively work to ensure the contexts and challenges identified in the initial assessment, improvement identification, and improvement evaluation activities are raised and that potential solutions are recommended.

Implementation Support Materials

Organizational Practices
Chapter 5

Case Studies
Chapter 5

Participant Engagement

Preliminary Meeting Invitation Email Template

From: <Assessment Facilitator>

Date: <Date>

Subject: TAM Assessment Process Preliminary Meeting; <Process Focus>

To: <Desired Members of Assessment Team>

Cc: <Project Sponsor>

You are invited to attend a preliminary meeting to discuss the process of examining our data and information system practices within <Process Focus>. This process will help our organization improve how data is defined, collected, accessed, analyzed, and used in the decision-making process specific to this asset. You are being asked to be a part of the assessment team for this process.

This preliminary meeting will review the planned assessment process, the roles & responsibilities, and expected level of involvement for team members. This meeting will hopefully receive your commitment as a part of this important effort.

The <Insert Duration> minute meeting is scheduled for <Meeting Date and Time> at <Meeting Location>. Please reach out if you will not be able to attend or if you have any questions.

Thank you,

<Assessment Facilitator>

Participant Engagement

<Process Focus> Preliminary Meeting Agenda

<Meeting Date>

<Meeting Location>

Objectives: Establish process need, inform participants of their need and value of involvement, finalize Assessment team

5 Minutes **Welcome and Meeting Overview**
- Welcome and Introductions
- Meeting objectives

15 Minutes **Assessment Process Context**
- Process need and focus area context
- Anticipated value of improvements

15 Minutes **Roles and Responsibilities of Team Members**
- Roles and expected level of involvement

15 Minutes **Assessment Team Implementation**
- Assessment team establishment
- Additional team members and contributors

10 Minutes **Questions and Feedback**

Kickoff Meeting

Kickoff Meeting Invitation Email Template

From: <Assessment Facilitator>

Date: <Date>

Subject: TAM Assessment Process Kickoff Meeting; <Process Focus>

To: <Members of Assessment Team>

Cc: <Project Sponsor>

Thank you for being a part of the <Process Focus> Assessment Team. This important effort will help our organization improve how data is defined, collected, accessed, analyzed, and used in the decision-making process for this asset.

You are invited to attend the kickoff meeting for <Process Focus>.

This meeting will give you a high-level overview of the process. It will introduce the guidebook framework, the element-level response template, and the digital tool. This meeting will also establish future meeting schedules and prepare you for the upcoming self-assessment activities.

The 90 minute meeting is scheduled for <Meeting Date and Time> at <Meeting Location>.
Please reach out if you will not be able to attend or if you have any questions.

Thank you,

<Assessment Facilitator>

Kickoff Meeting

Sample Kickoff Meeting Agenda

<Meeting Date>

<Meeting Location>

Objectives: Establish self-assessment meeting schedule and prepare participants for upcoming self-assessment activities

10 Minutes **Process Status Review and Meeting Objectives**
- Previous meeting review & current meeting objectives

20 Minutes **Assessment Process Overview**
- High-level overview of process
- Upcoming activities of the group

20 Minutes **Roles of Team Members**
- Explanation of expectations and desired perspectives from individual participants

20 Minutes **Introduction to Guidebook Content and Digital Tool**
- Framework and element-level response template walkthrough
- Introduction to digital tool, highlight of key contents and use

10 Minutes **Meeting Schedule and Preparations**
- Meeting duration and frequency
- Preparations for self-assessment activities

10 Minutes **Questions and Feedback**

Kickoff Meeting: Overview and Roles

Overview

Assess the Current and Desired State

Understand available data and information systems, tools, technologies, and practices for a specific asset or element within the data-life cycle. Identify associated data and information system improvements.

Prioritize Improvements

Evaluate identified improvements. Establish priority, relative impact, effort, and organizational challenges associated with potential improvement.

Communicate Improvements and Support Implementation

Create effective communication of the current and desired state, performance gaps, and priority improvements. Support implementation to realize successful, long-term improvements.

Key Roles

Asset Program Lead

Participant will be a program lead from within the selected TAM focus area. Typically, participants will be central office program management, project managers, analysts, or engineers who understand asset management decision-making needs from a policy perspective. Several such individuals should be included

Field Asset Management Leads

Typically, participants will be District asset managers, engineers, or maintenance supervisors who are involved in day-to-day decision making and execution. Must be able to share the practical realities, challenges, priorities, and constraints of field asset management staff. Several such individuals should be included

Information Technology and Staff

Key IT staff who have an understanding of existing technologies, applications, and priorities within the targeted area. Typically, participants will be IT relationship managers, system administrators, project managers, or business and technical analysts. Should be able to share data, technology, or application related context as business needs are discussed. Should be able to raise awareness of solutions leveraged in other business functions. Expected to share technical process, challenges, and constraints that would be anticipated when delivering IT solutions.

Data Life-Cycle Area Subject Matter Experts

Subject matter experts as appropriate to the asset program or specific data life-cycle areas, other key perspectives should be represented.

Data Life-Cycle Framework

A. Specify and Standardize		
A.1 Inventory, Condition and Performance Standards	A.1.a	Asset Inventory Data Model
	A.1.b	Asset Condition and/or Performance Data Model
	A.1.c	Design Model Standards
	A.1.d	Location Referencing
A.2 Treatments and Work Standards	A.2.a	Treatment and Work Data Model
	A.2.b	Treatment and Work Location Referencing
	A.2.c	Process Documentation and Management
A.3 Resource Allocation and Prioritization	A.3.a	Prioritization Factors
	A.3.b	Analysis Parameters
A.4 Metadata	A.4.a	Data Dictionary Standards and Guidelines
	A.4.b	Dataset Metadata Standards and Guidelines
A.5 Governance	A.5.a	Data Stewardship
	A.5.b	Data Standards & Guidelines Development / Adoption Processes
	A.5.c	Data Collection Approval / Coordination Practices
	A.5.d	Change Control (Systems and Data) Processes

B. Collect		
B.1 Inventory, Condition, and Performance Collection	B.1.a	Inventory, Condition, & Performance Coverage
	B.1.b	Inventory, Condition, & Performance Automation
	B.1.c	Inventory, Condition, & Performance Quality
B.2 Project Information Collection	B.2.a	Project Information Coverage
	B.2.b	Project Information Automation
	B.2.c	Project Information Quality
B.3 Maintenance Information Collection	B.3.a	Maintenance Information Coverage
	B.3.b	Maintenance Information Automation
	B.3.c	Maintenance Information Quality
B.4 Priority Criteria and Values Collection	B.4.a	Public Perception
	B.4.b	Decision Maker Values

C. Store, Integrate, and Access		
C.1 Databases	C.1.a	Efficient Storage
	C.1.b	Database Linkages
	C.1.c	Document Linkages
	C.1.d	Data Storage Capacity
C.2 Asset Life-Cycle Data Integration Workflows	C.2.a	Asset Management Data to Project or Work Order
	C.2.b	Project Planning to Project Development
	C.2.c	Project Development to Project Delivery
	C.2.d	Project Delivery to Asset Management Data
C.3 Other Data Integration Workflows	C.3.a	Revenue, Budget, and Expenditure Data
	C.3.b	Demand and/or Utilization Data
	C.3.c	Environmental Data
C.4 Data Access	C.4.a	Field Access to Data
	C.4.b	Public Access to Data
	C.4.c	Access Security

D. Analyze		
D.1 Data Exploration, Reporting, and Visualization	D.1.a	Analysis Environment
	D.1.b	Analysis Practices
	D.1.c	Analysis Tools
D.2 Modeling	D.2.a	Asset Performance Prediction
	D.2.b	Optimization / Prioritization

E. Act		
E.1 Resource Allocation and Prioritization	E.1.a	Performance Targeting
	E.1.b	Project Prioritization
E.2 Project Planning, Scoping, and Design	E.2.a	Data-Driven Project Planning and Scoping
	E.2.b	Data-Driven Project Design
E.3 Maintenance	E.3.a	Infrastructure Maintenance
	E.3.b	Equipment Maintenance

Kickoff Meeting

Kickoff Meeting Follow-Up Email Template

From: <Assessment Facilitator>

Date: <Date>

Subject: TAM Assessment Process Kickoff Meeting Follow-Up; <Process Focus>

To: <Members of Assessment Team>

Cc: <Project Sponsor>

Thank you for attending the <Process Focus> kickoff meeting.

In order to facilitate the completion of the upcoming self-assessment meetings, it is important for you to review the supplemental guidebook materials. These include the data life-cycle framework and the element-level response templates. It is also important to familiarize yourself with the digital tool.

Please find attached the meeting minutes and supplemental guidebook materials for you to review before our next meeting.

Here is a link to the digital tool: www.dataassessment.tam-portal.com.

Thank you,

<Assessment Facilitator>

Self-Assessment and Improvement Identification

Self-Assessment Meeting Invitation Email Template

From: <Assessment Facilitator>

Date: <Date>

Subject: TAM Self-Assessment Meeting; <Target Area> within <Process Focus>

To: <Members of Assessment Team>

Cc: <Project Sponsor>

You are invited to attend a self-assessment meeting for <Target Area> within <Process Focus>

This meeting will give you the <Target Area> overview and context. You will help complete self-assessment activities for <Target Area> which includes establishing current state of practice, documenting the desired state of the practice, and identifying improvements to close the performance gap. We will be using the supporting digital tool to aid in this process.

Attached are the previous meeting's minutes and <Guidebook Materials> that should be reviewed prior to this meeting.

Here is a link to the digital tool: www.dataassessment.tam-portal.com.

The 90-minute meeting is scheduled for <Meeting Date and Time> at <Meeting Location>. Please reach out if you will not be able to attend or if you have any questions.

Thank you,

<Assessment Facilitator>

Self-Assessment and Improvement Identification

Self-Assessment Meeting Agenda

<Meeting Date>

<Meeting Location>

Objectives: Complete self-assessment activities, document current and desired state of targeted area, and identify potential improvements to close performance gap.

Targeted Area: <Targeted area>

10 Minutes **Process Status Review and Meeting Objectives**
- Previous meeting review & current meeting objectives

10 Minutes **Area Overview and Context**
- General area overview

60 Minutes **Self-Assessment and Improvement Identification**
- Establish current state
- Document Desired State
- Identify Improvements

10 Minutes **Closing Discussion**
- Closing Comments or Questions
- Action Items
- Next Steps

Self-Assessment and Improvement Identification

Follow Up Email Template

From: <Assessment Facilitator>

Date: <Date>

Subject: TAM Assessment Process Self-Assessment and Improvement Identification Meeting <Target Area> within <Process Focus> Follow-Up

To: <Members of Assessment Team>

Cc: <Project Sponsor>

Thank you for attending the <Target Area> within <Process Focus> Self-Assessment and Improvement Identification meeting.

The key conclusions discussed in the meeting were <Meeting Summary>. For our next step, we will be focusing on <Next Target Area>.

In order to facilitate the completion of the upcoming self-assessment meeting, it is important for you to review the supplemental guidebook materials for <Next Target Area>. These include the data life-cycle framework and the element-level response templates. You may also review the assessment elements, benchmarks, and potential improvements here: www.dataassessment.tam-portal.com.

Attached are the meeting's minutes and <Guidebook Materials> that should be reviewed prior to the next meeting

Thank you,

<Assessment Facilitator>

Improvement Evaluation

Email to Gather Individual Responses

From: <Assessment Facilitator>

Date: <Date>

Subject: TAM Assessment Process Self-Assessment and Improvement Evaluation Meeting <Target Area> within <Process Focus> Follow-Up

To: <Members of Assessment Team>

Cc: <Project Sponsor>

In preparation for the upcoming Improvement Evaluation meeting.

The key conclusions discussed in the meeting were <Meeting Summary>. For our next step, we will be focusing on <Next Target Area>.

In order to facilitate the completion of the upcoming self-assessment meeting, it is important for you to review the supplemental guidebook materials for <Next Target Area>. These include the data life-cycle framework and the element-level response templates. You may also review the selected improvements and evaluation criteria in the supporting digital tool: www.dataassessment.tam-portal.com.

Attached are the meeting's minutes and <Guidebook Materials> that should be reviewed prior to the next meeting

Thank you,

<Assessment Facilitator>

Improvement Evaluation

Improvement Evaluation Meeting Invitation Email Template

From: <Assessment Facilitator>

Date: <Date>

Subject: TAM Improvement Evaluation Meeting; <Process Focus>

To: <Members of Assessment Team>

Cc: <Project Sponsor>

In preparation for the upcoming Improvement Evaluation meeting to evaluate the improvements selected in the previous Self-Assessment and Improvement selection meeting for <Process Focus>, please review the selected improvements and identify no more than five priorities for investment. Please pass along your prioritized improvements, along with your rational for selecting them, and some preliminary thoughts about their associated challenges to <Assessment Facilitator>.

Attached is the Chapter 4 Improvement Evaluation Handout for you to review along with a list of the improvements selected in the previous Self-Assessment and Improvement Selection meeting.

The upcoming 90-minute meeting is scheduled for <Meeting Date and Time> at <Meeting Location>. Please reach out if you will not be able to attend or if you have any questions.

Thank you,

<Assessment Facilitator>

Improvement Evaluation

<Process Focus> Improvement Evaluation Meeting Agenda

<Meeting Date>

<Meeting Location>

Objectives: Complete improvement evaluation activities, document potential implementation challenges and impacts, and prioritize improvements.

10 Minutes **Process Status Review and Meeting Objectives**
- Previous meeting review & current meeting objectives

50 Minutes **Improvement Evaluation Discussion**
- Review individual priorities
- Improvement impact vs. effort
- Implementation challenges

20 Minutes **High-Level Prioritization Discussion**
- Review assessment summary material
- Adjust improvement evaluation outcomes (based broader context)

10 Minutes **Questions and Feedback**

Improvement Evaluation Handout

Impact is characterized by the extent to which new or existing practices will transform TAM related business practices.

Effort is characterized by the level of resources and staff time required and the extent to which those can be incorporated into the responsibilities and budgets of existing business units.

Priority is established on the basis of when that improvement would be targeted for implementation, ranging from immediate action to being recognized for future, unplanned action.

Challenges can be categorized as into distinct categories of Time, Resource, Expertise, Coordination, Change, or Other.

Impact Evaluation

High Impact

Transforms current business in a way that addresses major process pain points, is likely to extend to multiple business units, and adds value to multiple business processes.

Medium Impact

Makes existing business processes significantly more efficient and effective, however may be within a limited area of business (e.g. a specific business function or process area).

Low Impact

Contributes a minor adjustment to an existing business process, but will not significantly change the business. In general, these improvements may already be informally in place, but are simply being formalized or being made clearer in the context of the program at large.

Effort Evaluation

High Effort

Requires a major commitment of resources and staff time, typically across multiple business units. Examples would include a major IT application, a statewide technology deployment, etc.

Medium Effort

May be incorporated within typical budgets and resources but would require planning and coordination, typically limited to a specific business function or process area.

Low Effort

Can be included within the routine responsibilities of a business unit or working group and typically able to be completed within a short timeframe.

Priority Evaluation

High Priority

Targeted for immediate action.

Medium Priority

Desired to begin within the next several investment or planning cycles (e.g. 1-2 years).

Low Priority

Recognized, but not anticipated for action within the near future and unlikely to be incorporated into near term planning activities.

Challenge Categorization

Time

Recommended when limited time is available for the given effort.

Resources

Recommended when level of resources or staff time would require executive approval.

Expertise

Recommended when the expertise required is not available to the DOT without specialized support.

Coordination

Recommended when engagement and agreement is required across many different areas of business within the DOT, particularly when many of the impacted business units do not typically work together as part of the routine business of the agency.

Change

Recommended when the improvement will significantly transform current business across multiple business units and processes, requiring extensive process reengineering and/or training to those impacted.

Improvement Evaluation

Improvement Evaluation Follow up Email Template

From: <Assessment Facilitator>

Date: <Date>

Subject: TAM Assessment Process Improvement Evaluation Meeting for <Process Focus> Follow-Up

To: <Members of Assessment Team>

Cc: <Project Sponsor>

Thank you for attending the <Process Focus> Improvement Evaluation meeting.

The key conclusions discussed in the meeting were <Meeting Summary>. For our next steps, we will be focusing on engaging with management and stakeholders and meeting with decision-makers. This will be aided by further summary materials, which will be developed and sent out in a later email.

In order to facilitate implementation, it is important for you to engage your management and stakeholders. Please feel free to reach out if you have any questions or need any help. You may also review the assessment and evaluation results here: www.dataassessment.tam-portal.com.

Attached are the meeting's minutes.

Thank you,

<Assessment Facilitator>

Appendix I: TAM Data Assistant Quick Reference Guide

This appendix provides instructions and a brief explanation of the web-based, supporting digital tool developed for this guidebook

TAM Data Assistant Overview

The web-based TAM Data Assistant is designed to support a streamlined user experience through the self-assessment, improvement identification, improvement evaluation, and results summary and communication activities of the Guidebook process.

Web-Based Tool Access

The tool is available on the web to anyone who is interested. User credentials are required, but only a valid email is needed to register an account.

The tool is hosted on the AASHTO TAM Portal website and directly accessible at the link provided to the right.

TAM Data Assistant Access
www.dataassessment.tam-portal.com

Note: If the direct link is not available, please check the AASHTO TAM Portal to see if an updated link is referenced.

Tool Organization

The tool is organized around the formal use cases and process described in Chapter 2 of the Guide. This organization results in five main pages linked from the Home Page.

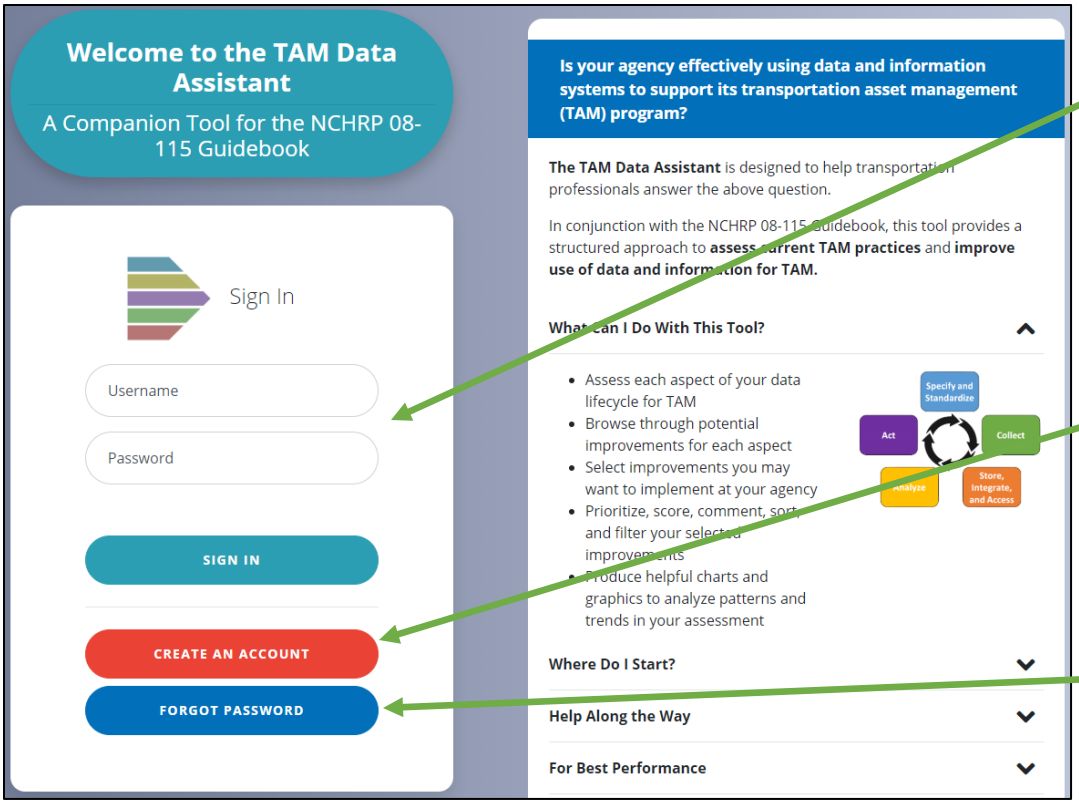
1. **Create.** This page allows the user to create new assessments. The user can create an unlimited number of individual assessments.
2. **Assess and Select Improvements.** This page allows the user to assess and document their current state of practice, desired state, and identify potential improvements against the 51 individual elements of the technical framework.
3. **Evaluate Selected Improvements.** This page allows the user to prioritize their selected improvements, while also evaluating anticipated implementation impact and effort, as well as identifying potential challenges
4. **Assessment Results:** This page provides summary results in a format useful for communication.
5. **All Assessments:** This page lists the assessments associated with the user's account, and can be used to easily navigate to any assessment the user has created.

Login Page

The login page prompts the user to enter their credentials in order to access the tool functionality. If a user has forgotten their login information, they are able to retrieve that information using the email address they associated with their account.

New users are also able to create a new account from this page.

Assessment Login Page Functionality



Main Elements of the Login Page

Username and Password Fields. The digital assessment tool requires a username and password to save assessments and keep them secure.

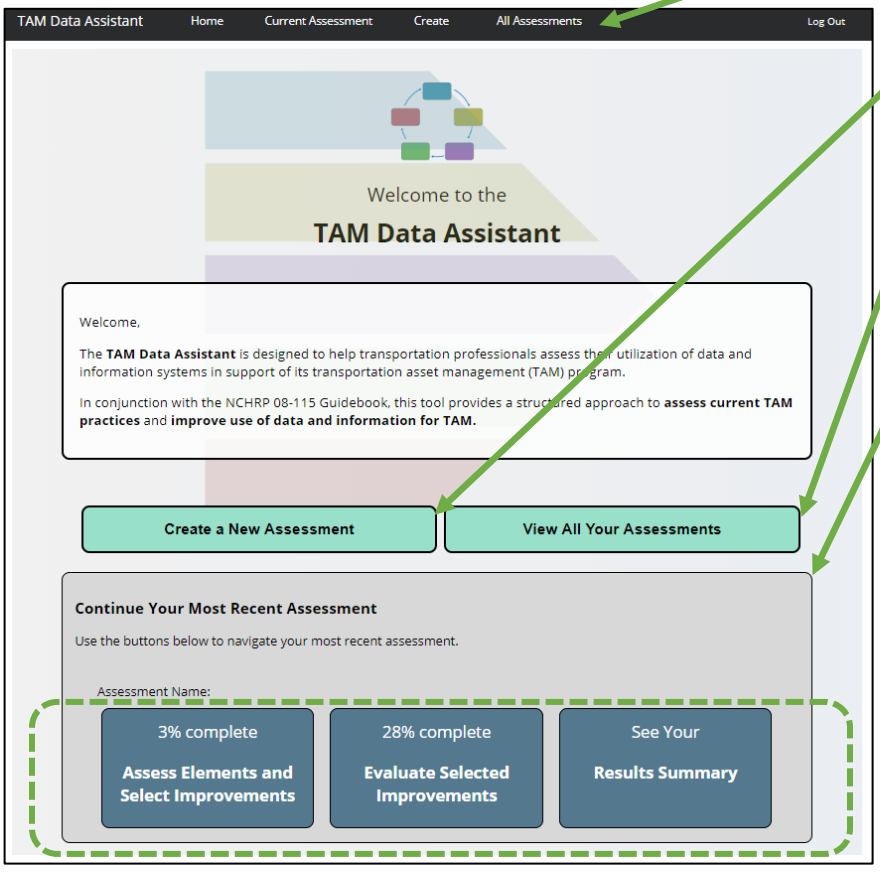
Create Account. Allows a new user to create an account which they can use to create assessments.

Forgot info. Allows the user to get their login information if they've forgotten it.

Landing Page

After logging in, the user finds landing page. From this page, new assessments can be created or previous assessments viewed. A dashboard also provides information summarized from the "Most Recent Assessment" selected by the user.

Assessment Landing Page Functionality



Navigation Menu. Easily navigate to any page of the tool.

Create. Click to begin the creation of a new assessment.

View All. Click for a summary view of all assessments associated with the user.

Most Recent. Shows information about the user's most recent assessment.

Results. Clicking takes the user to the results summary page.

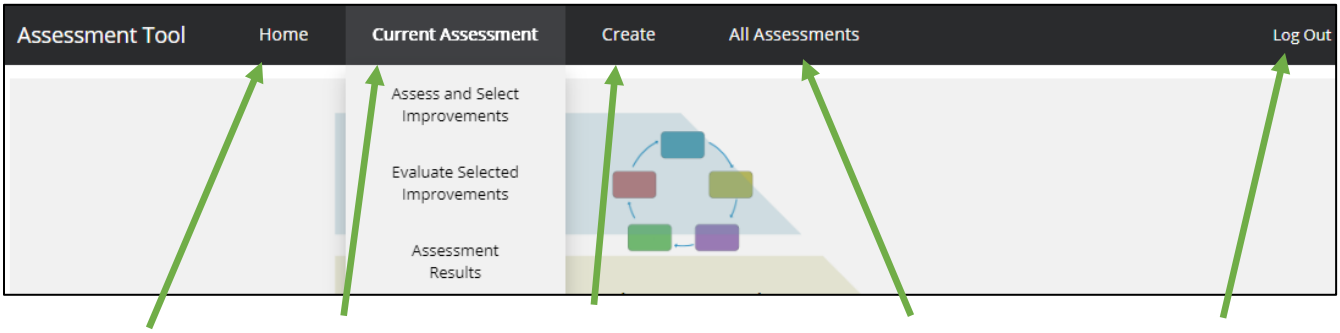
Evaluate. Shows how many improvements have been evaluated. Clicking takes the user to the improvement evaluation page.

Assess. Shows how much of the assessment is completed. Clicking takes the user to the most recently assessed element.

Assessment Menu

Each of the framework elements has its own landing page – color-coded to match its parent area's color scheme.

Assessment Menu Functionality



Home Link.

Returns the user to the page detailed in Figure 3.

Current Assessment Dropdown.

Current Assessment.

Takes the user the assessment homepage

Assess.

Takes the user to the assessment.

Evaluate.

Takes the user to the improvement evaluation.

Results.

Takes the user to the results summary page.

Create.

Takes the user to the assessment creation page. See figure 5.

All Assessments

Takes the user to a page showing all assessments associated with the user's account.

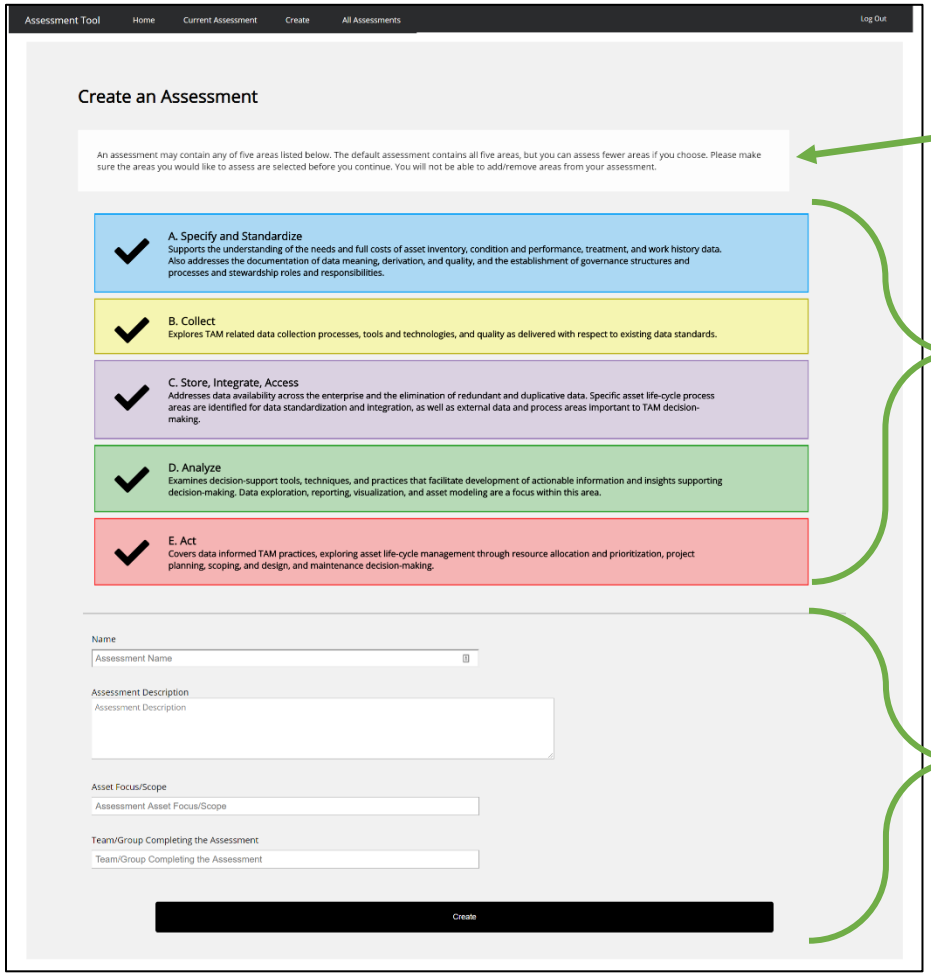
Log Out.

Logs the user out of the assessment tool.

Creation Page

This is where the user will create new assessments. Each assessment can be refined to a specific subset of the assessment areas within the Guidebook technical framework.

Assessment Creation Page Functionality



Directions. A brief set of instructions for using this page.

Assessment Area Selection. A description of each assessment Area. The user can select a group of areas they'd like to assess. This group can't be changed once the assessment is created.

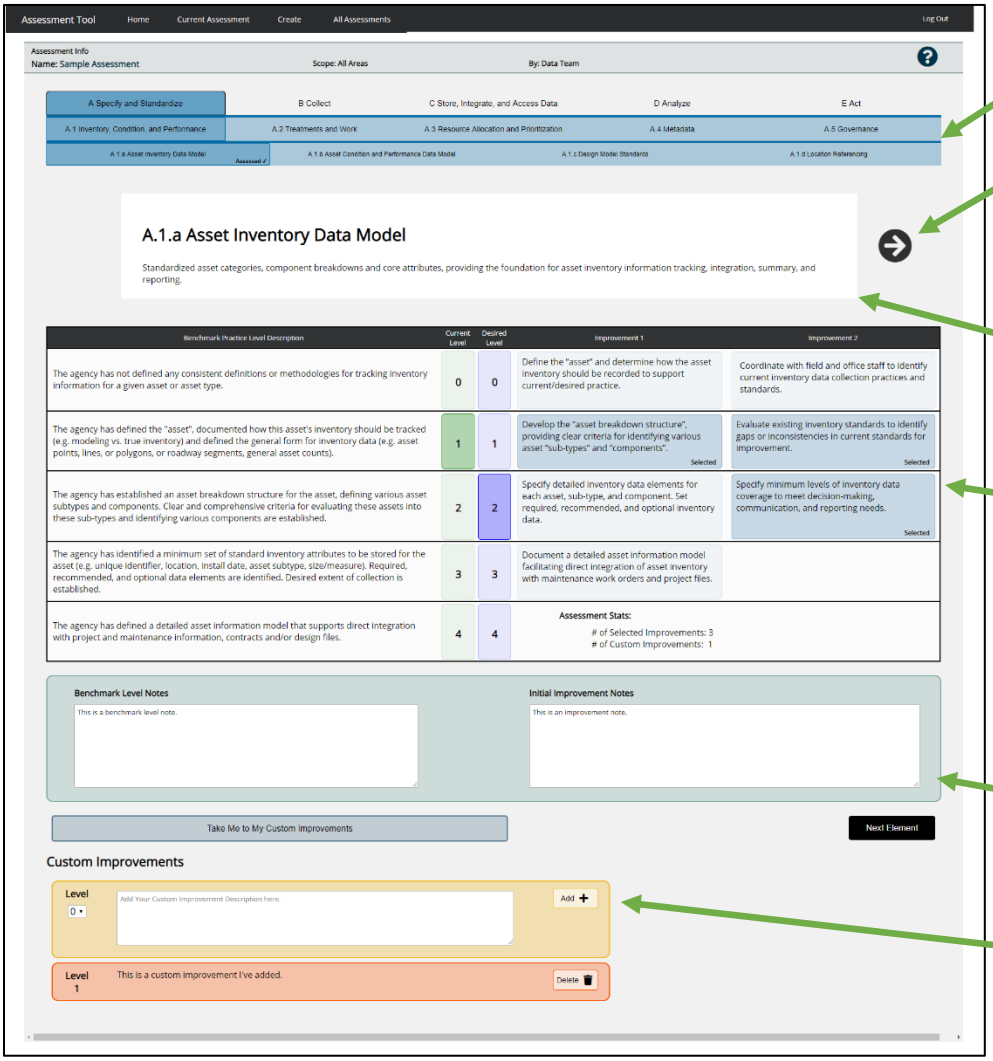
Assessment Information. The user can fill out information about the name, description, scope/focus, and group completing the assessment here.

Assessment Page

Each element has its own page with its own assessment table. Self-assessment can be completed by rating current and desired practice levels and selecting potential improvement activities by click within their associated boxes.

This functionality replaces the need for print response templates found in Appendices A-E.

Assessment Page Functionality



Navigation. Tabbed navigation for quick navigation about the assessment. There are also "Next" buttons for navigating to the next element.

Element Description. Brief description of the element being assessed.

Assessment Table. The user can set current and desired level of the element based on the description, and choose improvements related to the element.

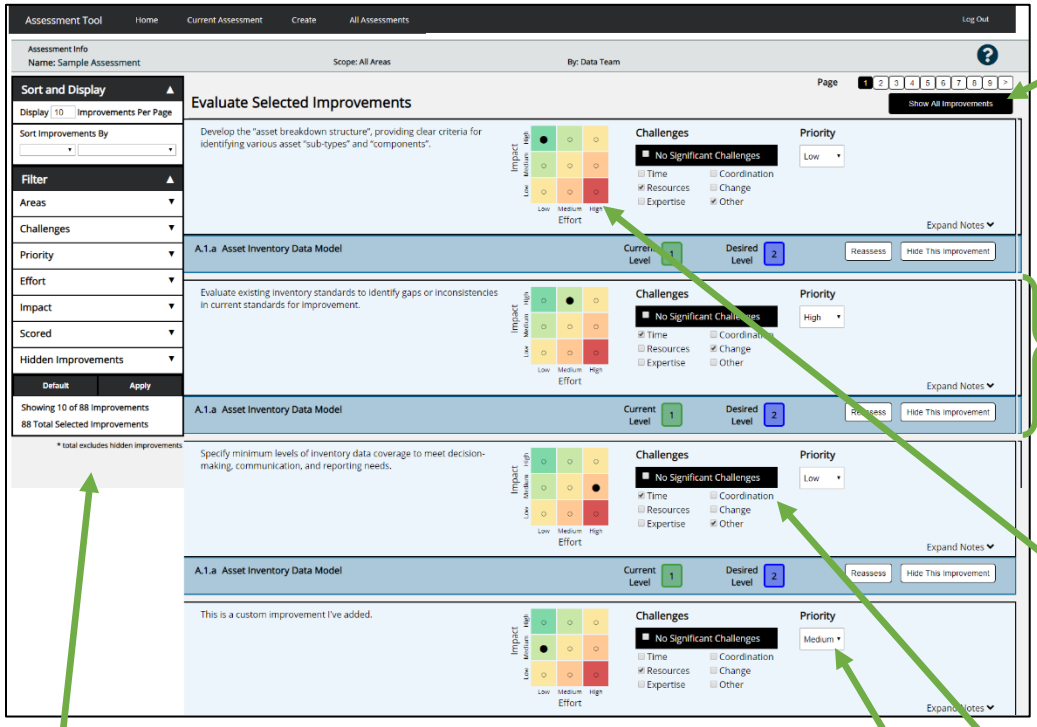
Notes Boxes. The user can take notes about their choices.

Custom Improvements. The user can write their own improvements for consideration.

Improvement Evaluation Page

This page collects and displays the improvements selected by the user. It features a number of tools to aid in navigating the improvement evaluation process.

Improvement Evaluation Page Functionality



Show All. Toggles displaying all improvements on one page.

Improvement Panel. Display a description of the improvement, and the ability to evaluate it in the following ways:

Impact/Effort. The user can characterize the improvement by the impact on the agency and the effort required.

Challenge Type. The user can specify some challenges associated with the improvement.

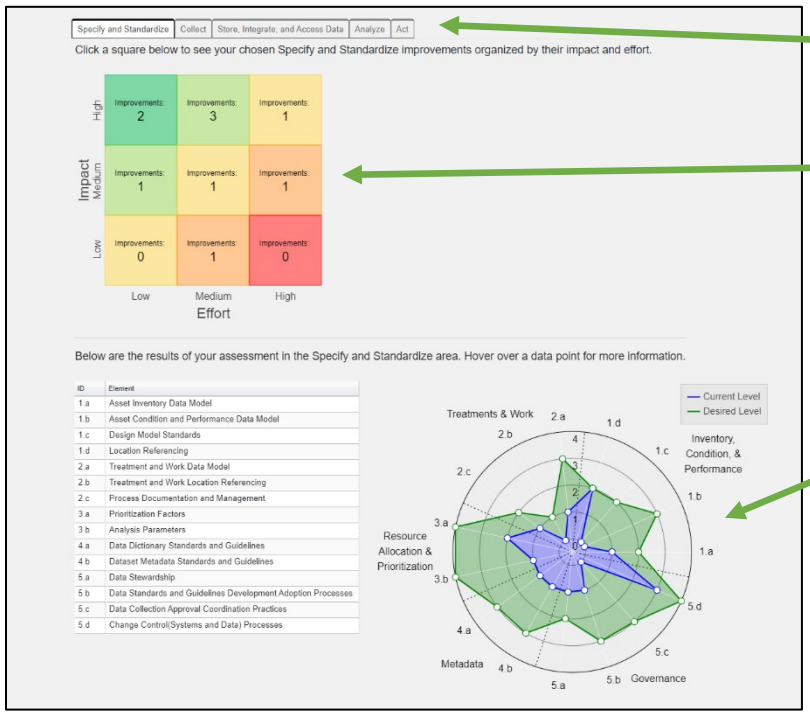
Priority. Users can choose Low, Medium, or High priority.

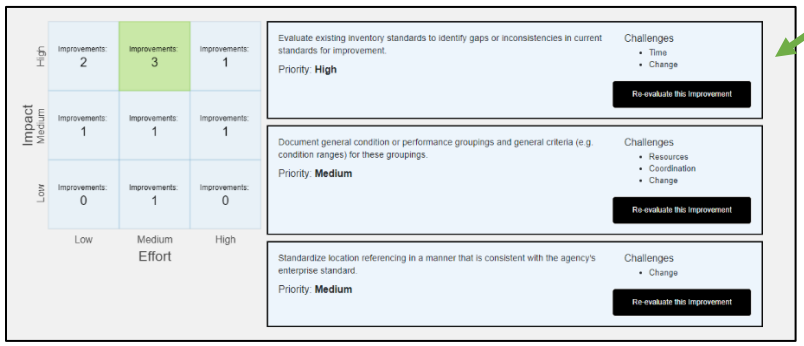
Sort & Filter. Allows the user to customize the improvements that are displayed. They can sort the improvements, or filter the improvements so only certain improvements are shown.

Results Page

This page provides a results summary useful for reviewing outcomes and summary and communication activities.

Results Page Functionality





Area Navigation. Show results from a certain area.

Impact/Effort Grid. Shows the number of improvements in the area that fall in each box of the grid.

Radar Chart. Shows the current and desired level for each Element in the Area.

Improvement Detail. Clicking an Impact/Effort box shows panels summarizing the improvement and its evaluations.

Reassessment. Users can reassess an improvement directly from the results page.

Excel Export

The user can export their results from the Improvement Evaluation page, the Results page, and the Current Assessment page. The export is an Excel spreadsheet with three worksheets: 1) Assess, 2) Evaluate, and 3) All.

The Assess sheet gives the element-by-element results of the current and desired practice assessment.

The Evaluate sheet gives information about each improvement, including priority, impact, effort, and identified challenges.

The All sheet joins the Assess and Evaluate results, giving all information about each improvement.

Assess Sheet Content

- Element ID
- Label
- Area Name
- Section Name
- Element Name
- Description
- Current Level
- Desired Level
- Assessment Notes
- Improvement Notes

Evaluate Sheet Content

- Improvement ID
- Description
- Associated Element
- Impact
- Effort
- Priority
- Time Challenge
- Resource Challenge
- Expertise Challenge
- Coordination Challenge
- Change Challenge
- Improvement Evaluation Note

Custom (indicates if custom improvement)

Status (indicates if selected improvement)

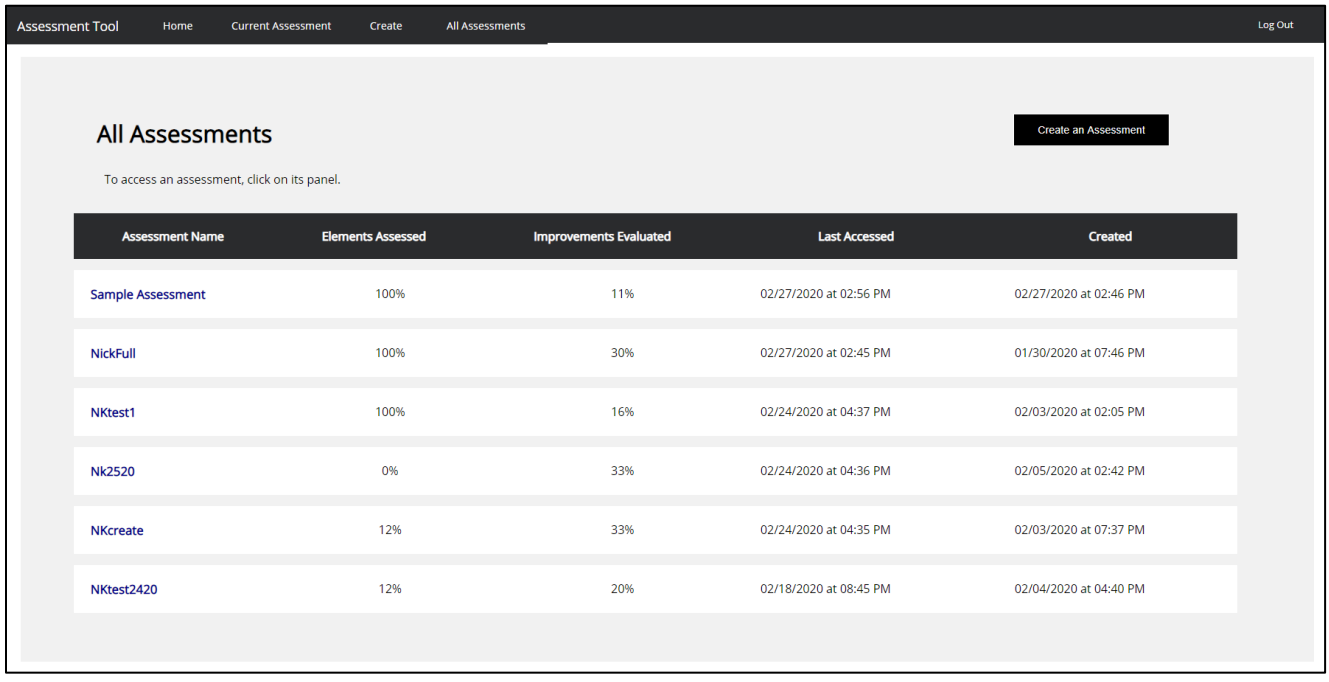
All Assessments Page

This page lists all the assessments that belong to the logged-in user.

The page shows the completion percentage of the Assessment and Improvement Evaluation activities based on the defined scope of the individual assessment. The date and time each assessment was created and last accessed are also provided.

Clicking a row will take the user to that assessment.

All Assessment Page Functionality



Current Assessment Page

This page gives some information about the current active assessment and provides links to the various sections of the assessment tool. The user can edit information about the Assessment here.

Current Assessment Page Functionality