# Transportation Asset Management Webinar Series

## Webinar 70

# Information and Systems

Sponsored by FHWA and AASHTO

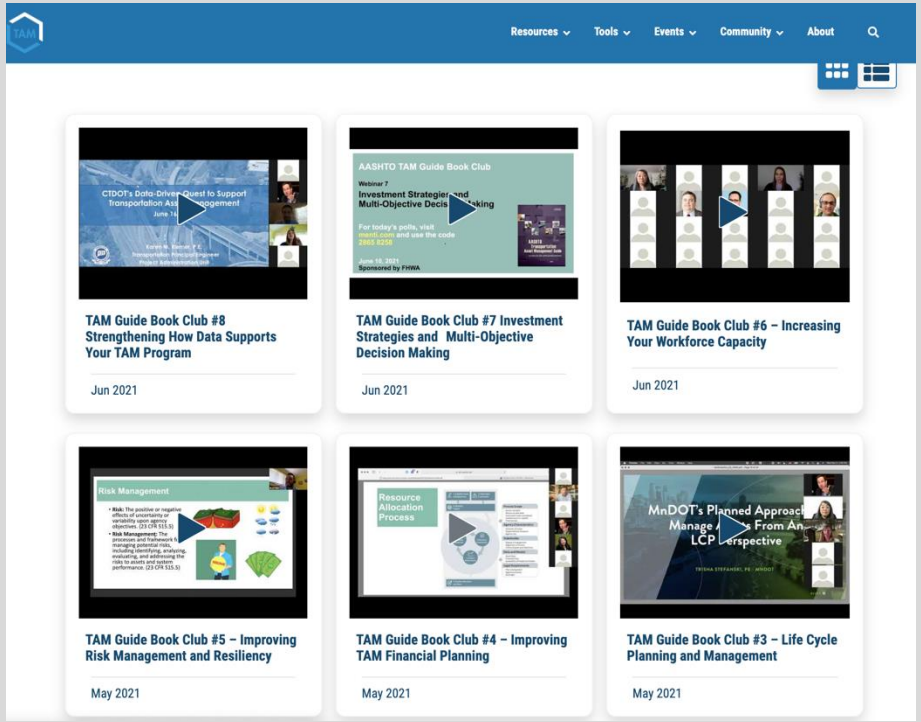
U.S. Department of Transportation
Federal Highway Administration

AASHTO
The Voice of Transportation

**August 21, 2024**

# FHWA/AASHTO Asset Management Webinar Series

- This is the 70th in a webinar series that has been running since 2012
- Webinars are held every two months, on topics such as off-system assets, asset management plans, asset management and risk management, and more
  - Usually, the 3rd Wednesday of the month, 2PM Eastern
- We welcome ideas for future webinar topics and presentations
- Submit your questions using Zoom's chat feature



# Welcome

FHWA and the AASHTO Sub-Committee on Asset Management are pleased to sponsor this webinar series

- Sharing knowledge is a critical component of advancing asset management practice
- FHWA Asset Management Hub: https://www.fhwa.dot.gov/asset/pubs.cfm

# Webinar Objectives

- Learn about the TAM Guide Chapter 7 – Information and Systems.
- Highlight how data drives TAM activities and the importance of well-managed data and integrated information systems.
- Feature best practices from state transportation agencies regarding information systems and TAM.

# Webinar Agenda

**2:00** **Welcome, Overview, and Agenda**
Anna McLaughlin, AASHTO
Tashia Clemons, FHWA
Hyun-A Park, Spy Pond Partners

**2:10** **Topic Overview - Digital TAM Guide Chapter 7**
Will Duke, Spy Pond Partners

**2:25** **Lifecycle BIM for Infrastructure: A Business Case for Project Delivery and Asset Management.**
Chris Williges, HDR

**2:40** **Virginia DOT Guardrail Inspection Program Innovations**
Wenling Chen & Matt Barret, Virginia DOT

**2:55** **Indiana DOT AI Project Bundling for Improved TAM Results**
Louis Feagans, Indiana DOT

**3:10** **Q&A, Discussion and Next Steps**
Hyun-A Park, Spy Pond Partners
Anna McLaughlin, AASHTO

# AASHTO Transportation Asset Management Guide

# Information & Systems

August 21, 2024

spy pond partners, llc

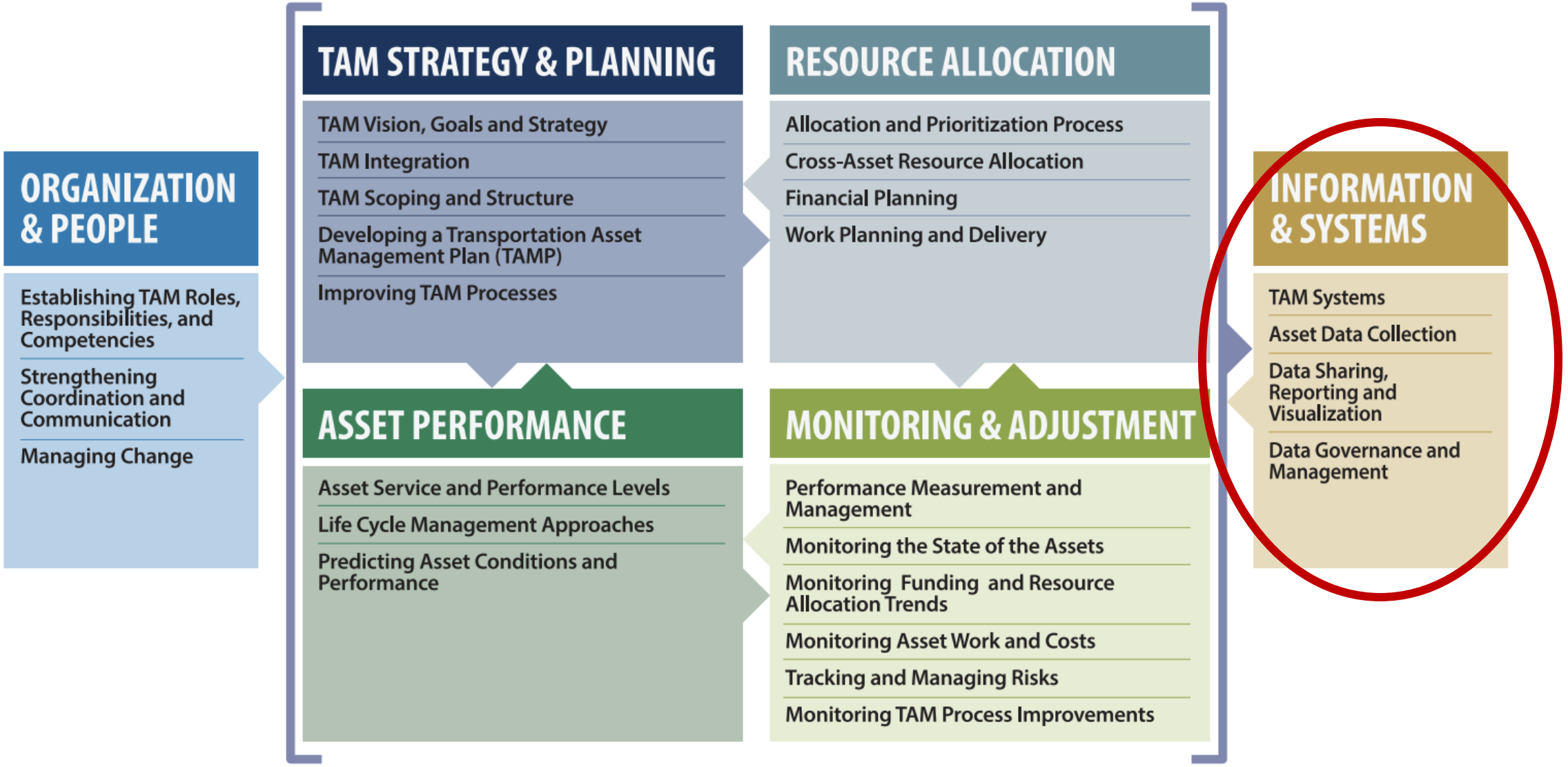
## NCHRP 08-137

# Updates to the Digital Edition of the AASHTO Transportation Asset Management Guide

spy pond partners, llc

applied pavement TECHNOLOGY

# TAM Guide Framework



# Information and Systems

**Planning for information needs and thoughtful investment in data and systems is essential to a successful TAM program.**

- Asset management is a data-driven activity
- Trusted, well understood, accessible data are needed.
- Collecting and maintaining data and developing and implementing systems is a costly endeavor.
- Agencies have limited resources for data collection and management.

# Information and Systems

**This chapter helps agencies answer critical questions to identify asset management data needs.**

- What decisions do we need to make or questions need to be answered?
- What data items are required or desired? What value will each data item provide?
- What level of detail and accuracy is required? How often should data be updated?
- How can data be sustainably integrated and made accessible and useful to targeted users.

# Information and Systems

## So what's new in the Digital TAM Guide?

- New Sections
- New Research
- New Practice Examples
- New Checklists
- New How To's
- New Videos
- New Audio
- New Knowledge Check
- New TAM Assessment

# Information and Systems



This section has the following parts:

1. **TAM Data and Systems**. Addresses the data and systems necessary to support TAM decision-making.
2. **Why Integrate?**. Describes the benefits to be derived from integrated views of asset information.
3. **Planning for TAM Information Integration**. Discusses different levels of information integration and steps to strengthen integration.
4. **Integrating Asset Information Across the Life Cycle**. Addresses the use of tools, standards and processes to manage data for an asset over its entire life cycle from scoping and design through construction, maintenance and operation.
5. **TAM Data Guide**. Highlights the importance of effective data and information systems in supporting Transportation Asset Management (TAM) programs.

NEW

# Information and Systems

NEW SECTION

Section 7.5 Home | 7.5.1 | 7.5.2

This section has the following parts:

1. **Building Information Modeling**. Discusses Building Information Modeling (BIM) for Transportation as an emerging practice that integrates asset data across the planning, design, construction, operation, and lifecycle management of transportation assets.
2. **CRP Project TFRS-02**. Discusses the completion of CRP Project TFRS-02 and the resulting publication of CRP Special Release 4, focusing on the application of Building Information Modeling (BIM) in transportation asset management.

# Information and Systems

## New Research and Resources

**Building Information Modeling (BIM) for Bridges and Structures**
August 8, 2023 | FHWA

**BIM Beyond Design Guidebook**
January 1, 2020 | Transportation Research

**Establishing Multisource Data-Integration Framework for Transportation Data Analytics**
February 19, 2020 | Journal of Transportation

**National Transit Database**
October 17, 2023 | FTA

**Collaborative Practices for Performance-Based Asset Management Between State DOTs and MPOs**
January 1, 2021 | TRB

**Guidebook for Data and Information Systems for Transportation Asset Management**
December 31, 2022 | Transportation

**Transit Asset Management Systems Handbook**
October 15, 2020 | FHWA

and more…

# Information and Systems

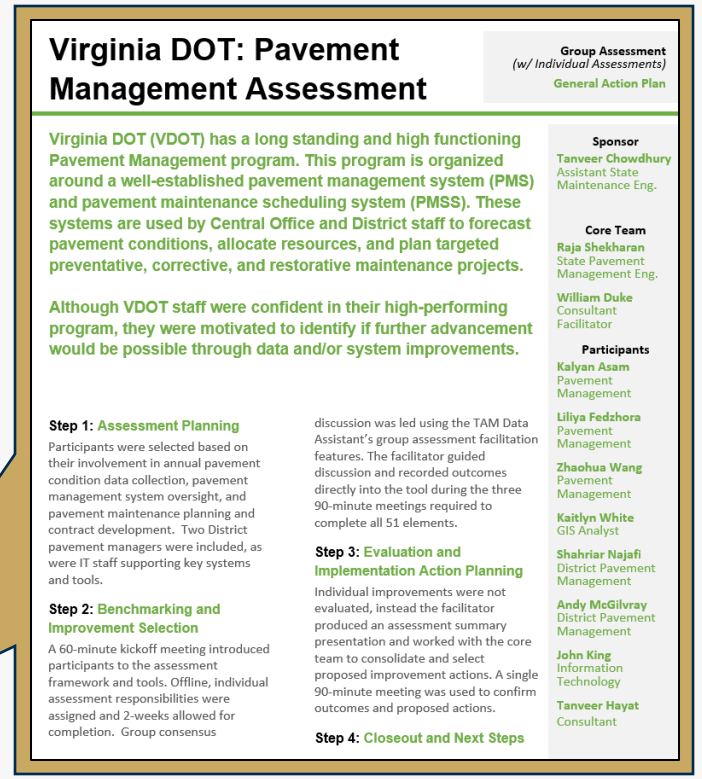
## New Practice Examples

Practice Example
**VDOT Pavement Management Systems Assessment**

### Virginia DOT

Virginia DOT (VDOT) has a long standing and high functioning Pavement Management program. This program is organized around a well-established pavement management system (PMS) and pavement maintenance scheduling system (PMSS). These systems are used by Central Office and District staff to forecast pavement conditions, allocate resources, and plan targeted preventative, corrective, and restorative maintenance projects. Although VDOT staff were confident in their program, they were motivated to identify if further improvement would be possible through data and/or system improvements.

**Note: This practice example was derived from NCHRP Final Research Implementation Report 08-115: Guidebook for Data and Information Systems for Transportation Asset Management. More TAM Data Assessment research implementation examples are available at: https://www.tamdataguide.com/research-implementation-examples/*



**Virginia DOT: Pavement Management Assessment**

Group Assessment
*(w/ Individual Assessments)*
General Action Plan

Virginia DOT (VDOT) has a long standing and high functioning Pavement Management program. This program is organized around a well-established pavement management system (PMS) and pavement maintenance scheduling system (PMSS). These systems are used by Central Office and District staff to forecast pavement conditions, allocate resources, and plan targeted preventative, corrective, and restorative maintenance projects.

Although VDOT staff were confident in their high-performing program, they were motivated to identify if further advancement would be possible through data and/or system improvements.

**Step 1: Assessment Planning**
Participants were selected based on their involvement in annual pavement condition data collection, pavement management system oversight, and pavement maintenance planning and contract development. Two District pavement managers were included, as were IT staff supporting key systems and tools.

**Step 2: Benchmarking and Improvement Selection**
A 60-minute kickoff meeting introduced participants to the assessment framework and tools. Offline, individual assessment responsibilities were assigned and 2-weeks allowed for completion. Group consensus discussion was led using the TAM Data Assistant's group assessment facilitation features. The facilitator guided discussion and recorded outcomes directly into the tool during the three 90-minute meetings required to complete all 51 elements.

**Step 3: Evaluation and Implementation Action Planning**
Individual improvements were not evaluated, instead the facilitator produced an assessment summary presentation and worked with the core team to consolidate and select proposed improvement actions. A single 90-minute meeting was used to confirm outcomes and proposed actions.

**Step 4: Closeout and Next Steps**

**Sponsor**
Tanveer Chowdhury
Assistant State Maintenance Eng.

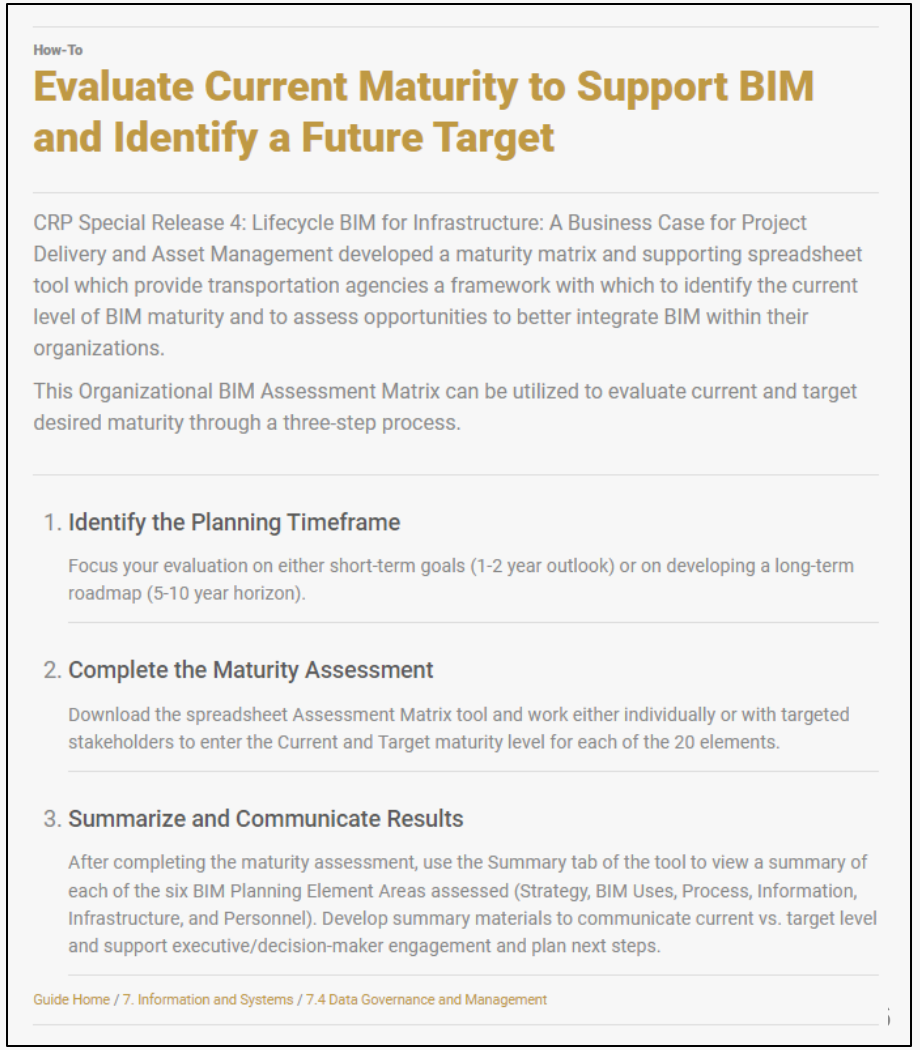
**Core Team**
Raja Shekharan
State Pavement Management Eng.
William Duke
Consultant Facilitator

**Participants**
Kalyan Asam
Pavement Management
Liliya Fedzhora
Pavement Management
Zhaohua Wang
Pavement Management
Kaitlyn White
GIS Analyst
Shahriar Najafi
District Pavement Management
Andy McGilvray
District Pavement Management
John King
Information Technology
Tanveer Hayat
Consultant

# Information and Systems

## New How To's

- Perform a Data Management Maturity Assessment
- Perform a Data Value Assessment and Develop a Data Value Improvement Plan
- Perform a TAM Data Assessment
- Evaluate BIM Maturity and Identify a Future Target
- Evaluate ROI for BIM



How-To

### Evaluate Current Maturity to Support BIM and Identify a Future Target

CRP Special Release 4: Lifecycle BIM for Infrastructure: A Business Case for Project Delivery and Asset Management developed a maturity matrix and supporting spreadsheet tool which provide transportation agencies a framework with which to identify the current level of BIM maturity and to assess opportunities to better integrate BIM within their organizations.

This Organizational BIM Assessment Matrix can be utilized to evaluate current and target desired maturity through a three-step process.

1. Identify the Planning Timeframe

   Focus your evaluation on either short-term goals (1-2 year outlook) or on developing a long-term roadmap (5-10 year horizon).

2. Complete the Maturity Assessment

   Download the spreadsheet Assessment Matrix tool and work either individually or with targeted stakeholders to enter the Current and Target maturity level for each of the 20 elements.

3. Summarize and Communicate Results

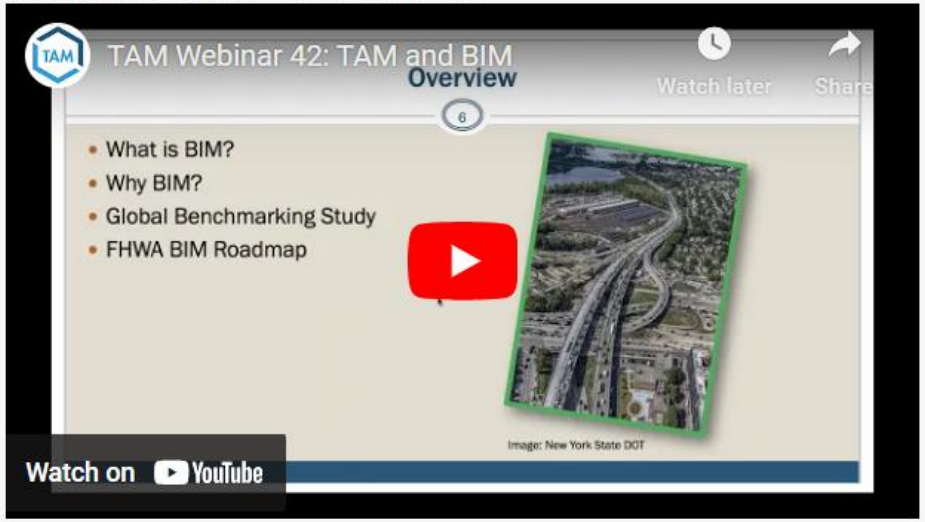
   After completing the maturity assessment, use the Summary tab of the tool to view a summary of each of the six BIM Planning Element Areas assessed (Strategy, BIM Uses, Process, Information, Infrastructure, and Personnel). Develop summary materials to communicate current vs. target level and support executive/decision-maker engagement and plan next steps.

Guide Home / 7. Information and Systems / 7.4 Data Governance and Management

# Information and Systems

## New Videos

TAM Webinar #42 - TAM and BIM




TAM Webinar #51 - TAM and Transportation Systems Management and Operations (TSMO)

# Information and Systems

## New Topics

## Data Management, Analytics & Visualization

**This page features information on managing and maintaining your data.** Whether you want to monitor data
more effectively, bolster your data collection systems, or improve your data modeling, you can find what you need here.

### Overview:

Transportation asset management is by its nature a data intensive activity. State DOT's and other transportation agencies are facing increasing pressures to do more with their limited TAM resources. Whether you want to monitor data more effectively, bolster your data collection system, advance your data modeling, or improve your data-driven communication, you can find what you need here.

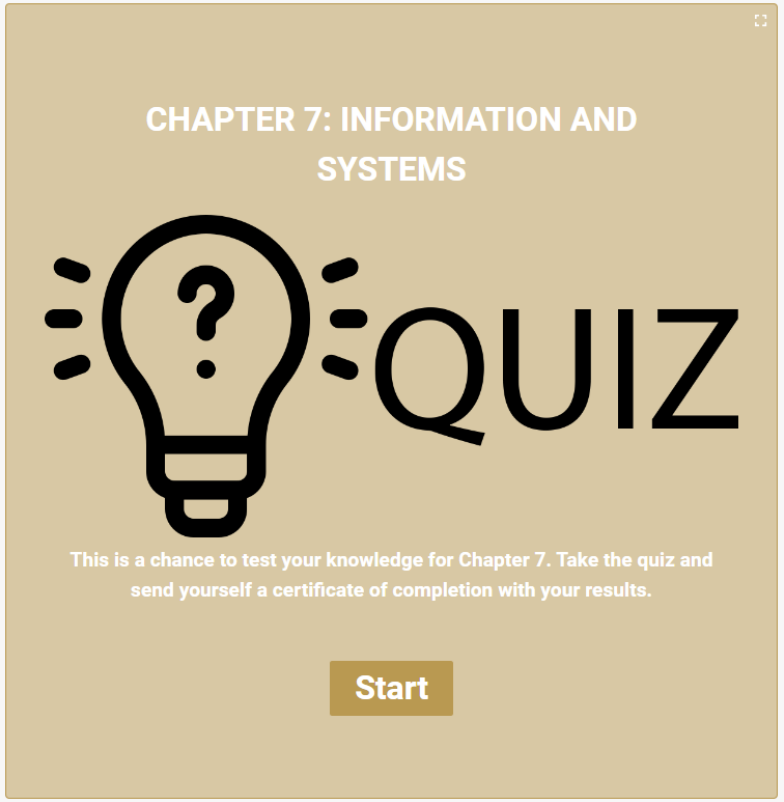
# Information and Systems

## New Audio

Chapter 7 Information and Systems

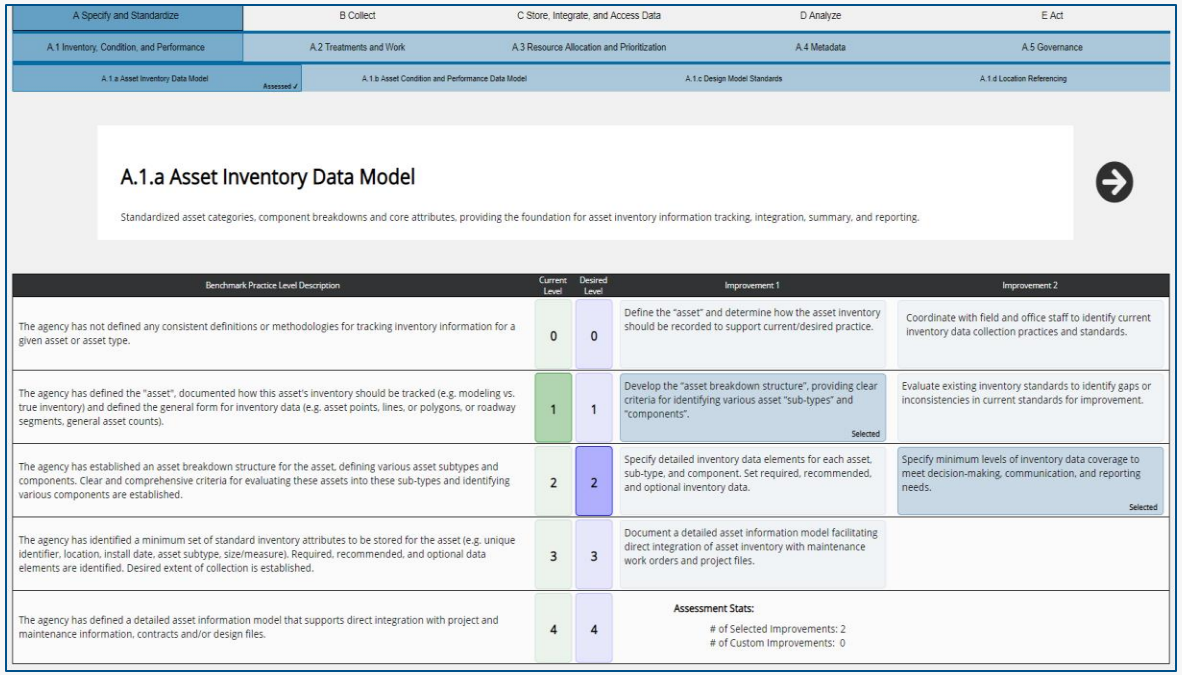
# Information and Systems

## New Knowledge Checks

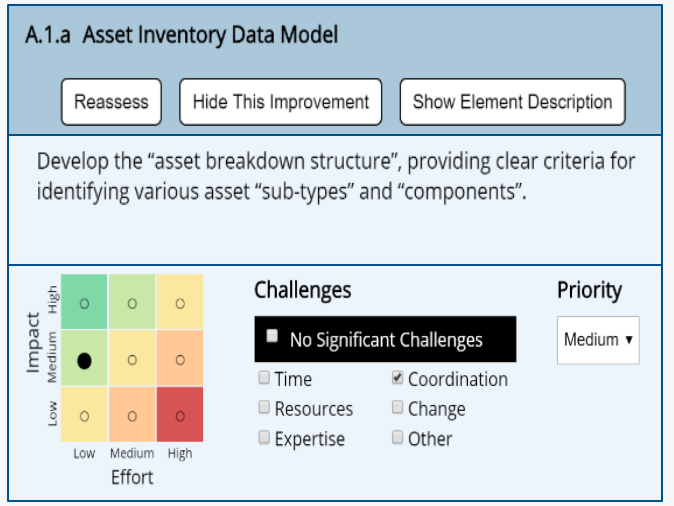


# Information and Systems

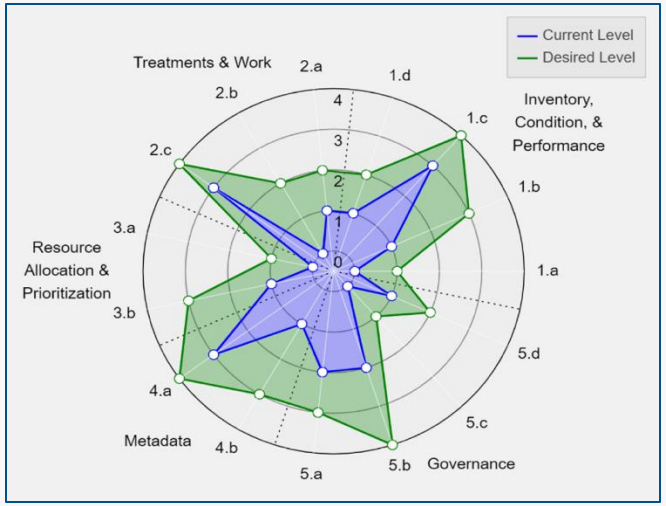
## New TAM Data and Data Management Assessments




Benchmark current and desired practices




Select and prioritize candidate improvements




Summarize and communicate outcomes

# Thank You

**Please contact me any time!**

**Will Duke**
**Spy Pond Partners**
wduke@spypondpartners.com

# AASHTO/ FHWA TAM Webinar #70

*Lifecycle BIM for Infrastructure - A Business Case for Project Delivery and Asset Management*

August 21, 2024

# Agenda

- Research Overview
- What is BIM?
- BIM Use Cases
- BIM Benefits and Costs
- BIM ROI Tool
- Best Practices and Lessons Learned

# TFRS-02 Lifecycle BIM for Infrastructure

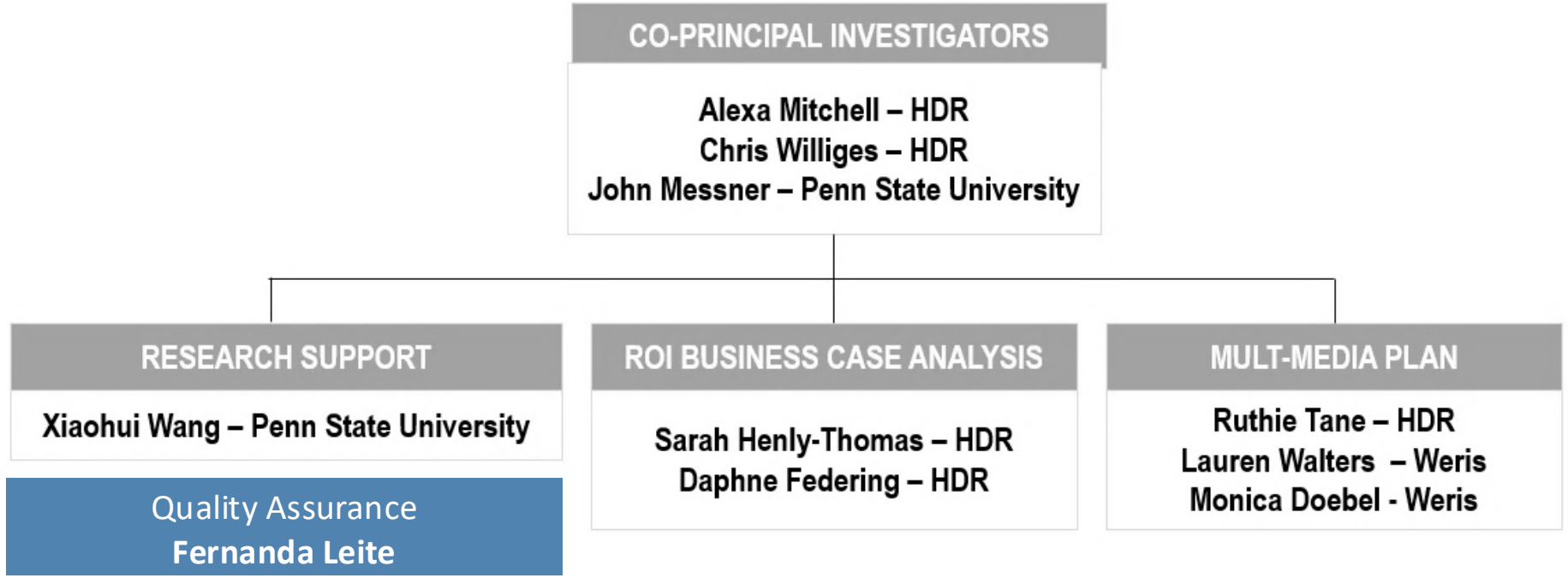
A Business Case for Project Delivery and Asset Management

Study funded by the Turner Fairbanks Highway Research Center via TRB

"The objective of the study is to evaluate and communicate the business case for BIM deployment in the United States"

1. Can benefits of BIM be quantified?
2. Are the benefits substantial to justify investment?
3. How do we realize maximum benefits?

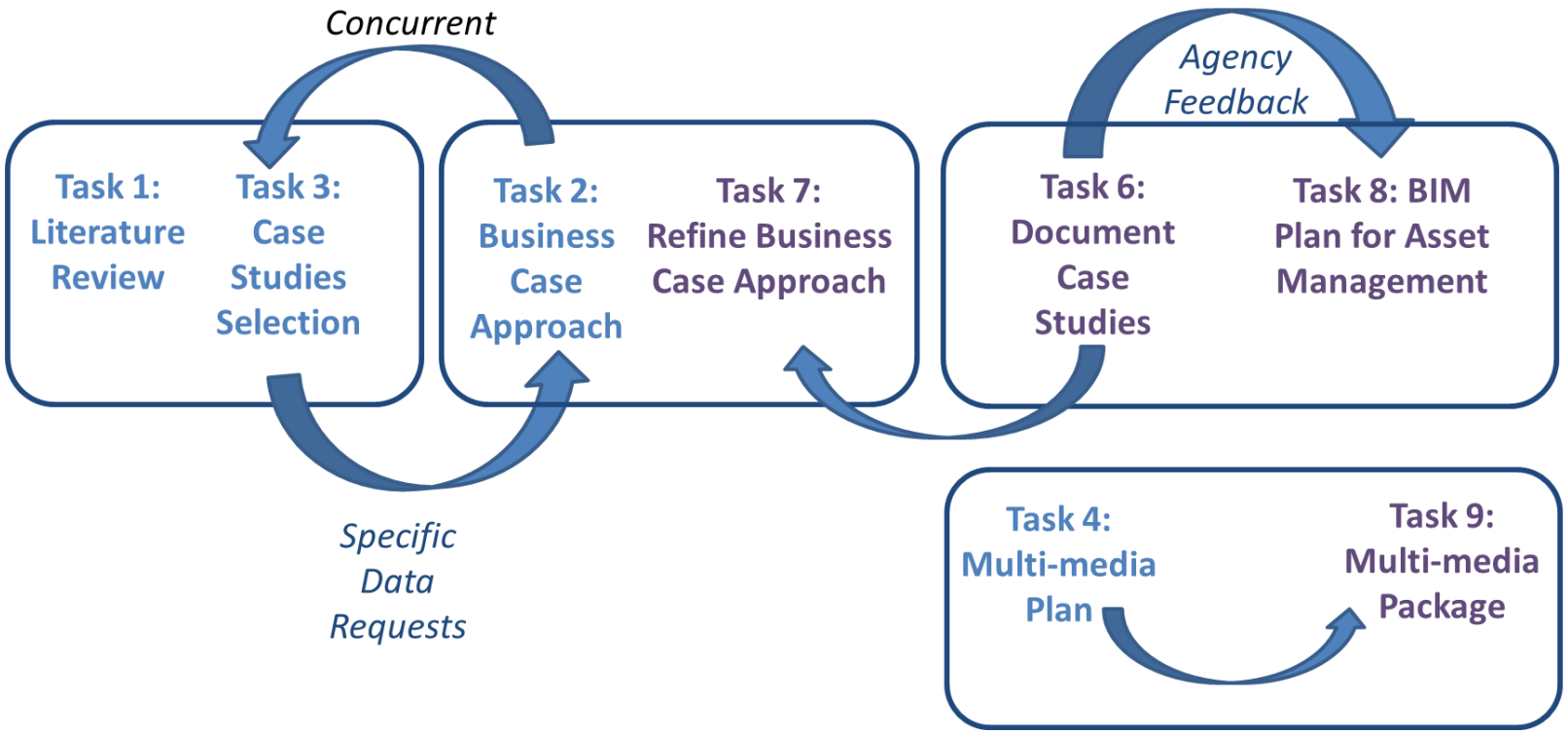
# Research Team




**TFRS-02 Panel Members:**

Lance Parve – WSP (Chair); Morgan Kessler – FHWA (Sponsor);
Becky Hjelm – UDOT; Bill Pratt – CTDOT; John Wilkerson – MDOT; Jon Starr – NDOT;
Mike Kennerly – Iowa DOT; Mohamed Mahogub – NJIT; Steve Tritsch - IASU

# Project Approach



# What Is BIM?

Set of Tools

Lifecycle Management

Digital Processes that Touch Planning, Design, Construction, and O&M

Collaborative

# When to Use BIM

## Planning & Design

- Visualization of asset in a simulated environment
- Increased productivity

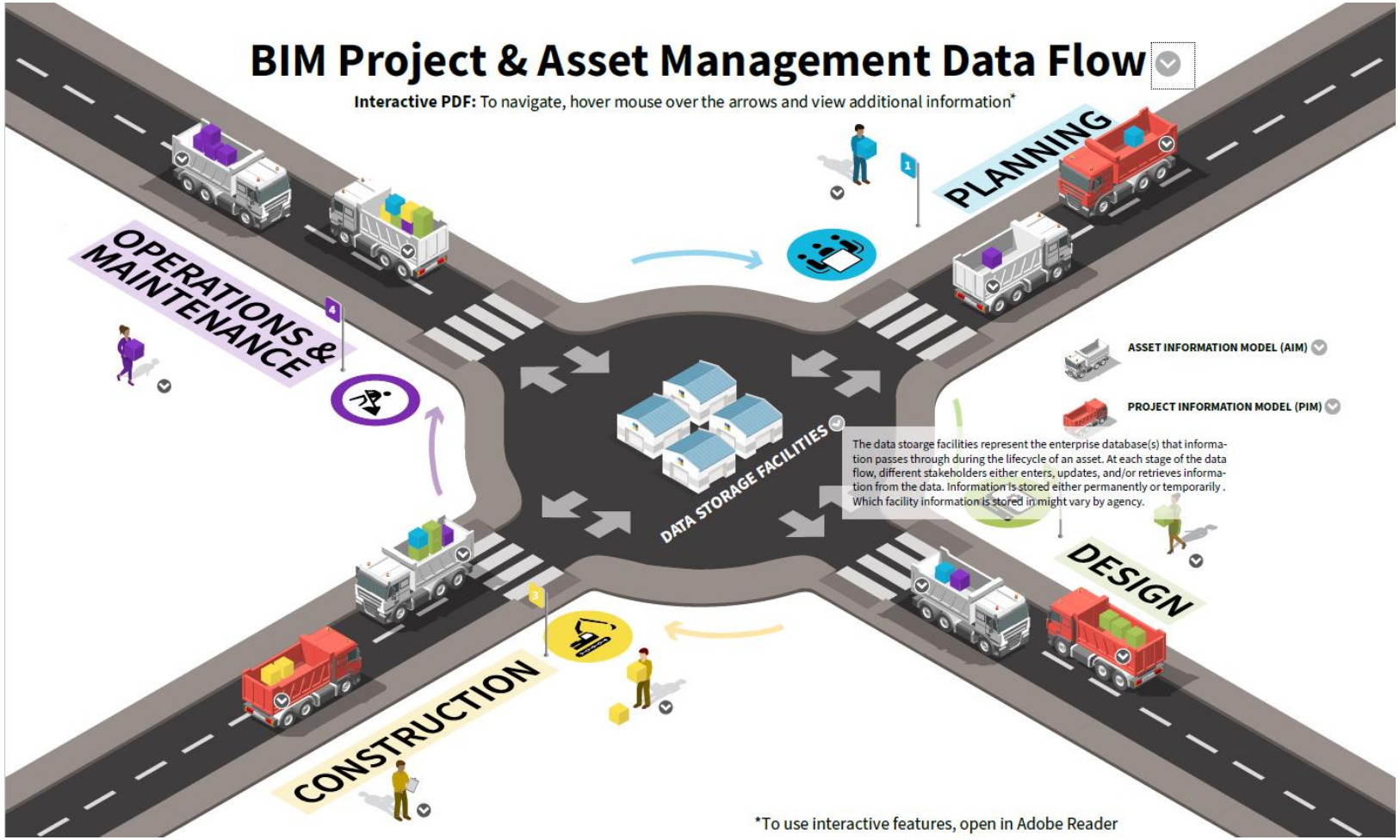
## Construction

- Increased prefabrication of construction materials
- Accelerated project delivery

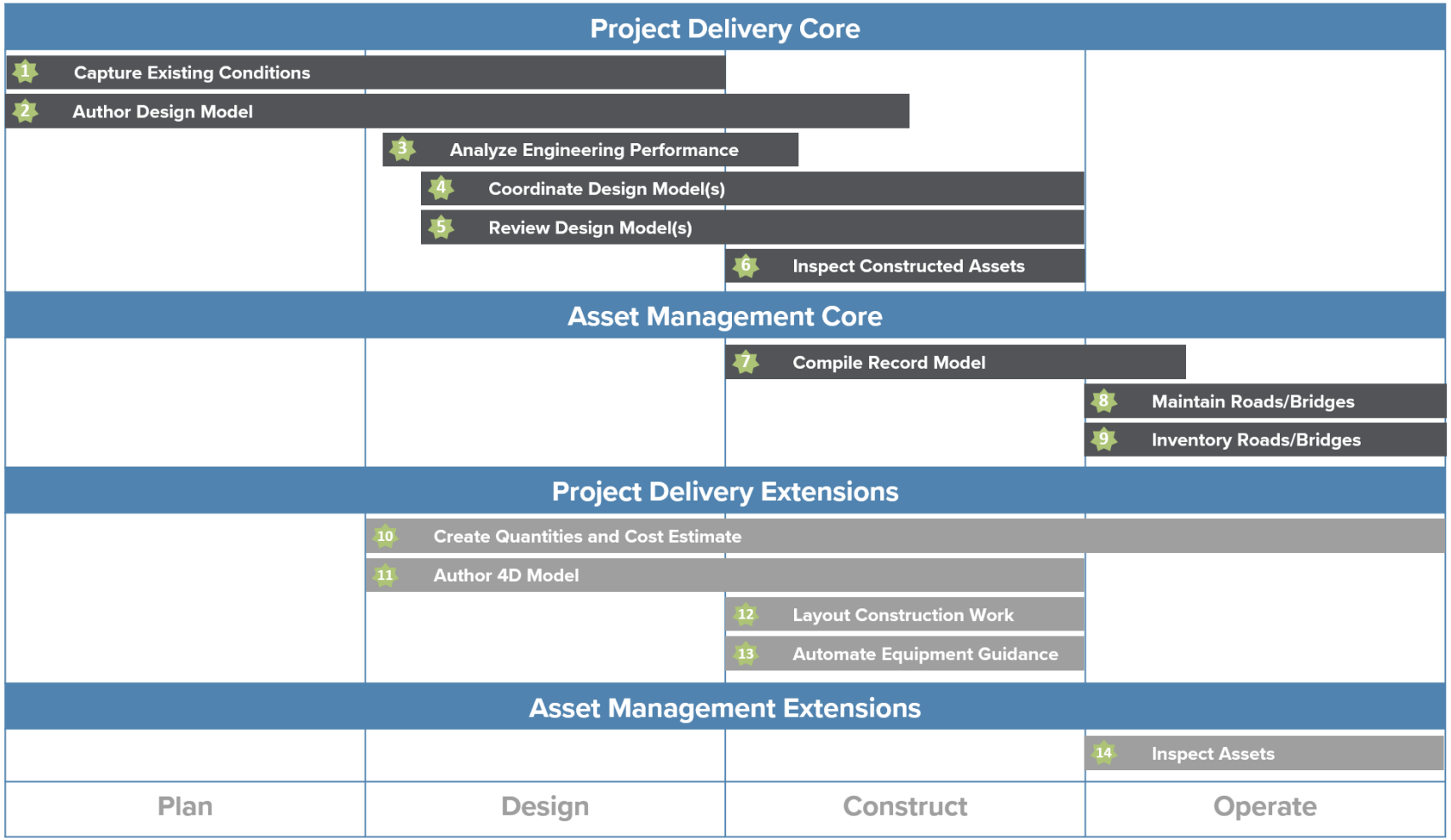
## Asset Management

- Road or bridge models to schedule maintenance activities
- Information about design can be accessed in the field

# Asset Management & Project Management Interaction



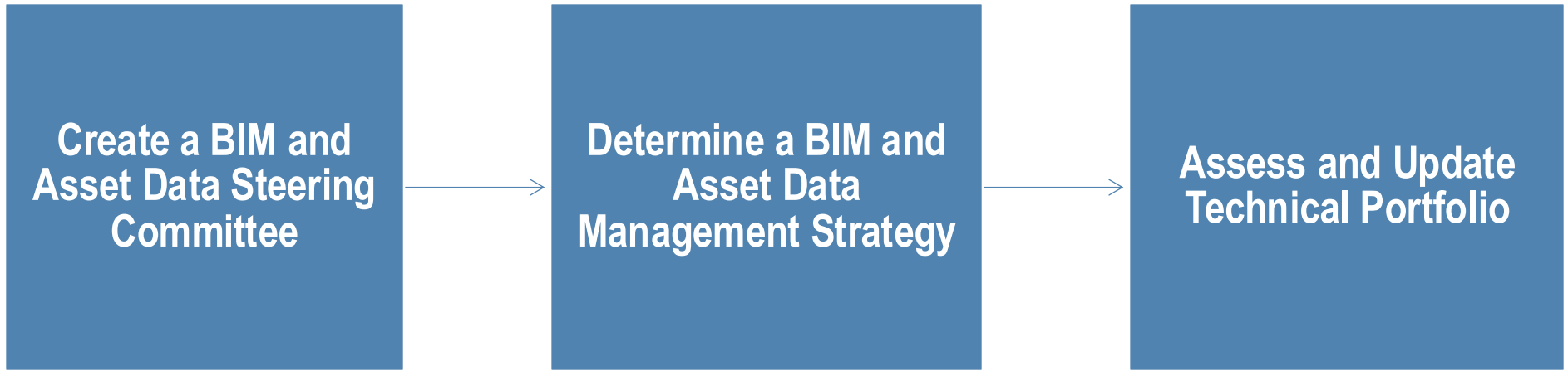
# Determining the Right Use Case for BIM



# BIM for Asset Management Plan

## *Final Report – Chapter 5*

*Part 1: BIM for Asset Data Management Strategic Plan*



# BIM for Asset Management Plan

## *Final Report – Chapter 5*

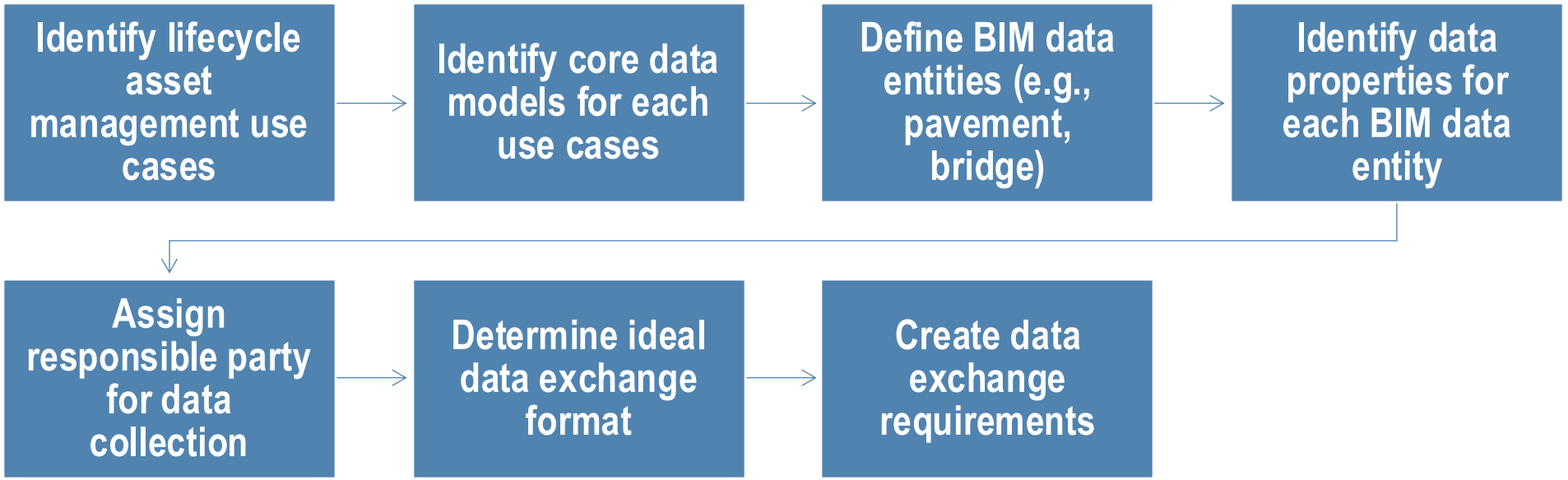
### *4-Part Process for Creating an Implementation Plan*

- Part 1: BIM for Asset Data Management Strategic Plan
- Part 2: Information Exchange Requirements for BIM Asset Data
- Part 3: BIM in the Delivery Phase
- Part 4: BIM for Operation Phase

# BIM for Asset Management Plan

## *Final Report – Chapter 5*

*Part 2: Information Exchange Requirements for BIM Asset Data*

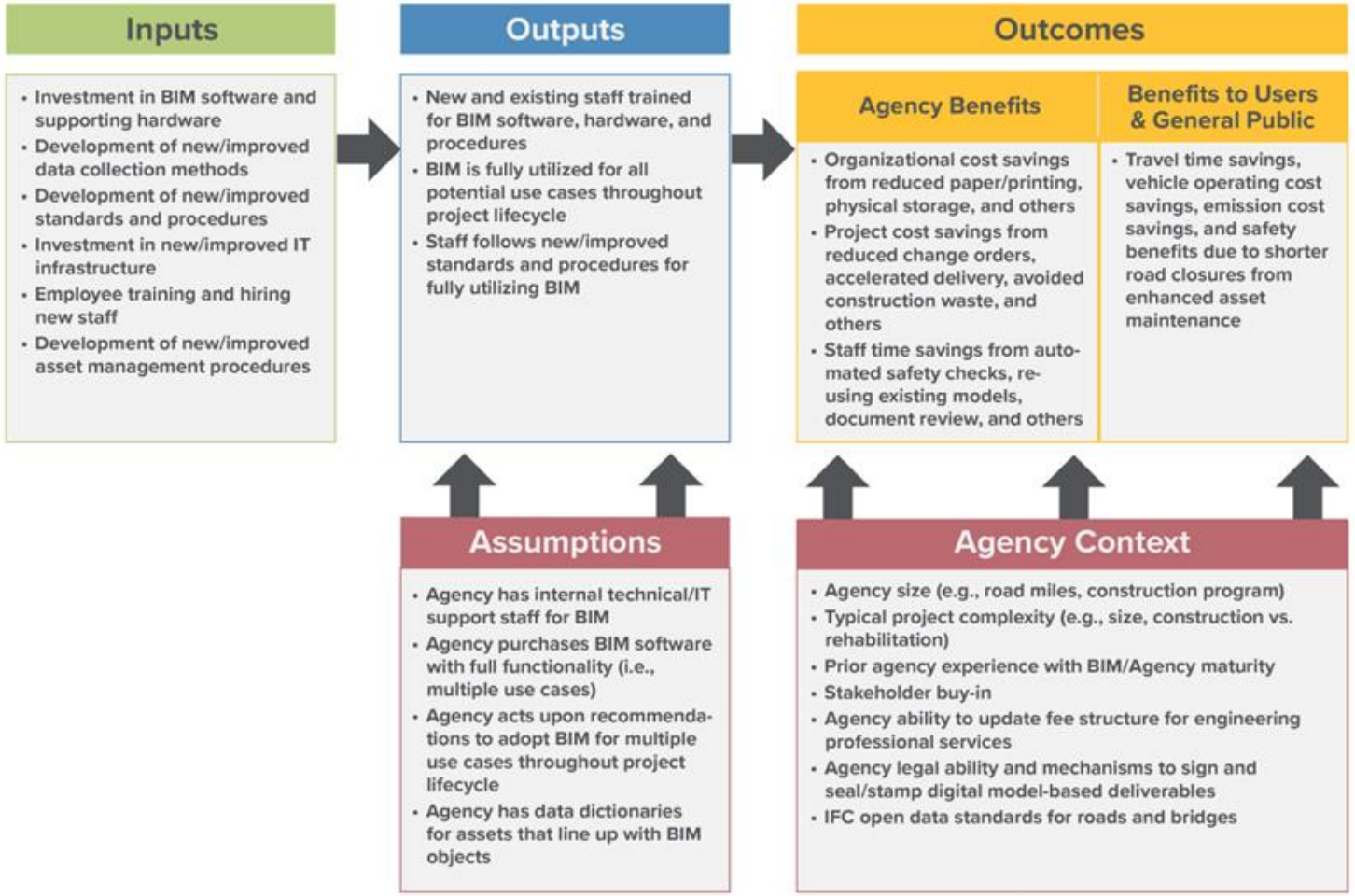


# BIM for Asset Management Plan

## *Final Report – Chapter 5*

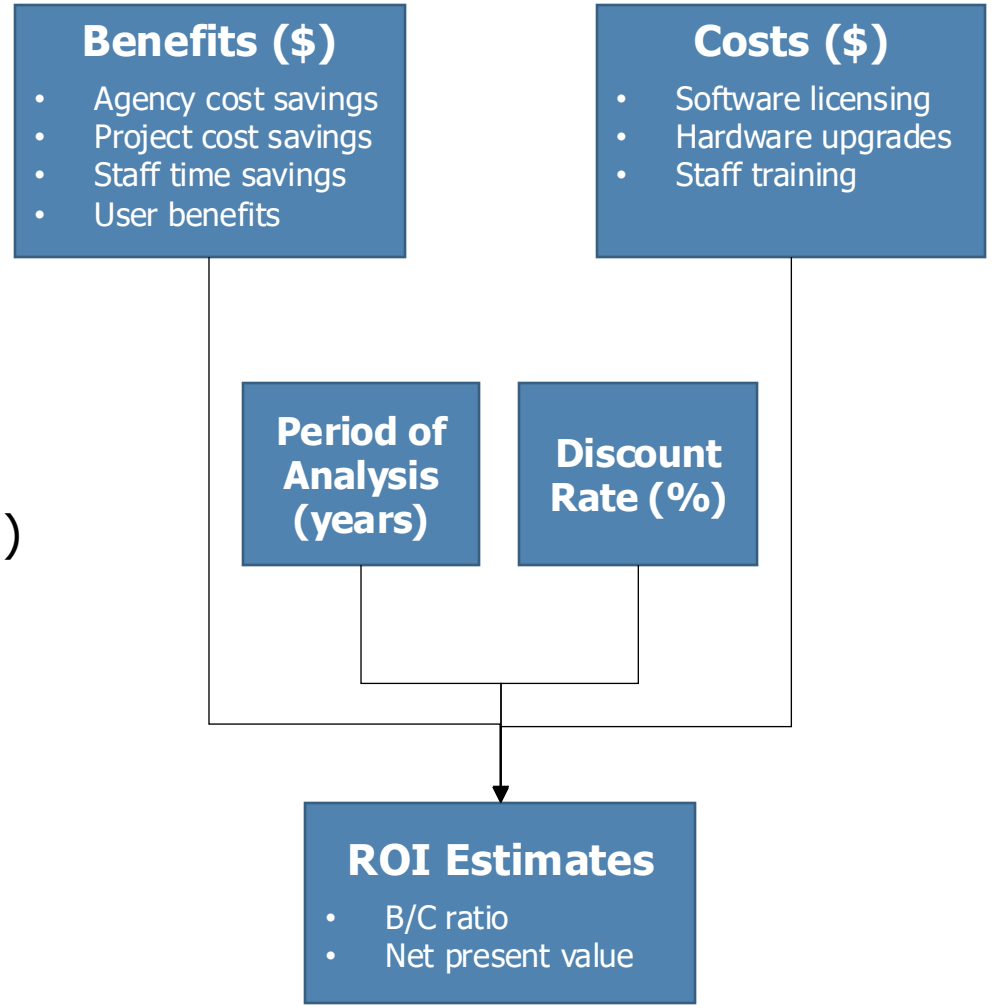
*Part 4: BIM for Operations Phase*

# Input-Output Approach for Identifying Outcomes from Adopting BIM



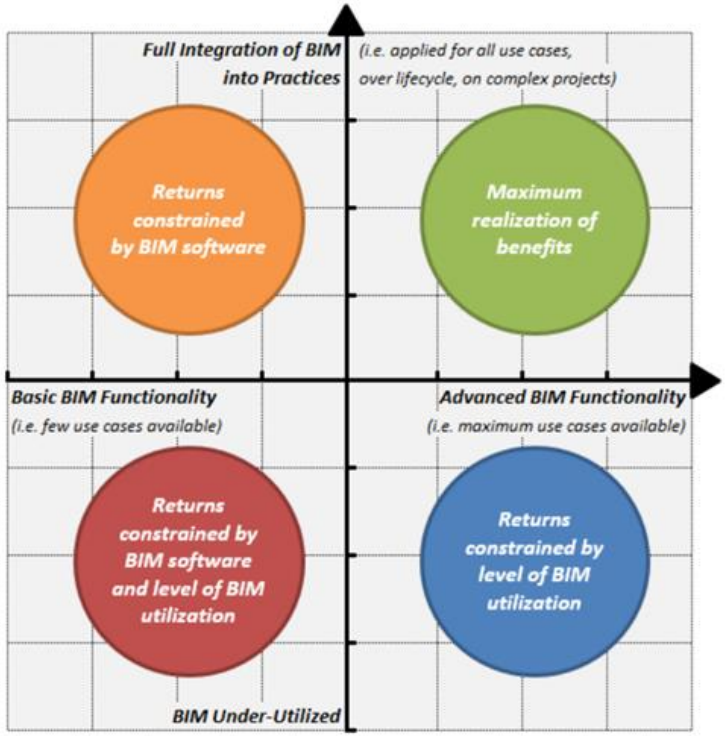
# ROI Defined

- ROI analysis determined by benefit-cost analysis (BCA)
- Base Case:
  - State of the world where investment in BIM is not made (i.e., business as usual)
- Investment Case:
  - State of the world where investment is made



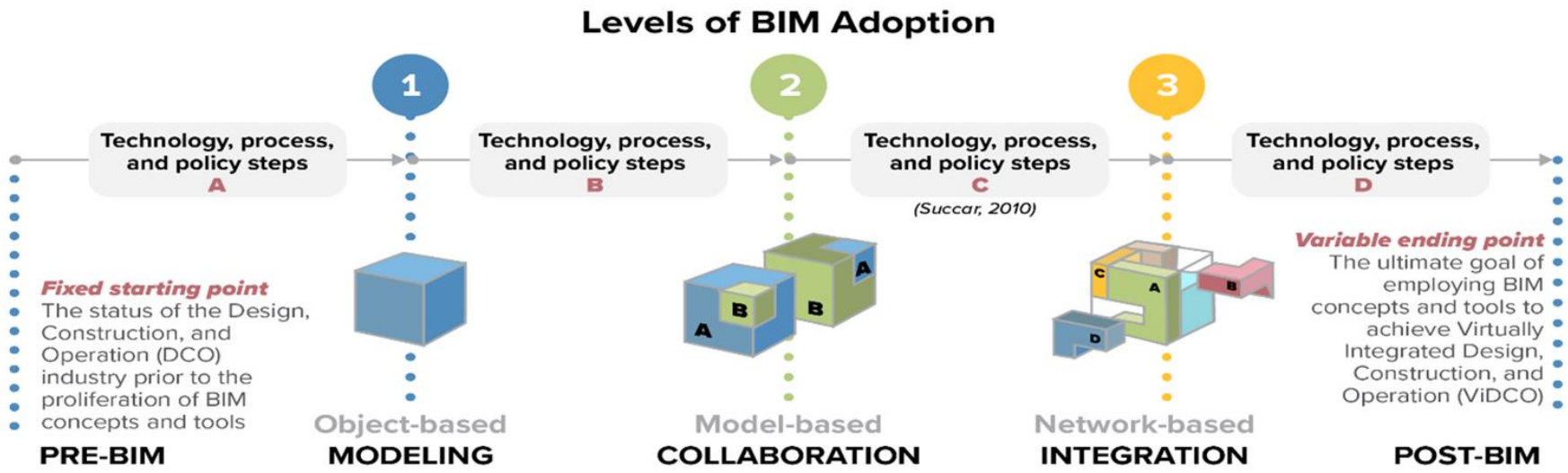
# ROI Approach

- Mapped benefits to one or more use cases to create a link
  - Purchasing functionality that supports more use cases provides more opportunities for benefits
- Program-level ROI
  - Costs not fully recovered by one project
  - Some benefits accrue to the agency, not a specific project
  - Benefits build up over time
  - Program of "typical" projects



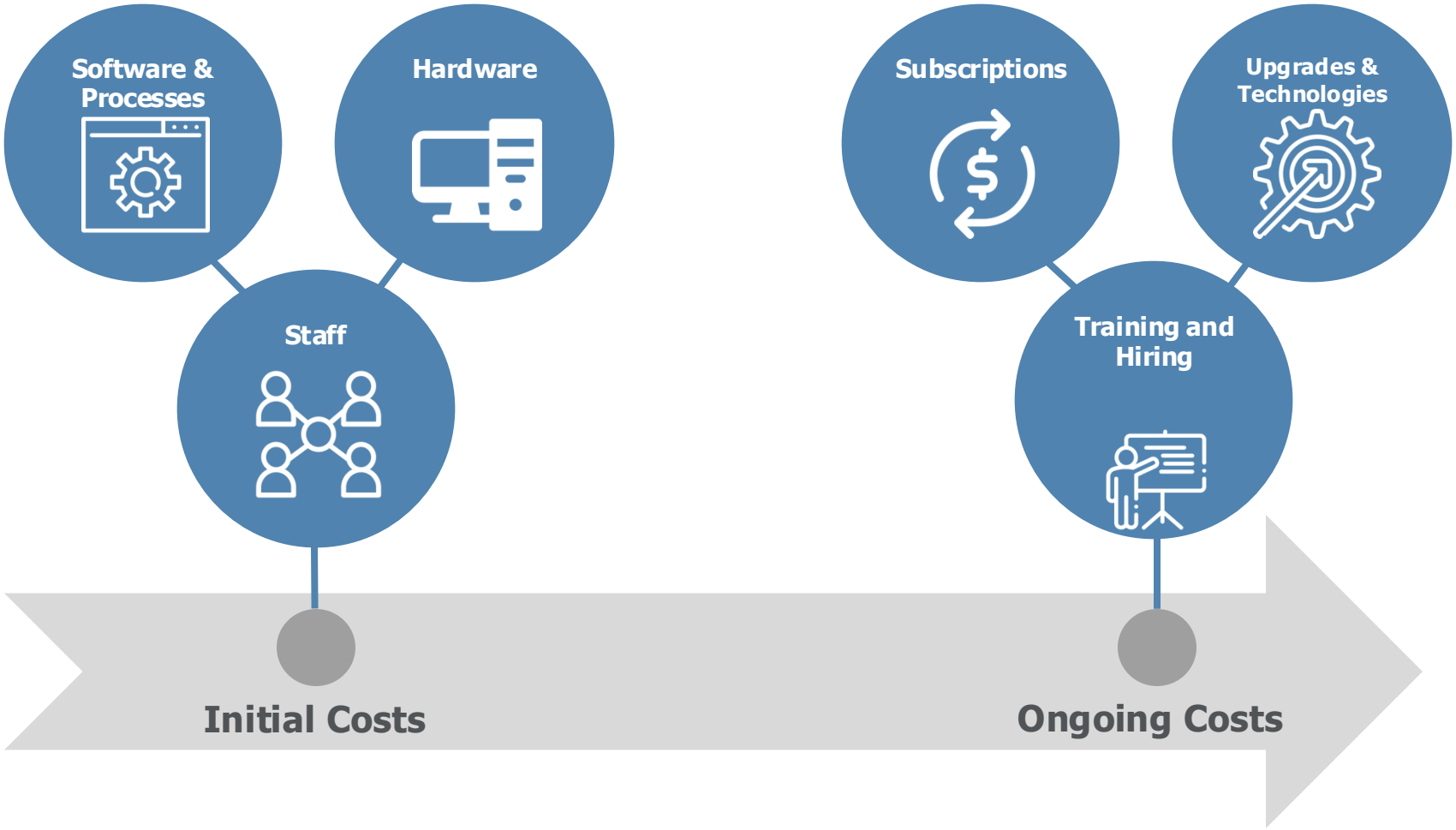
# Agency Maturity

Increasing BIM Maturity




*Adapted from original source: Source: Succar, et. al., 2013*

# Framework: Costs of Implementing BIM



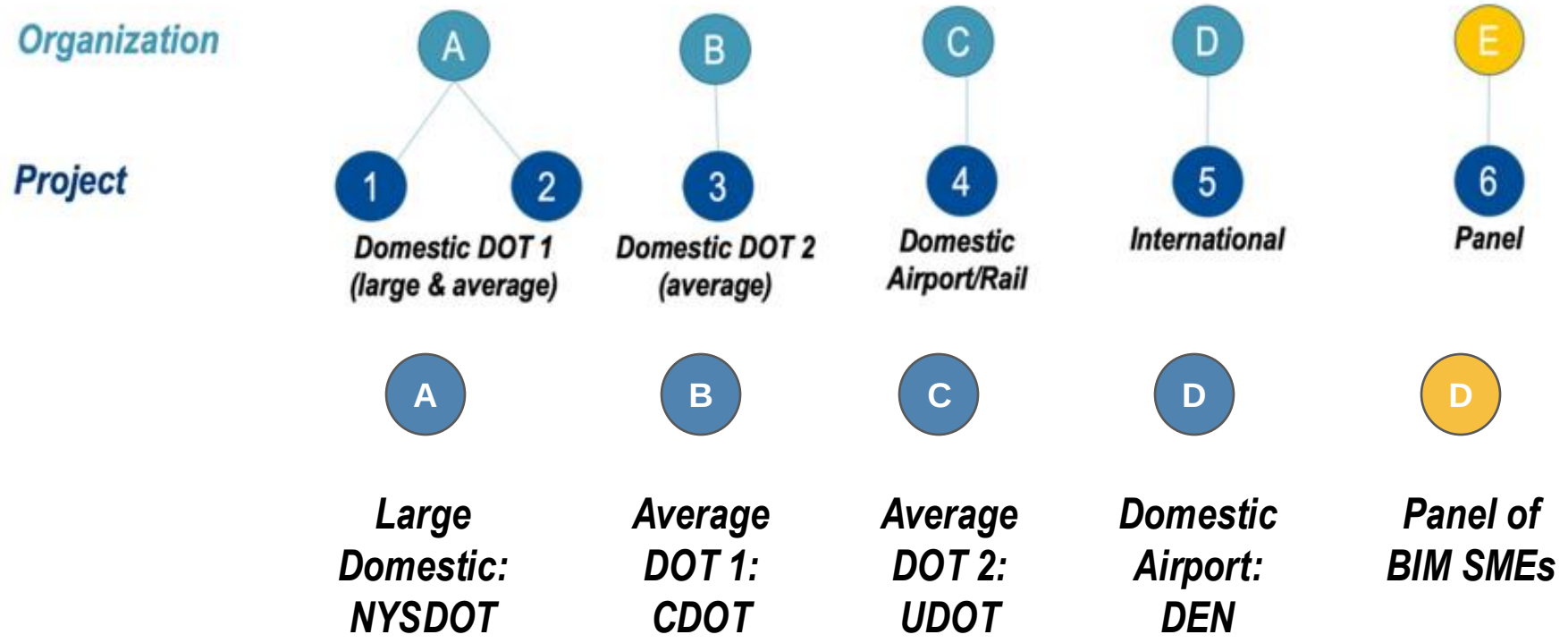
# Framework: Quantifiable Benefits of Implementing BIM

| | |
|---|---|
|  **In-house agency cost savings** |  **Project cost savings** |
|  **Staff time savings** |  **User benefits** |

# Case Studies and BIM Expert Validation

## *Final Report – Chapter 3*

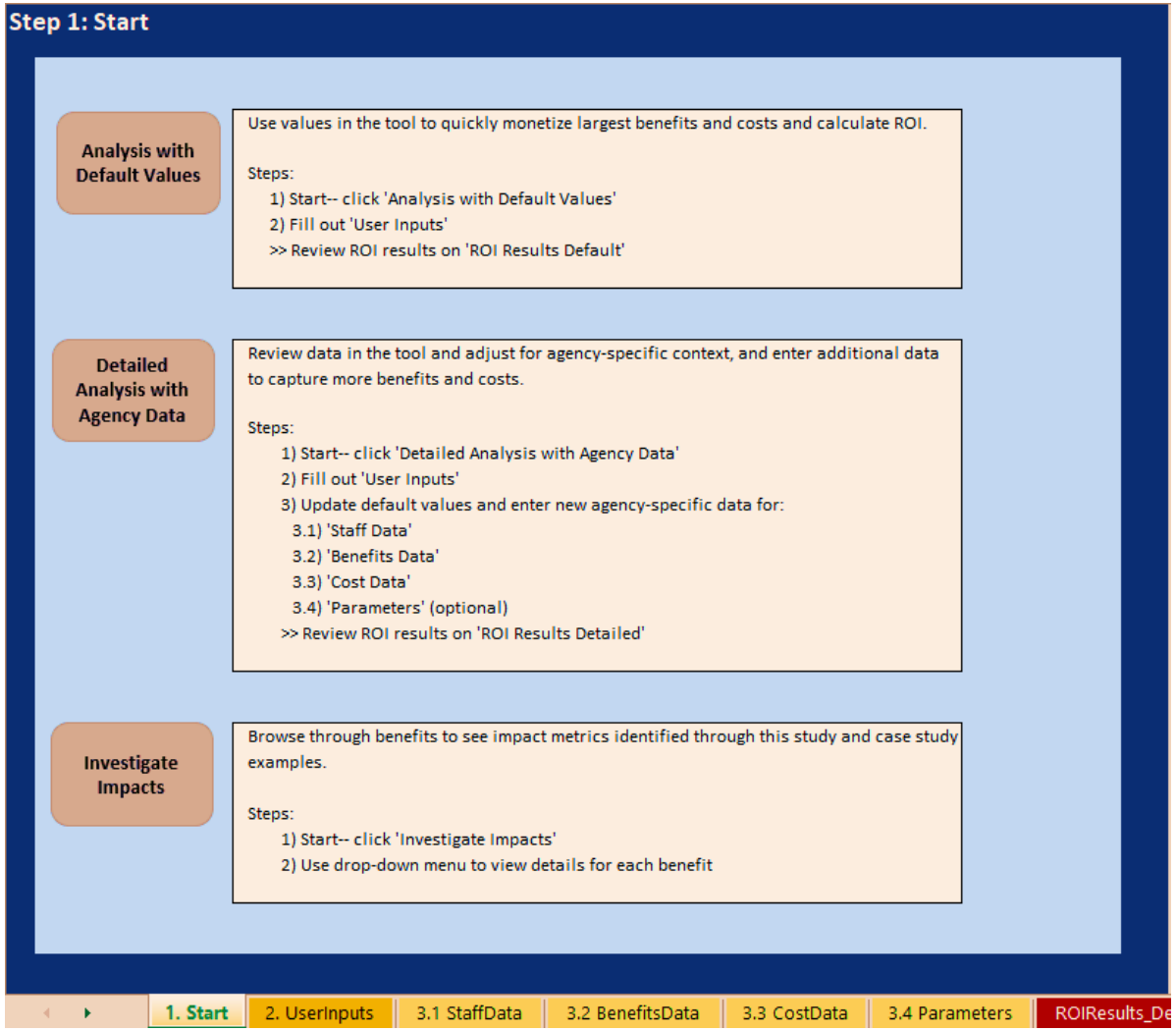
### *Case Studies Approach*



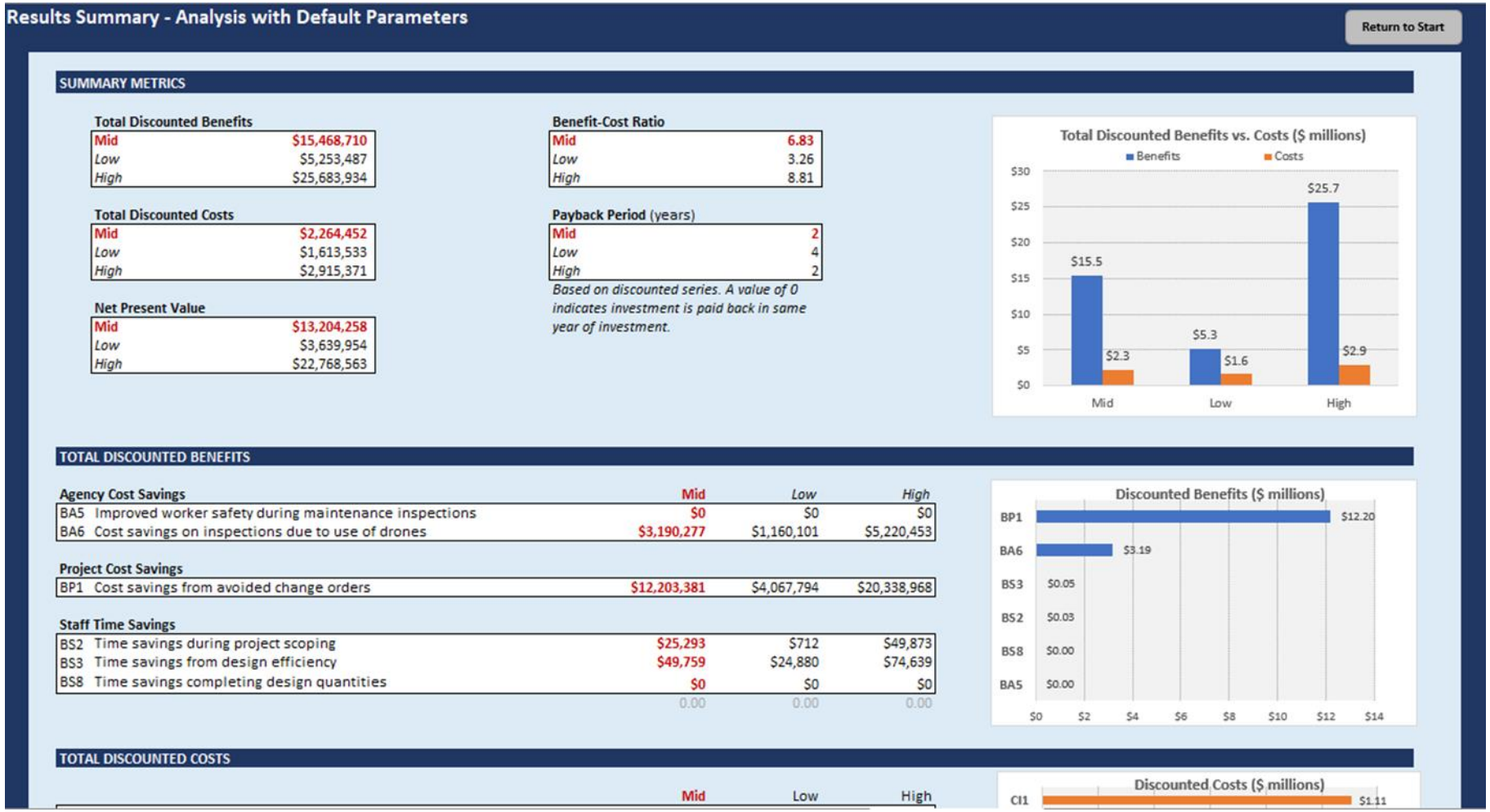
# Agency-Specific Benefits

| | CDOT | DIA | Highways England | NYSDOT | UDOT |
|---|---|---|---|---|---|
| Improved Design Efficiency | ✓ | | | ✓ | |
| Avoided Change Orders | ✓ | ✓ | | ✓ | ✓ |
| Improved Schedule Management | ✓ | | | | |
| Construction Material Optimization | ✓ | | | | |
| Improved Worker Safety | | ✓ | ✓ | | ✓ |
| Reduced Need for Non-Scheduled Maintenance | | ✓ | | | |
| Reduced Physical Storage Needs | | ✓ | | | |
| Improved Quantity Estimation | | | ✓ | | |
| Pre-construction Utility Visualization | | | ✓ | | |
| Accelerated Delivery | | | ✓ | | |
| Increased Accuracy in Material Quantities | | | | ✓ | |
| Identification of Alternate Construction Options | | | | ✓ | |
| Centralization of Information | | | | | ✓ |
| High-quality Design and Visualization | | | | | ✓ |

# BIM ROI Tool


Step 1: Start
Analysis with Default Values
Use values in the tool to quickly monetize largest benefits and costs and calculate ROI.
Steps:
1) Start-- click 'Analysis with Default Values'
2) Fill out 'User Inputs'
>> Review ROI results on 'ROI Results Default'
Detailed Analysis with Agency Data
Review data in the tool and adjust for agency-specific context, and enter additional data to capture more benefits and costs.
Steps:
1) Start-- click 'Detailed Analysis with Agency Data'
2) Fill out 'User Inputs'
3) Update default values and enter new agency-specific data for:
3.1) 'Staff Data'
3.2) 'Benefits Data'
3.3) 'Cost Data'
3.4) 'Parameters' (optional)
>> Review ROI results on 'ROI Results Detailed'
Investigate Impacts
Browse through benefits to see impact metrics identified through this study and case study examples.
Steps:
1) Start-- click 'Investigate Impacts'
2) Use drop-down menu to view details for each benefit
1. Start
2. UserInputs
3.1 StaffData
3.2 BenefitsData
3.3 CostData
3.4 Parameters
ROIResults_De

# BIM ROI Tool


Results Summary - Analysis with Default Parameters
Return to Start
SUMMARY METRICS
Total Discounted Benefits
Mid $15,468,710
Low $5,253,487
High $25,683,934
Benefit-Cost Ratio
Mid 6.83
Low 3.26
High 8.81
Total Discounted Costs
Mid $2,264,452
Low $1,613,533
High $2,915,371
Payback Period (years)
Mid 2
Low 4
High 2
Based on discounted series. A value of 0 indicates investment is paid back in same year of investment.
Net Present Value
Mid $13,204,258
Low $3,639,954
High $22,768,563
Total Discounted Benefits vs. Costs ($ millions)
Benefits
Costs
$30
$25
$20
$15
$10
$5
$0
$15.5
$2.3
$5.3
$1.6
$25.7
$2.9
Mid
Low
High
TOTAL DISCOUNTED BENEFITS
Agency Cost Savings
BA5 Improved worker safety during maintenance inspections $0 $0 $0
BA6 Cost savings on inspections due to use of drones $3,190,277 $1,160,101 $5,220,453
Project Cost Savings
BP1 Cost savings from avoided change orders $12,203,381 $4,067,794 $20,338,968
Staff Time Savings
BS2 Time savings during project scoping $25,293 $712 $49,873
BS3 Time savings from design efficiency $49,759 $24,880 $74,639
BS8 Time savings completing design quantities $0 $0 $0
0.00 0.00 0.00
Discounted Benefits ($ millions)
BP1 $12.20
BA6 $3.19
BS3 $0.05
BS2 $0.03
BS8 $0.00
BA5 $0.00
$0 $2 $4 $6 $8 $10 $12 $14
TOTAL DISCOUNTED COSTS
Mid Low High
Discounted Costs ($ millions)
CI1 $1.11

# Challenges to BIM Adoption

- Insufficient Trainings
- Resistance to Change
- Evolving Software
- Lack of Modeling Standards and Information Requirements

# Best Practices & Lessons Learned

- **Trainings are key!**
  - CDOT recommends training programs that cover uses of technology, BIM processes and methods, and using modeling standards.
- **Standards must be established and continuously reviewed**
  - NYSDOT found that standardization of BIM tools saves time and prevents manual adjustments later
- **Collaboration leads to success**
  - Highways England's contractor, Costain, recommends designers and contractors work together to achieve mutual project goals.
- **Dedicated Leads & Stakeholder Input**
  - Having a dedicated lead can help ensure processes are followed, stakeholders are on board, and the right use cases/tools are identified.

# Research Products

Excel-Based
ROI Toolkit

Multi-Media
Package

Final Report

**Final Report available as CRP Special Release 4**


VDOT
Virginia Department of Transportation

# VIRGINIA DOT

## Limited Scope Guardrail Terminal Maintenance Inspection Program

Wenling Chen – Asset Engineering Program Manager
Matt Barret – Asset Implementation Deputy Program Manager

**August 2024**

# Presentation Overview

- **Program Context and Background**
- **Limited Scope Guardrail Terminal Maintenance Inspection Program Implementation**
- **Program Outcomes: The First Year**
- **Next Steps**

# Program Context and Background

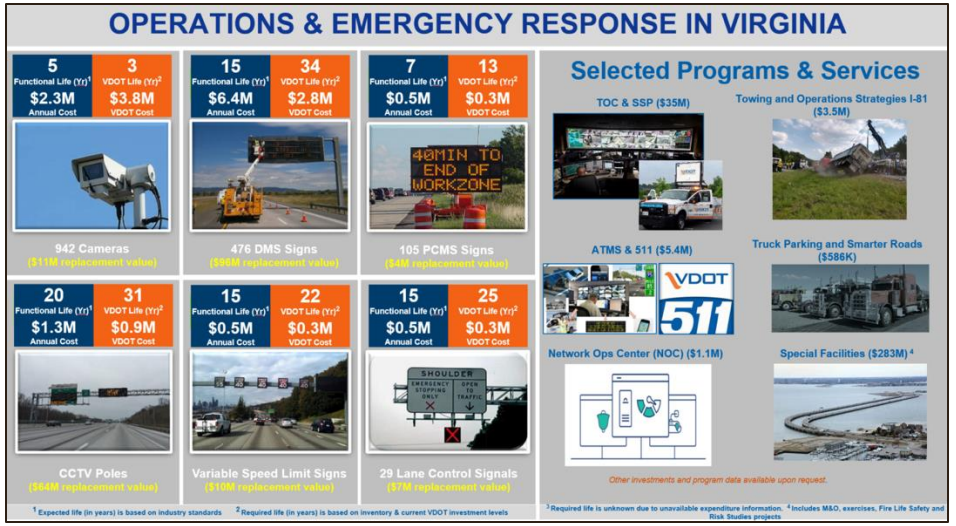
# VDOT's Traffic Operations Asset Program

## The Scope

- 129k lane miles of VDOT maintained roads
- $6B in replacement values of Traffic Operations Assets & Programs

## The Approaches

- Set data-driven, lifecycle and return-on-investment based targets and investment priorities
- Continuously improve process, policy and technical guidance
- Engage cross-functional teams for program delivery
- Leverage technology to drive efficiency and accountability

# Limited Scope GR Terminal Maintenance Inspection Program

## National Concerns

- Guardrail terminals found which were ***not*** installed and maintained per manufacturer specs and crash testing
- Intensive media interest in GR safety
- Many states planned statewide review

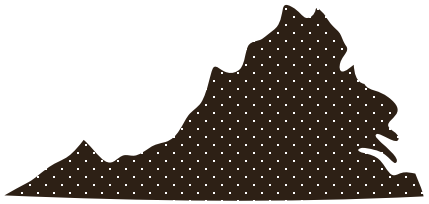
## Objective of VDOT's Response

- Recognized safety concerns for the traveling public
- Committed to "boots-on-the-ground" assessment of all statewide terminals for installation and maintenance issues

## Targeted Issues

- Mix & Match Hardware
- Severely Rusted Terminals
- ET-Plus 4" vs. 5" Verification
- Severe Damage, Incorrect Bolts, Loose Cables, Other Construction Issues

# Program Challenges



## *SCALE & URGENCY*

***150,000+ terminal to be assessed in 3 years.***

## *COMPLEXITY*

***30+ products, with unique hardware and installation requirements.***

## *RESOURCE CONSTRAINTS*

***Limited technical guidance, industry capacity, and funds.***

## *TRAFFIC SAFETY*

***A max of 15 minutes per site to ensure worker safety and reduce costs.***

## *CONFIDENCE*

***Data across 9 Districts and 20+ contracted crews must be trusted.***

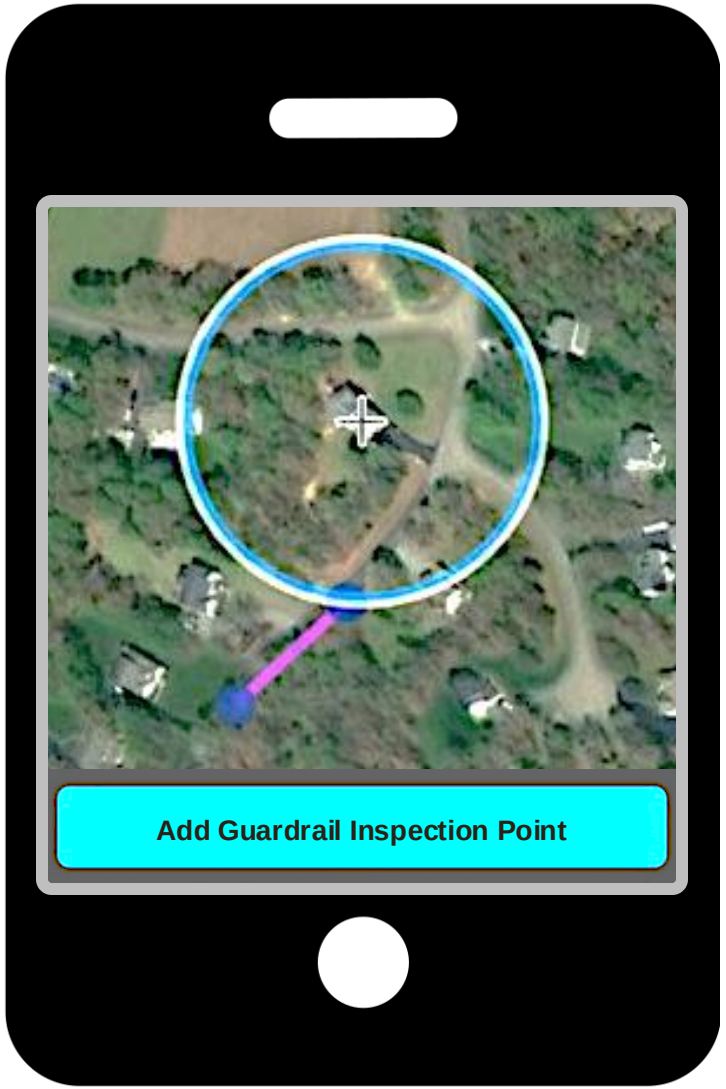
# Data and System Innovations

**Simple to use suite of mobile app and BI tools:**

- “Smart forms” to streamline data collection
- Data & technology driven solution to Mix & Match identification
- Statewide and District performance reporting and quality management applications

**Supported by:**

- First-of-its-kind terminal identification and inspection methodology
- Easy to reference and consume “pocket guides”
- Innovative training & certification to scale teams



# Limited Scope Maintenance Inspection Program Implementation

# Program Implementation Activities

| | |
|---|---|
| **Program Concepts** (Feb-Apr 2023) | • Evaluate field inspection alternatives, secure executive approval<br>• Examine 30+ terminal products and their installation/hardware requirements<br>• Develop reliable methodology to evaluate observable terminal components |
| **Pilot Process & Tools** (Apr-Jun 2023) | • Develop field collection tools and supporting field pocket guide<br>• Configure quality control/assurance tools and performance dashboards<br>• Pilot approach to ensure safety and reliability |
| **Implementation Prep** (Jul-Sept 2023) | • Develop inspector training and certification materials<br>• Contract inspection forces through available on-call contracts<br>• Organize and hold District training and certification workshops |
| **Year 1 Implementation** (Oct-Aug 2024) | • Coordinate and monitor data collection<br>• Ramp up collection to peak of ~4,000 terminals per week<br>• Complete 100,000 terminal assessments by Aug 2024 |

# Inspection Alternatives Considered

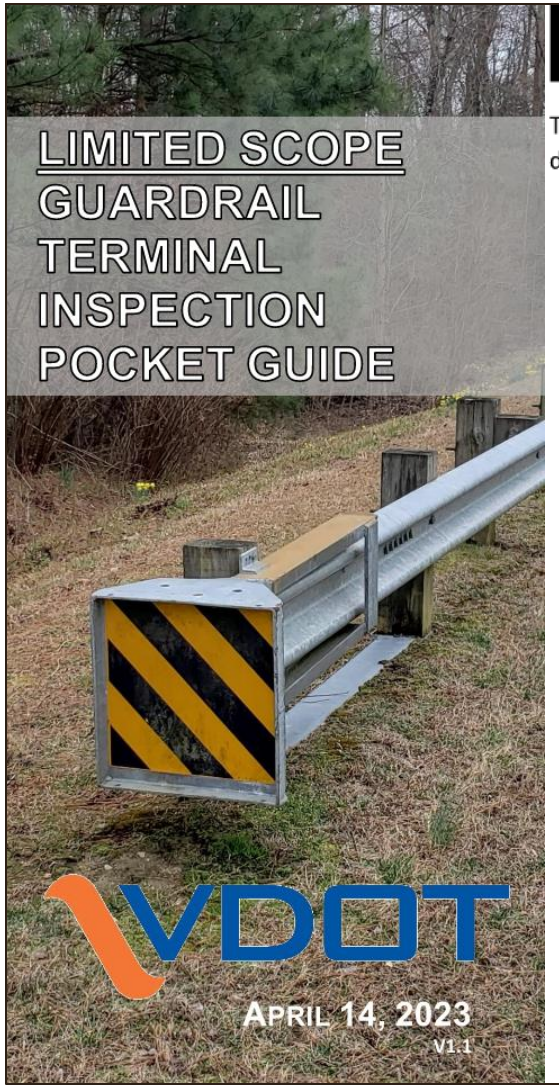
| | Option 1<br>DETAILED ONSITE INSPECTION | Option 2<br>LIMITED ONSITE INSPECTION | Option 3<br>FIELD WINDSHIELD ASSESSMENT | Option 4<br>VIRTUAL WINDSHIELD ASSESSMENT |
|---|---|---|---|---|
| Inspection Level | • Full Functional Inspection<br>• Evaluate Hazard & Length-of-Need | • Targeted Inspection (specific observable components, and other obvious issues) | • Corridor based drive-by assessment<br>• Capture visually obvious deficiencies | • Use latest pavement video log imagery<br>• Capture visually obvious deficiencies |
| Site Photos | • Comprehensive photos (~12 / site) | • Select photos (~4 / site) | • Limited photos (~1-2 from vehicle, if applicable) | • None |
| GR Tracker Data Entry | All Inspected guardrail<br>• Overall condition<br>• Detailed data elements and photos<br>• Recommended improvements | All Inspected guardrail<br>• Mix-and-match and hardware install issues<br>• Damage<br>• Rust<br>• Other obvious issues | Observed Issues Only<br>• Deficiency type and severity<br>• *Note: unlikely to capture most mix-and-match issues* | Observed Issues<br>• Deficiency type and severity<br>• *Note: unlikely to capture most mix-and-match issues* |

# Field Inspection Methodology and Supporting Pocket Guide

## 17 Readily Observable Components

*(with standardized responses addressing all possibilities across 30+ terminal types)*

| Product | Strut? | Rail Slots | Cable Anchor Connection | Post 1 Post | Post 1 Bolt | Post 2 Post | Post 2 Bolt | Post 3 Post | Post 3 Bolt |
|---|---|---|---|---|---|---|---|---|---|
| | Yes | 10 or 13 short | Bolted | Wood CRT | **No bolt** | Wood CRT | Long bolt | Wood CRT | **No bolt** |
| | No | 10 or 13 short | Bolted | Steel Square Tube Breakaway | **No bolt** | Hinged Breakaway | **Short bolt** | Standard Guardrail | **No bolt** |
| | Yes | 6 Long | Bolted | Hinged Breakaway | **Short bolt** | Hinged Breakaway | **No bolt** | Wood CRT | Long bolt |
| | Yes | 6 Long | Bolted | Wood CRT | Long bolt | Wood CRT | Long bolt | Wood CRT | Long bolt |
| | Yes | None | Cleat | Wood CRT | **No bolt** | Wood CRT | Long bolt | Wood CRT | Long bolt |
| | Yes | 3, 10, or 13 Short | Bolted | Wood CRT | **No bolt** | Wood CRT | Long bolt | Wood CRT | Long bolt |
| | No | 3, 10, or 13 Short | Bolted | Steel Square Tube Breakaway | **No bolt** | Hinged Breakaway | **Short bolt** | Standard Guardrail | Long bolt |
| | Yes | 3, 10, or 13 Short | Bolted | Plug Weld Breakaway in Square Tube | **No bolt** | Plug Weld Breakaway in Square Tube | **Short bolt** | Plug Weld Breakaway | Long bolt |
| | Yes | None | Cleat | Hinged Breakaway | **No bolt** | Steel Yielding | **Short bolt** | Steel Yielding | Long bolt |
| | Yes | None | Cleat | Hinged Breakaway | **No bolt** | Steel Yielding | **Short bolt** | Steel Yielding | Long bolt |
| | Yes | None | Cleat | Hinged Breakaway | **No bolt** | Hinged Breakaway | **No bolt** | Hinged Breakaway | Long bolt |
| | Yes | None | Cleat | Wood CRT | **No bolt** | Wood CRT | Long bolt | Wood CRT | Long bolt |
| | Yes | None | Cleat | Wood CRT | **No bolt** | Steel Yielding | **Short bolt** | Steel Yielding | Long bolt |
| | Yes | 13 short | Bolted | Steel Square Tube Breakaway | **No bolt** | Hinged Breakaway | **Short bolt** | Standard Guardrail | Long bolt |
| | No | None | Bolted | Wood CRT | Long bolt | Standard Guardrail | Long bolt | N/A | N/A |
| | Yes | None | Bolted | Wood CRT | Long bolt | Wood CRT | Long bolt | N/A | N/A |

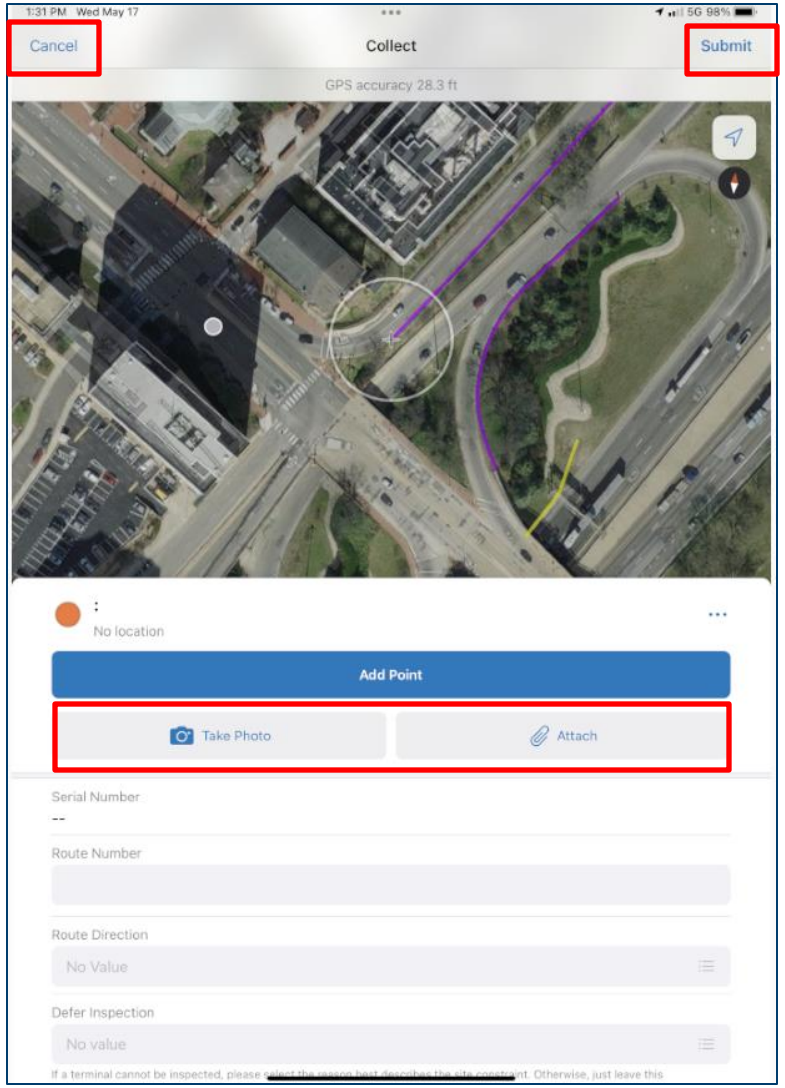


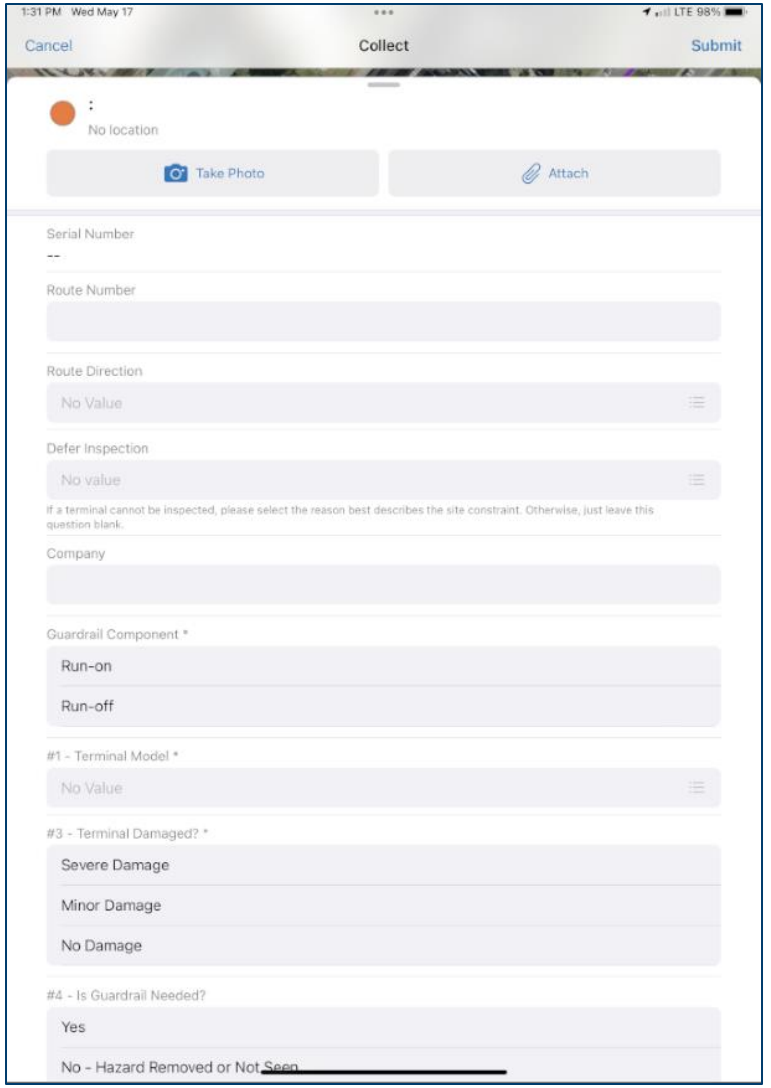

**INSPECTION CHECKLIST**

The inspector shall observe the following items as detailed on the following pages:

- ☐ 1. Identification
- ☐ 2. Reflective sheeting
- ☐ 3. Damage
- ☐ 4. Is the guardrail needed?
- ☐ 5. Photos
- ☐ 6. Ground strut
- ☐ 7. Height
- ☐ 8. Rail slots
- ☐ 9. Posts
- ☐ 10. Corrosion (rust)
- ☐ 11. Cable tension
- ☐ 12. Cable anchor connections
- ☐ 13. Cable bearing plate
- ☐ 14. Post #1 attachment
- ☐ 15. Impact head rail insertion
- ☐ 16. Impact attenuator size
- ☐ 17. General notes

# Field Data Collection Mobile Application




## Smart Form Features

- Form configured to hide/show certain fields as user fill out the form
- Automatically populate the “Mix & Match Components” field as user answers related questions

# Data Quality Management and Monitoring

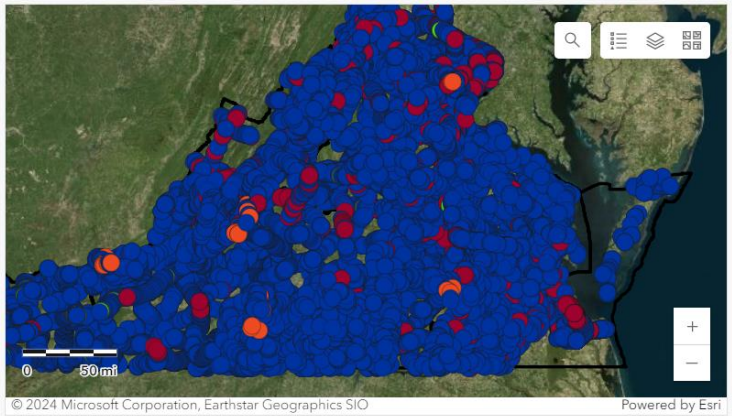

## Limited Scope Guardrail Terminal Inspection Status

Inspection Date: 8/15/2024 and before

District: None

**Filters**

- SRT 2nd Panel Orientation: None
- Potential Mix & Match/Misinstallation: None
- Potential Deficiency Rating: None
- Potential Damage: None
- Corrosion (Rust): None
- Cable Anchor Tight?: None
- Cable Bearing Plate: None
- Supplemental Information: None
- Deferred Inspection: None

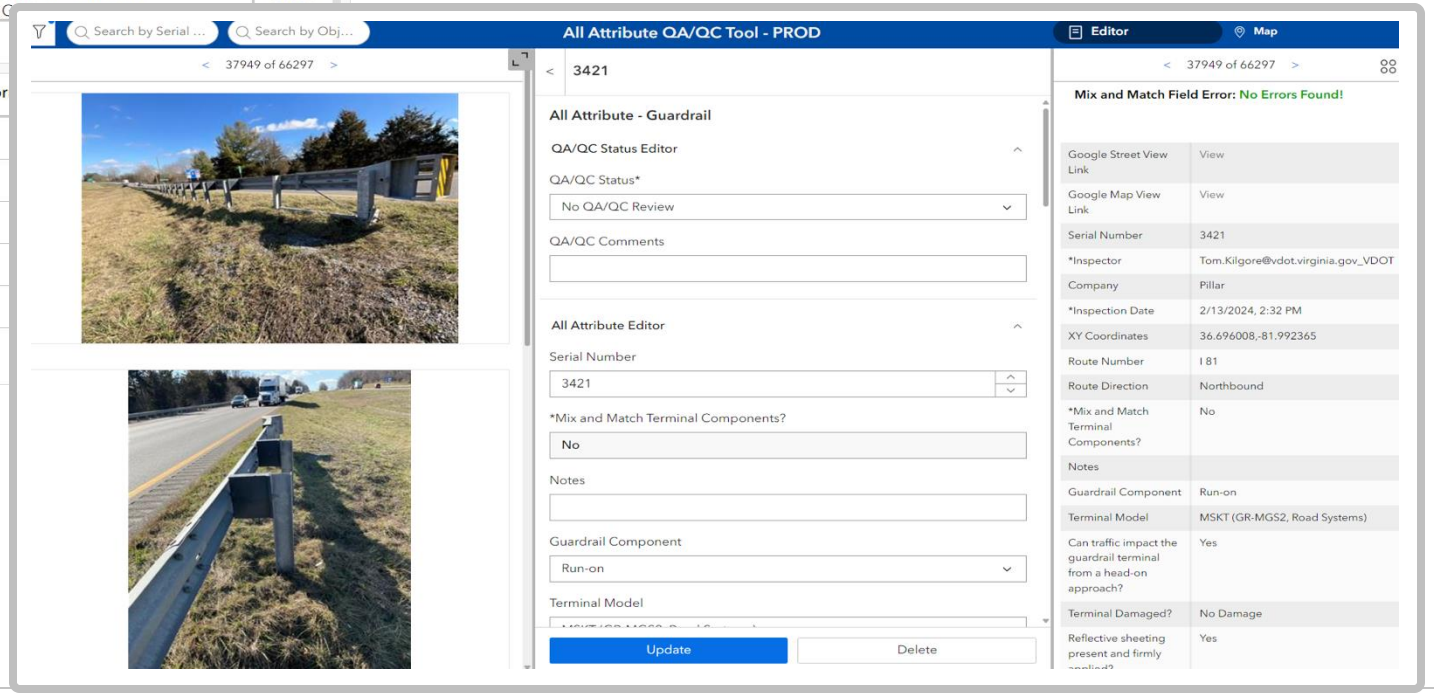



| Terminal Model | Count |
|---|---|
| Blunt End | 16,628 |
| FOA-Various | 16,028 |
| Radial | 10,750 |
| GR-11, non-proprietary | 10,517 |
| MSKT (GR-MGS2, Road Systems) | 9,873 |
| SKT-SP (GR-9, Road Systems) | 6,978 |
| ET-Plus mod., 4" (GR-9, Trinity) | 6,739 |

No. Inspections: 102,597

No. Deferred Inspections: 5,347

| Serial Number | *Inspection Date | Terminal Model | Terminal Damaged? | Cor |
|---|---|---|---|---|
| | 12/12/2023 | Sand Barrels | No Damage | |
| | 8/6/2024 | Blunt End | No Damage | |
| | 8/7/2024 | Blunt End | No Damage | |
| | 8/7/2024 | MELT (GR-7, non-proprietary) | No Damage | |
| | 8/7/2024 | Blunt End | No Damage | |
| | 8/7/2024 | GR-6, non-proprietary | No Damage | |



# Inspector Training and Certification

- Trained and certified over 100 inspectors
- Held workshops at each District office
- Addressed GR terminal identification, detailed inspection methodology, and program-specific worker safety guidance
- Included field demonstration at nearby guardrail installations
- Required training certification for all inspectors prior to approval to participate in the program

# Program Outcomes: The First Year

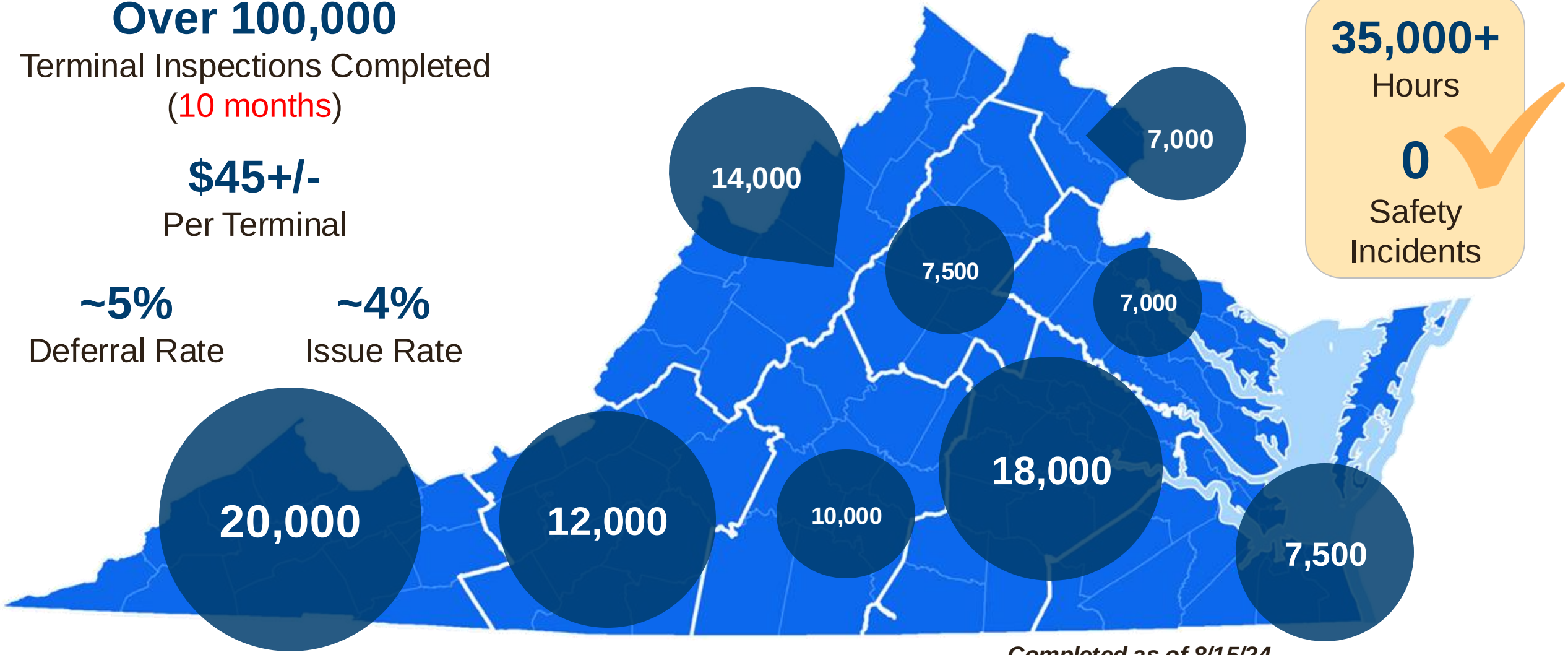
# Year 1: Interstate & Primary Systems (100% Complete)

**Over 100,000**
Terminal Inspections Completed
(10 months)

**$45+/-**
Per Terminal

**~5%**
Deferral Rate

**~4%**
Issue Rate




**35,000+**
Hours

**0**
Safety Incidents

*Completed as of 8/15/24*

# Next Steps

# Continue Inspections

## Complete Secondary Routes

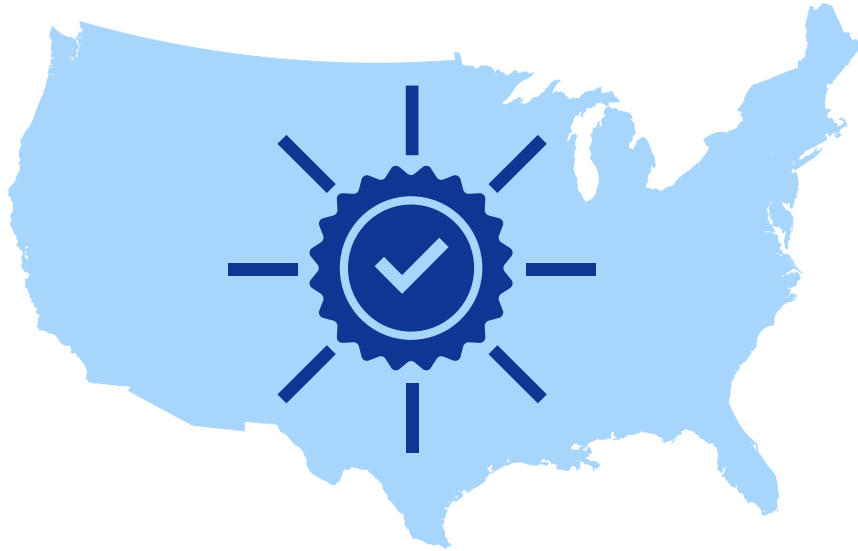
- Anticipate lower efficiency (more miles, less guardrail, more challenges safely parking and accessing terminal locations)

## Work with Executives and Districts

- Perform 100% quality assurance of “Mix & Match” and Severely Damage hardware
- Summarize deficient and deferred locations for investment
- Address high priority and low hanging fruit repairs

# Sharing Best Practice and Lessons Learned

- Consolidate and share District best practices and lessons learned
- Support other state DOT implementation (e.g. Iowa and Wisconsin DOTs)
- Participate in Midwest Roadside Safety Pooled Fund
- Engage national audiences though AASHTO, TRB, or other opportunities



# VIRGINIA DOT

## Limited Scope Guardrail Terminal Maintenance Inspection Program

Wenling Chen – Asset Engineering Program Manager
Matt Barret – Asset Implementation Deputy Program Manager

**August 2024**

# Indiana AI/Machine Learning Project Bundling for Improved TAM Results

Louis Feagans, Managing Director of System Performance and Transportation Policy,

Indiana Department of Transportation

# What is the difference between AI and Machine Learning?

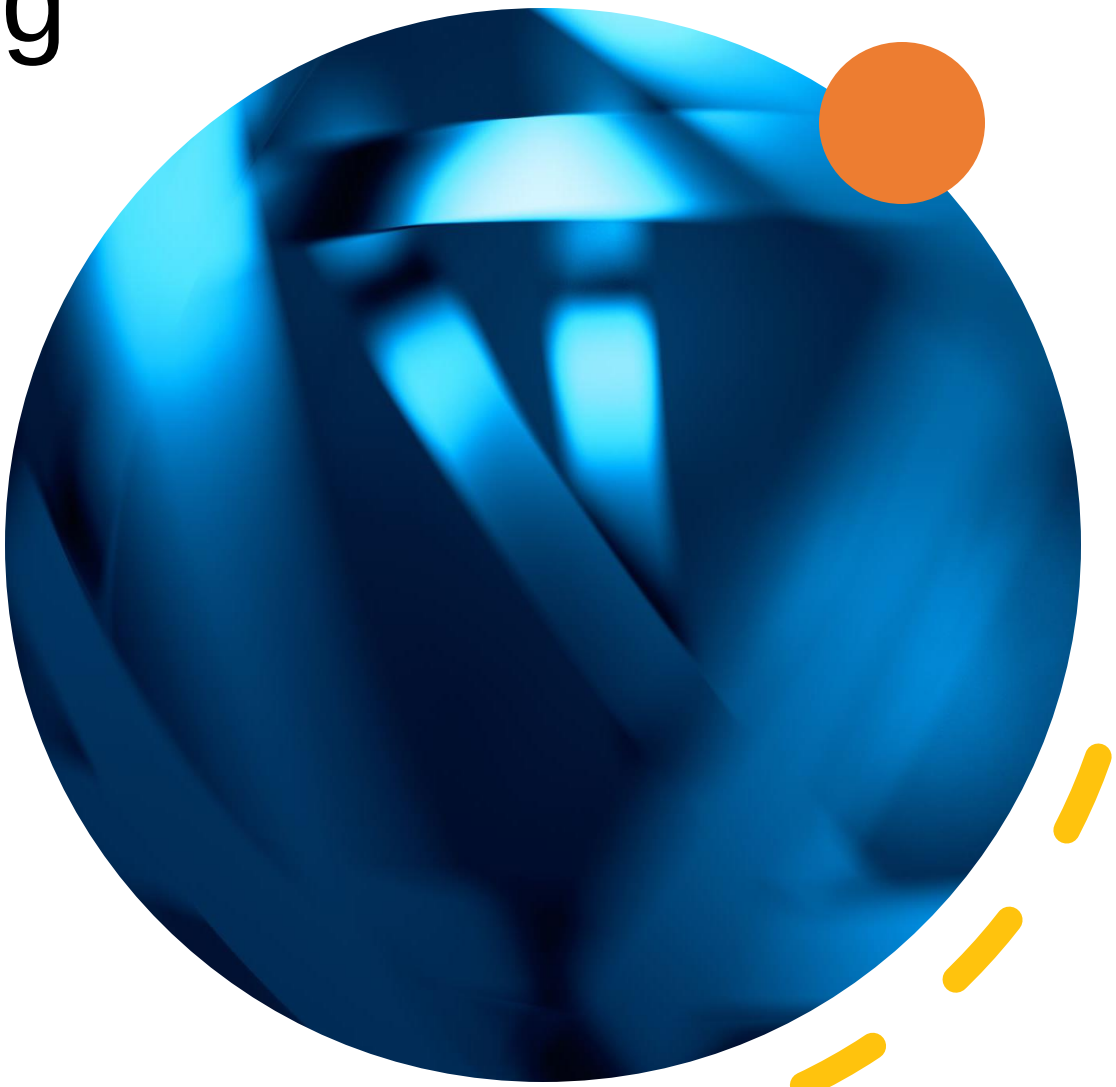
- Typically, an AI is programmed to behave a certain way and fulfill a task.
- Machine learning is a unique subfield of artificial intelligence in which algorithms learn to fulfill tasks.

# What is Machine Learning

Machine learning (ML) is the use of algorithms that improve automatically through experience.

ML is a subset of artificial intelligence (AI).

ML algorithms build a mathematical model based on sample data to make predictions or decisions without being explicitly programmed to do so.



ML algorithms are used in a wide variety of applications where it is difficult or infeasible to develop conventional algorithms to perform the needed tasks.

# How AI/ML is Process Built

- Process Mapping
- Identify Data Points
- Structure Data for Usability
- Algorithm Design
- Algorithm Optimization
- Dashboard/Results

# Keys To Successful Using AI/ML

- Data Governance
- Business Rules
- Data
- Expert Review

# Things You will Learn Using AI/ML

- Data Issues
  - Incomplete Data
  - Not Consistent Data entry
- The Need for Rules for Data Collection/Management
- Defining Goals for Projects
  - What is a win?
  - Process Mapping
- Expert Review

# Challenges Implementing AI/ML

- Ethical Fear
  - Staff should interpret/validate and explain process
  - Label AI or ML items
- Privacy and Security Concerns
  - Assess Risk of sharing data
    - Is there private data in it?
- Bias
  - Be careful not to over trust initial results
  - Validate them with expert staff review
- Fear of AI/ML taking jobs
  - Show how it is a tool
  - Support new staff

# INDOT Success Story on Bundling

- Business Rules and Process for ML
- How has it worked
- Challenges
- The Next Steps

# Keys to Success for Bundling

## Bundling Criteria/Business Rules

Work Types
- 2-3 similar work types: 2%
- 4-5 similar work types: 4%
- 6-7 similar work types: 6%
- >7 similar work types: 8%

Distance
- 0-10 miles: 6%
- 11-15 miles: 5%
- 16-20 miles: 3%
- 20-30 miles: 2%

Crossing local boundaries will incur a penalty
- 2 locals: -2%
- 3-4 locals: -3%
- 5 locals: -5%

Added penalties for larger distances:
- 30-40 miles: -2%
- > 40 miles: -6%

## Asset Rules and Life-cycle planning

dTIMS modeling

20 year Plan
Interstate Plan
Life Cycle Planning

# Best Bundle Algorithm

## “Brute-force” method of determining best bundles

## Simulated Annealing

- Start with each project in its own bundle
- Randomly move projects to new bundles
  - If total bundle score is better, keep bundle. If not, revert to previous bundle.
    - Bundle keep algorithm will also weight decision to keep bundle. Will keep more often toward the end of the run. More likely to swap at beginning.
  - Repeat until maximum number of iterations met

# INDOT Success Story on Bundling – Testing of Process

- ML Created 221 vs Staff Created 209
- Largest Bundle was 55 des numbers vs Staff 53
- Mean Bundle Size ML 3.5 vs 3.9

Modifications to Business Rules

- Added Unions
- Added trades that are connected to Work Types
- Added Corridor Bundling

# Key Bundling Criteria

- What worked?
  - Best bundling opportunities were found by looking at 3 key criteria
    - Corridors
    - Geographic Location
    - Work Types

# Corridor Bundles

- What to Consider…
  - Multiple work types on
    - Interstate or high volume multi-lane routes

      OR
    - City or single highway
  - Similar Maintenance of Traffic (MOT)
  - Construction time
  - Do Not mix interstate with non-interstate

# Work Type Bundles

- What to Consider…
  - Bridge Bundles
    - Historic Bridge projects should stand alone
    - Specialty Equipment
      - Flexible/Thin (Polymeric) Overlays with like project types
    - Paint Projects should be bundled with like project types
      - Exception: when complex MOT (e.g. narrow truss bridge with single lane signalized MOT.)
      - Exception: when painting will be required as part of a larger project
    - Large culvert/small structures/ 3 sided structures
      - typically different that traditional bridge contracts
      - Exception: Bundling small structure, bridges and road projects into a corridor contract has benefits to coordination, mobilization and MOT.

# Work Type Bundles Continued…

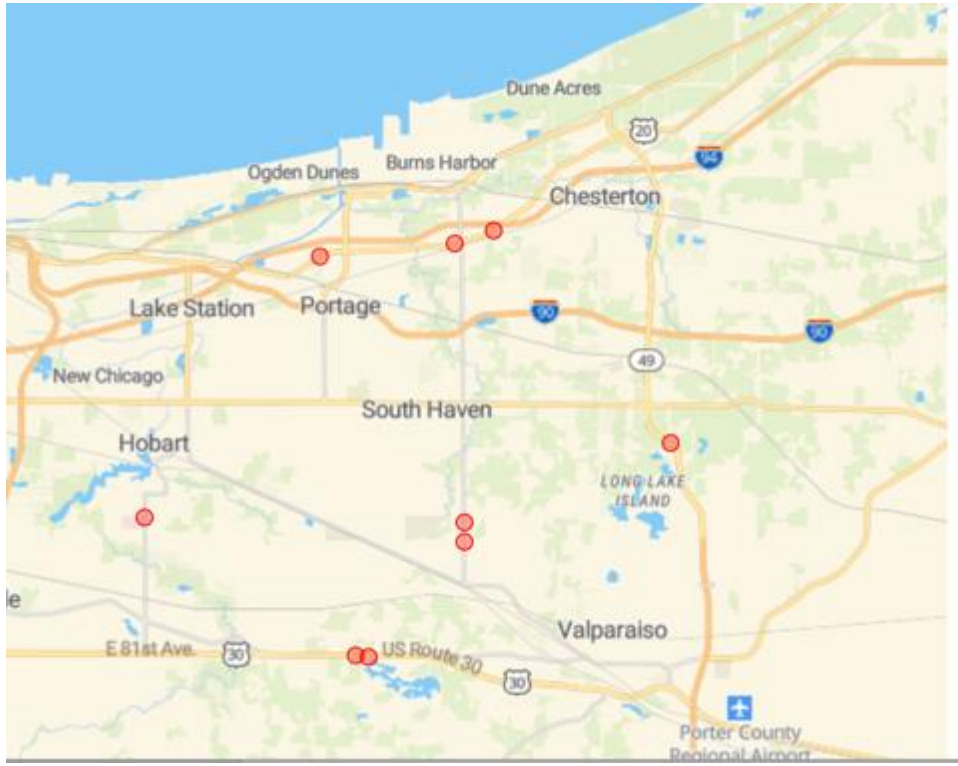
- Road Bundles
  - Unless within a corridor, road bundles have not been more cost effective or beneficial
  - Look for MOT conflicts
  - Timing and construction completion dates
  - Make sure you have a lead contractor

# Key Bundling Criteria

Corridors

Geographic Location

Work Types




**INDOT Bundled Projects**

Bundle Number 40606 - (14 projects) $1,735,517 - Savings Score: -4 %

| DES No. | Work Type | County | Year | Route | Est. Savings |
|---|---|---|---|---|---|
| 1701442 | Small Structure Replacement | Porter | 2022 | US-20 | -$2,232.48 |
| 1701332 | Small Structure Pipe Lining | Lake | 2022 | US-30 | -$3,991.56 |
| 1701444 | Small Structure Pipe Lining | Lake | 2022 | US-231 | -$2,812.8 |
| 1701454 | Small Structure Pipe Lining | Lake | 2022 | SR-51 | -$1,875.2 |
| 1701472 | Small Structure Pipe Lining | Lake | 2022 | SR-312 | -$5,621.76 |
| 1701509 | Small Structure Pipe Lining | Lake | 2022 | US-231 | -$11,700 |

**FORO Bundles**

| Bundle Number | Number of Projects | Score | Bundle Value |
|---|---|---|---|
| 198 | 7 | 8% | $2,984,384 |
| 656 | 7 | 9% | $18,147,381 |
| 516 | 4 | 8% | $3,657,480 |
| 824 | 4 | 8% | $3,314,985 |
| 859 | 2 | 8% | $393,286 |
| 201 | 6 | 8% | $6,241,435 |

# Examples of Successful Bundles

- I-74 mixed bridge rehab work types along a Corridor
  - 11 Des #s
  - Engineers Estimate - $ 2,540,301
  - Award - $ 2,081,968
    - **18 % savings**
- I-74 mixed bridge work types along a Corridor
  - 10 Des #s
  - Engineers Estimate - $ 17,443,874
  - Award - $14,659,979
    - **16 % savings**
- SR 63 Small Structure Pipe Linings
  - 6 Des #s
  - Engineers Estimate - $1,251,800
  - Award - $1,097,163
    - **8% savings**
- US 50 Bridge Rehabilitation Corridor
  - 23 Des #s, primarily thin deck overlays with 2 joint repairs
  - Engineers Estimate - $2,286,205
  - Award $1,667,760
    - **27% savings**
- US 31 Road Resurfacing and Deck Overlays
  - 3 Des #s
  - Engineers Estimate - $ 4,396,942
  - Award - $ 3,657,475
    - **17 % savings**

# INDOT Success with ML on Bundling

- Staff Time Savings
  - Before Bundling took weeks to over a Month
  - Now a week
- Breaking Down of Human Barriers
  - District lines
- Allows INDOT to Innovate looking at Bundles

# INDOT Next Step with ML on Bundling

- Multi Years
- Adding additional Criteria
  - Resiliency
  - Equity
  - Max Size of Bundles

# Thank You

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**More to follow!**


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