Bridge Deck Preservation Tool

WJE

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Wiss, Janney, Elstner Associates, Inc.

Michigan Bridge Week 2026

Project Objectives

The bridge deck preservation tool, or BDPT, is designed to be **a nationally accessible, interactive, and customizable decision-making aid** for selecting **preservation and maintenance for concrete bridge decks**

- **Bridge Deck Preservation Portal - Phase I (ElBatanouny et al. 2020)**

    - Project led by Iowa DOT & FHWA; ME, WA, OR, and NC DOTs also on TAC

    - Objective: to develop a framework for a BDPP to aid engineers in choosing an *optimal preservation strategy* for *a given bridge deck* based on calculated *cost, service life, and risk/uncertainty*

    - Modules: User Inputs, Selection of Maintenance Actions, Algorithms, Optimization, Output

Project Objectives

- **Bridge Deck Preservation Tool - Phase II (Implementation)**

  - Pooled fund study TPF-5(474) with IA, IN, MN, MO, NM, TX DOTs and FHWA
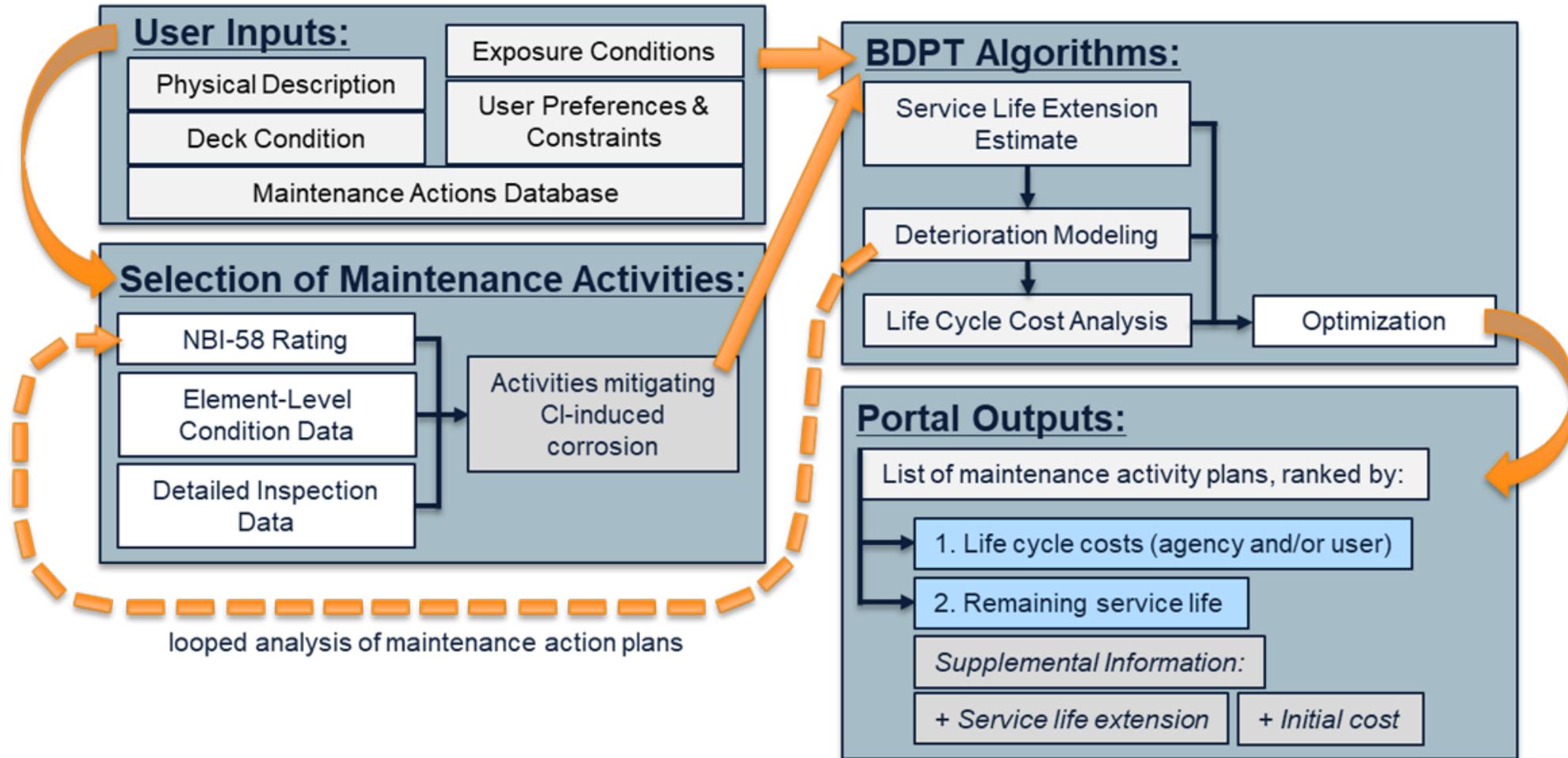
  To develop

  a fully-functional, cloud-based Bridge Deck Preservation Tool (BDPT)

  hosted on the FHWA LTBP InfoBridge web portal.

  1. Finalize BDPT framework *(Tier 1)*

  2. Incorporate final BDPT into InfoBridge *(Tier 2)*

  3. Promote use of the BDPT *(Tier 3)*

Analytical Framework

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Overview of the BDPT

Introduction to the Bridge Deck Preservation Tool (BDPT)

The BDPT is a decision-making aid intended to be used at a project or asset level to compare different preservation or maintenance strategies for a given bridge deck. The comparison is based on the strategies' relative initial costs, service life benefits, life cycle costs, and risk (expressed in terms of the uncertainty in the estimated service life impact).

Usage | Constraints | Limitations | Resources

The BDPT analysis is designed for reinforced concrete bridge decks for which the following is true:

- The current deck general condition rating (NBI Item 58 or SNBI Item B.C.01) is at least 5.
- The governing deterioration mechanism is chloride-induced corrosion of the topside of the deck.
- A comparative analysis between preservation or maintenance strategies using only the inputs available in InfoBridge is deemed sufficient by the user for decision making purposes.

At a minimum, the deck general condition rating must be known and a deterioration model forecasting the deck general condition rating must be available. Users are encouraged to provide any available element-level data and detailed inspection data, such as crack mapping information, in addition to the general condition rating.

Users are strongly encouraged to provide their own cost estimates for the different maintenance actions available for analysis.

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Help ▼ | FHWA InfoHighway ▼

HOME   DATA   ANALYTICS   TOOLS   LIBRARY

About

Bridge Information

Data Source

Bridge Properties

Deck Condition

Exposure Conditions

Analysis

Analysis Options

Maintenance Actions

Analysis Selection

Bri

N

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HOME   DATA   ANALYTICS   TOOLS   LIBRARY

Bridge Information

Data Source

Bridge Properties

Deck Condition

Exposure Conditions

Analysis

Analysis Options

Maintenance Actions

Analysis Selection

Introduction to the Bridge Deck Preservation Tool (BDPT)

The BDPT is a decision-making aid intended to be used at a project or asset level to compare different preservation or maintenance strategies for a given bridge deck. The comparison is based on the strategies' relative initial costs, service life benefits, life cycle costs, and risk (expressed in terms of the uncertainty in the estimated service life impact).

| Usage | **Constraints** | Limitations | Resources |

About

The BDPT is not to be used if:

- The structural capacity of the bridge or its deck is in question such that public safety may be compromised.
- The options under consideration are rehabilitation, replacement, and/or deferred replacement.
- The project being scoped has service life requirements that specify the minimum service life (or service life extension) to be achieved and require service life design to be performed, e.g., as described by the AASHTO Guide to Service Life Design of Highway Bridges. Service life requirements are typically limited to bridges that are major investments, such as signature bridges and bridges crossing state borders, for which a more refined analysis than what the BDPT can provide is justified because of the magnitude of the project expense.
- Deterioration caused by chloride-induced corrosion of the underside of the deck or by other degradation mechanisms, including but not limited to abrasion, alkali-aggregate reaction, and freeze-thaw deterioration, is controlling or otherwise impacting the deck general condition rating.

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Introduction to the Bridge Deck Preservation Tool (BDPT)

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| Usage | Constraints | **Limitations** | Resources |

Users should be aware of the following key limitations when interpreting and using the results of the BDPT:

- **Cost Estimates:** The cost estimates from the BDPT are not to be taken as exact values. While the BDPT has default unit costs for each deck maintenance action that are used to estimate and compare the costs of the preservation or maintenance strategies, maintenance unit costs are expected to vary based on the locality as well as bridge- and site-specific factors. In some scenarios, the order of the least expensive maintenance to the most expensive maintenance may differ from the order of the BDPT's default estimates. Because this can impact the results of the BDPT's comparative analysis, users have the ability and are strongly encouraged to replace the default unit cost values with agency- or bridge-specific values.

- **Deck Service Life Estimates:** Estimates of the deck service life extension offered by the maintenance actions are not to be taken as absolute predictions. The actual service life extension will depend on variables that are not readily available without an in-depth condition assessment, and will also depend on the construction procedures and quality, the particular materials and products used, the exposure conditions experienced by the deck in the future, and other factors that cannot be predicted without material testing or additional investigations. The BDPT coarsely considers many of these variables, and its probabilistic deck service life extension estimates are deemed sufficient for the comparative analysis performed by the BDPT. If desired, users may override the estimates provided by the BDPT.

- **BDPT User Discretion:** The BDPT generally allows the user to change any input or default value within its analysis and to control the specific preservation or maintenance strategies to be analyzed. While the BDPT sometimes cautions or warns the user of selections that are considered poor practice, it has very few restrictions on the selections that can be made and the user is responsible for ensuring that the analysis is carried out and interpreted appropriately.

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Bridge Information

Data Source

Bridge Properties

Deck Condition

Exposure Conditions

Analysis

Analysis Options

Maintenance Actions

Analysis Selection

Introduction to the Bridge Deck Preservation Tool (BDPT)

The BDPT is a decision-making aid intended to be used at a project or asset level to compare different preservation or maintenance strategies for a given bridge deck. The comparison is based on the strategies' relative initial costs, service life benefits, life cycle costs, and risk (expressed in terms of the uncertainty in the estimated service life impact).

| Usage | Constraints | Limitations | **Resources** |

About

- User Guide for the Bridge Deck Preservation Tool
- BDPT Introduction Video
- BDPT Overview Video
- TPF-5(474) Bridge Deck Preservation Tool

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Deck Maintenance Action	Default Agency Unit Cost
Penetrating sealer	$1.4 per sq ft
Crack-chasing of concrete	$5 per lin ft
Floodcoat	$3 per sq ft
Hot mix asphalt overlay with a waterproofing membrane	$10 per sq ft
Modified asphalt overlay	$15 per sq ft
Portland cement concrete or high performance concrete overlay	$20 per sq ft
Ultra high performance concrete overlay	$56 per sq ft
Latex-modified concrete overlay	$22 per sq ft
Thin polymer overlay	$8 per sq ft
Premixed polymer concrete overlay	$15 per sq ft
Deck replacement	$100 per sq ft

Deck Maintenance Action	Feasible Range
Penetrating sealer	3 to 6 years
Crack-chasing of concrete	3 to 10 years
Floodcoat	5 to 15 years
Hot mix asphalt overlay with a waterproofing membrane	7 to 20 years
Modified asphalt overlay	6 to 15 years
Portland cement concrete or high performance concrete overlay	10 to 35 years
Ultra high performance concrete overlay	25 to 45 years
Latex-modified concrete overlay	10 to 35 years
Thin polymer overlay	7 to 15 years
Premixed polymer concrete overlay	10 to 30 years

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HOME   DATA   ANALYTICS   TOOLS   LIBRARY

Bridge Information

Data Source

Bridge Properties

Deck Condition

Exposure Conditions

Analysis

Analysis Options

Maintenance Actions

Analysis Selection

Bridge Deck Preservation Tool

About

New Analysis   Open Analysis

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HOME   DATA   ANALYTICS   TOOLS   LIBRARY

Bridge Information	Bridge Deck Preservation Tool	About

Data Source

Bridge Properties

Deck Condition

Exposure Conditions

Analysis

Analysis Options

Maintenance Actions

Analysis Selection

New Analysis	Open Analysis	Save Analysis

Data Source

Bridge Data Source: ● LTBP InfoBridge   ○ Agency Data

Select Bridge

Select State: 19 - Iowa ▼

	1 - State Name	8 - Structure Number	22 - Owner Agency	3 - County Name	107 - Deck Structure Type Code	58 - Deck Condition Rating	CAT29 - Deck Area (sq.ft)	Bridge Age (yr)	29 - Average Daily Traffic	27 - Ye
	~ [ ] x	~ 36281 x	~ [ ] x	~ [ ] x	== [ ] x	== 58 - Deck Condition Rating x	== [ ] x	== [ ] x	== [ ] x	==
⬀	19 - Iowa	000000000036281	State Highway Agency	129 - Mills County	1	7	6706.3	14	6800	
⬀	19 - Iowa	000000000362810	County Highway Agen	125 - Marion County	1	7	5557	38	62	
⬀	19 - Iowa	000000000362815	County Highway Agen	121 - Madison Cour	1	6	3484.3	38	40	

View 1 - 3 of 3 |◀ ◀◀ 1 of 1 ▶▶ ▶| 25 ▼

Previous	Next

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HOME   DATA   ANALYTICS   **TOOLS**   LIBRARY

Bridge Information

Data Source

Bridge Properties

Deck Condition

Exposure Conditions

Analysis

Analysis Options

Maintenance Actions

Analysis Selection

Bridge Deck Preservation Tool

About

| New Analysis | Open Analysis | Save Analysis |

Bridge Information

State Name: 19 - Iowa   Structure Number: 000000000036281   Owner Agency: State Highway Agency

Bridge Properties   ☐ Override

Year Built (NBI-27):	2010
Year Reconstructed (NBI-106):	
Did reconstruction include deck replacement? ⓘ	○ Yes ◉ No
Deck Structure Type (NBI-107):	1 - Concrete Cast-in-Place ▾
Wearing Surface Type (NBI-108A):	1 - Monolithic Concrete (concurrently placed with structural deck) ▾
Membrane Type (NBI-108B):	0 - None ▾
Deck Protection Type (NBI-108C):	1 - Epoxy Coated Reinforcing ▾
Structure Length, ft. (NBI-49):	154.9
Deck Width - Out to Out, ft. (NBI-52):	43.3

| Reset Form | | Previous | Next |

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HOME   DATA   ANALYTICS   **TOOLS**   LIBRARY

Bridge Information

Data Source

Bridge Properties

Deck Condition

Exposure Conditions

Analysis

Analysis Options

Maintenance Actions

Analysis Selection

Bridge Deck Preservation Tool

About

| New Analysis | Open Analysis | Save Analysis |

Bridge Information

State Name: 19 - Iowa   Structure Number: 000000000036281   Owner Agency: State Highway Agency

Bridge Properties   ☐ Override

| Year Built (NBI-27): | 2010 |

| Year Reconstructed (NBI-106): | |

Did reconstruction include deck replacement? ⓘ   ○   ● No

> The Year Reconstructed (NBI-106) does not necessarily identify the year in which the bridge was replaced. The FHWA *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges* (1995, with 2012 and 2018 errata) requires that for a bridge to be defined as "reconstructed," the work performed must have been eligible for Federal-aid funding, and lists examples of types of eligible work that are not to be considered as reconstruction, but does not specify which types of eligible work are to be considered reconstruction. As a result, "reconstruction" may refer to activities that do not necessarily include deck replacement, such as the year in which the superstructure and/or substructure was replaced or rehabilitated, or the year in which the bridge was widened. Because of this uncertainty, the BDPT assumes that the current deck of the bridge was constructed in the Year Built (NBI-27) unless the BDPT user indicates that the scope of the work completed in the Year Reconstructed (NBI-106) included deck replacement.

Deck Structure Type (NBI-107):   e Cast-in-Place   ⌄

Wearing Surface Type (NBI-108A):   nic Concrete (concurrently placed with structural deck)   ⌄

Membrane Type (NBI-108B):   ⌄

Deck Protection Type (NBI-108C):   Coated Reinforcing   ⌄

Structure Length, ft. (NBI-49):

Deck Width - Out to Out, ft. (NBI-52):

| Reset Form | | Previous | Next |

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HOME   DATA   ANALYTICS   TOOLS   LIBRARY

Bridge Information

Data Source

Bridge Properties

Deck Condition

Exposure Conditions

Analysis

Analysis Options

Maintenance Actions

Analysis Selection

Bridge Deck Preservation Tool   About

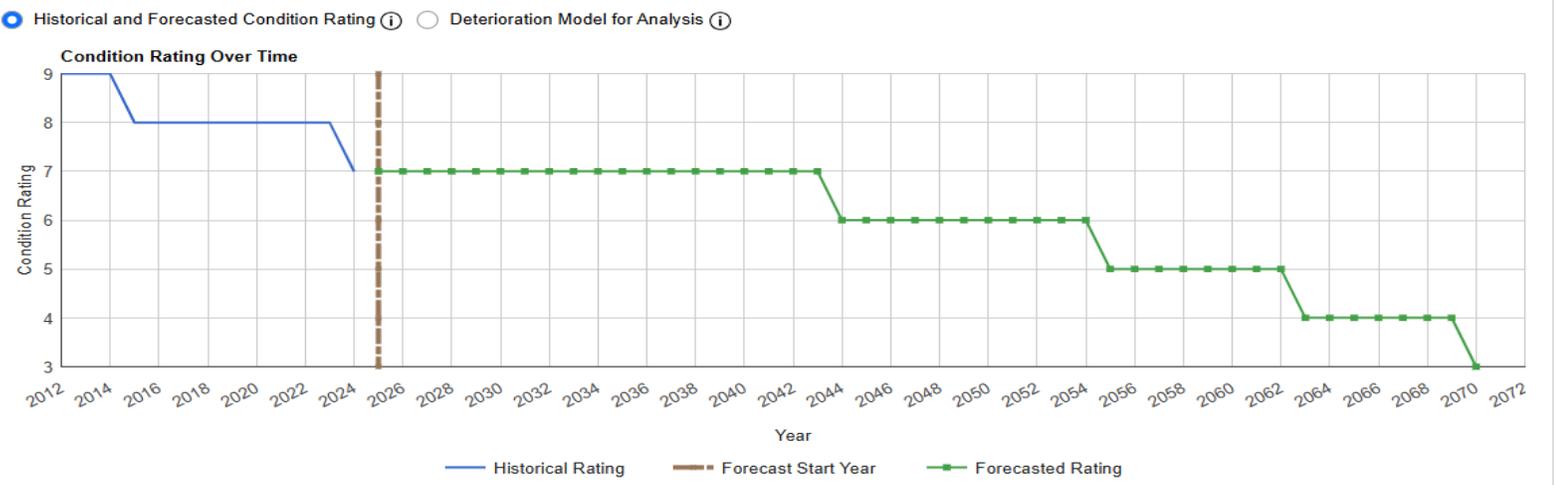New Analysis   Open Analysis   Save Analysis

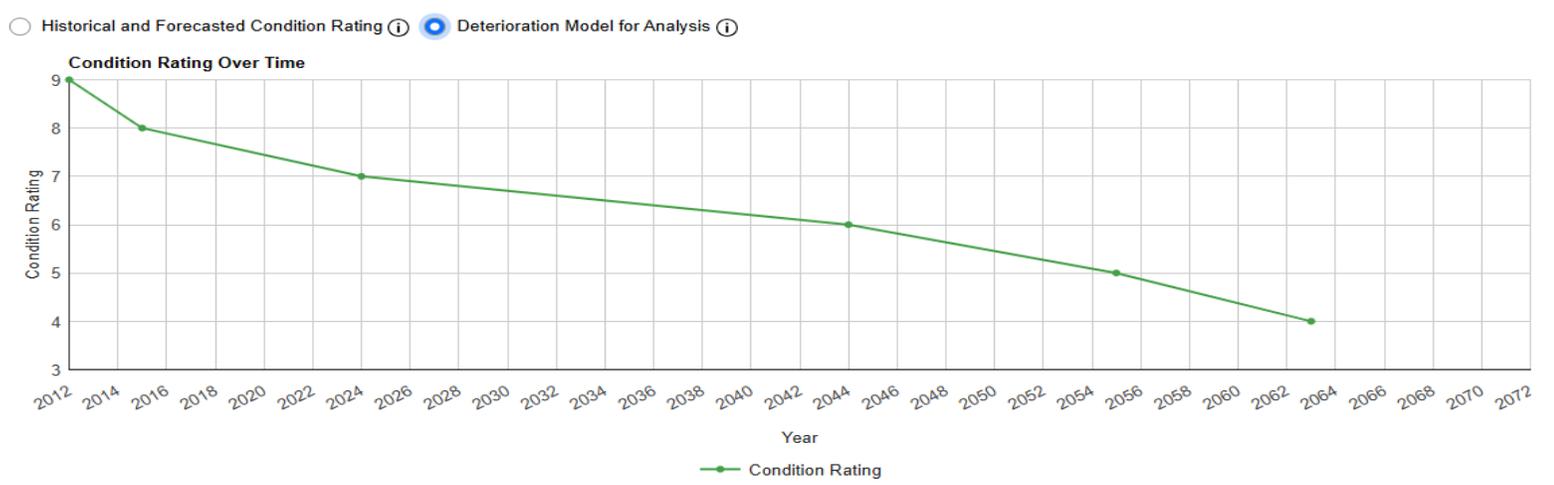### Bridge Information

State Name: 19 - Iowa   Structure Number: 000000000036281   Owner Agency: State Highway Agency

Deck Condition   ☐ Override

Current and Forecasted General Deck Condition Ratings ⓘ   ⬇ Save as Image   ⬇ Save as CSV

Year:	Condition Rating
2012	9
2015	8
2024	7
2044	6
2055	5
2063	4

● Historical and Forecasted Condition Rating ⓘ   ○ Deterioration Model for Analysis ⓘ

Condition Rating Over Time

Legend: — Historical Rating   -·- Forecast Start Year   —■— Forecasted Rating

Element-Level Condition Data ⓘ

Is Element level data available?   ● Yes   ○ No

Element Type	CS1 (%)	CS2 (%)	CS3 (%)	CS4 (%)
12 - Reinforced Concrete Deck ▼	99	0	0	0
510 - Wearing Surfaces ▼				

Are quantities associated with each defect type known?   ○ Yes   ● No

Detailed Inspection Data ⓘ

Is detailed inspection data available? ⓘ   ○ Yes   ● No

Reset Form   Previous   Next

InfoBridge : Tools

HOME   DATA   ANALYTICS   TOOLS   LIBRARY

Bridge Information

Data Source

Bridge Properties

Deck Condition

Exposure Conditions

Analysis

Analysis Options

Maintenance Actions

Analysis Selection

Bridge Deck Preservation Tool

About

New Analysis   Open Analysis   Save Analysis

Bridge Information

State Name: 19 - Iowa   Structure Number: 000000000036281   Owner Agency: State Highway Agency

Deck Condition   ☐ Override

Current and Forecasted General Deck Condition Ratings ⓘ   ⬇ Save as Image   ⬇ Save as CSV

○ Historical and Forecasted Condition Rating ⓘ   ● Deterioration Model for Analysis ⓘ

Year:	Condition Rating
2012	9
2015	8
2024	7
2044	6
2055	5
2063	4

Condition Rating Over Time

Element-Level Condition Data ⓘ

Is Element level data available?   ● Yes   ○ No

Element Type	CS1 (%)	CS2 (%)	CS3 (%)	CS4 (%)
12 - Reinforced Concrete Deck ⌄	99	0	0	0
510 - Wearing Surfaces ⌄				

Are quantities associated with each defect type known?   ○ Yes   ● No

Detailed Inspection Data ⓘ

Is detailed inspection data available? ⓘ   ○ Yes   ● No

Reset Form   Previous   Next

InfoBridge : Tools

HOME   DATA   ANALYTICS   TOOLS   LIBRARY

Bridge Information	Bridge Deck Preservation Tool	About

Bridge Information

Data Source
Bridge Properties
Deck Condition
Exposure Conditions

New Analysis	Open Analysis	Save Analysis

Bridge Information

State Name: 19 - Iowa	Structure Number: 000000000036281	Owner Agency: State Highway Agency

Analysis

Analysis Options
Maintenance Actions

Deck Condition   ☐ Override

Current and Forecasted General Deck Condition Ratings ⓘ   ⬇ Save as Image   ⬇ Save as CSV

Detailed Inspection Data ⓘ

Is detailed inspection data available? ⓘ   ● Yes   ○ No

Crack Map Information	Typical Crack Widths ⓘ	Please Select ⌄
	Crack Density (ft/ft^2) ⓘ	
Delamination Survey	Total Delaminated Area (%)	
Half-Cell Potential Data	Area likely to be corroding (%) ⓘ	
Chloride Data	Is the chloride concentration at the depth of the reinforcing steel sufficiently elevated such that corrosion is a risk? ⓘ	○ Yes ● No or chloride testing not conducted

---

Element-Level Condition Data ⓘ

Is Element level data available?   ● Yes   ○ No

Element Type	CS1 (%)	CS2 (%)	CS3 (%)	CS4 (%)
12 - Reinforced Concrete Deck ⌄	99	0	0	0
510 - Wearing Surfaces ⌄				

Are quantities associated with each defect type known?   ○ Yes   ● No

Detailed Inspection Data ⓘ

Is detailed inspection data available? ⓘ   ○ Yes   ● No

Reset Form		Previous	Next

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Bridge Information

Data Source

Bridge Properties

Deck Condition

Exposure Conditions

Analysis

Analysis Options

Maintenance Actions

Analysis Selection

Bridge Deck Preservation Tool   About

New Analysis   Open Analysis   Save Analysis

Bridge Information

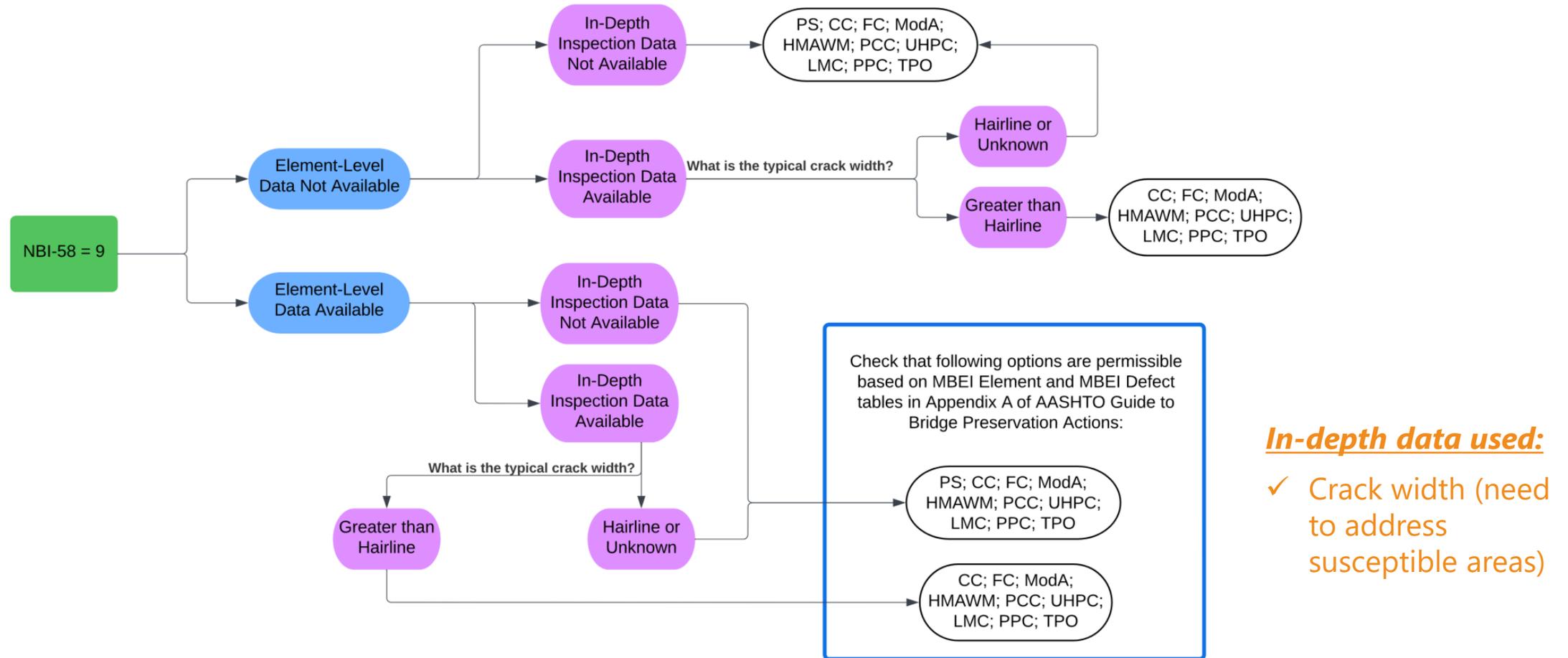State Name: 19 - Iowa   Structure Number: 000000000036281   Owner Agency: State Highway Agency

Exposure Conditions   ☐ Override

Primary Chloride Source: ⓘ	Deicing chemicals ⌄
Average Daily Traffic (NBI-29):	6800
Average Daily Truck Traffic (% ADT) (NBI-109):	31
Number of Freeze-Thaw cycles (days): ⓘ	115
Annual Days of Snowfall: ⓘ	43

Reset Form   Previous   Next

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Bridge Information

Data Source

Bridge Properties

Deck Condition

Exposure Conditions

Analysis

Analysis Options

Maintenance Actions

Analysis Selection

Bridge Deck Preservation Tool

About

New Analysis	Open Analysis	Save Analysis

Bridge Information

State Name: 19 - Iowa   Structure Number: 000000000036281   Owner Agency: State Highway Agency

Analysis Options

Data Submittal Year: ⓘ	2024
Year to Perform Maintenance: ⓘ	2025
Available Budget ($): ⓘ	40000

Parameters for Life Cycle Cost Analysis

Analysis Period (Years): ⓘ	100
Discount Rate (%): ⓘ	4
Consider User Cost: ⓘ	○ Yes ● No

Optimization Weights ⓘ

Agency Life Cycle Cost:	0.5
Remaining Service Life:	0.5
User Life Cycle Cost:	

Reset Form		Previous	Next

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HOME   DATA   ANALYTICS   TOOLS   LIBRARY

Bridge Properties

Deck Condition

Exposure Conditions

Analysis

Analysis Options

Maintenance Actions

Analysis Selection

Bridge Information

State Name: 19 - Iowa	Structure Number: 000000000036281	Owner Agency: State Highway Agency

Maintenance Actions

Consider Element Level Data:	○ Yes ● No	
Consider Detailed Inspection Data:	○ Yes ● No	
Use Default Service Life Extension (SLE) Estimate Algorithm: ⓘ	● Yes ○ No	
Use Default Maintenance Action Costs:	● Yes ○ No	
Augmentation Factor: ⓘ		1

| Maintenance Actions	Construction Risk ⓘ	Default SLE Range (Years) ⓘ		Custom SLE (Years) ⓘ	Agency Cost ($/unit)	Unit	User Costs ($)
		Min	Max				
☑ Penetrating Sealer ⓘ ⚠	Low ▾	3	6		1.4	SF	
☐ Crack-Chasing of Concrete ⓘ 🚫	Low ▾	3	10		5	LF	
☑ Floodcoat ⓘ ⚠	Low ▾	5	15		3	SF	
☑ HMA Overlay with a Waterproofing Membrane ⓘ	Moderate ▾	7	20		10	SF	
☑ Modified Asphalt Overlay ⓘ	Moderate ▾	6	15		15	SF	
☑ PCC/HPC Overlay ⓘ	Low ▾	10	35		20	SF	
☑ UHPC Overlay ⓘ	High ▾	25	45		56	SF	
☑ LMC Overlay ⓘ	Moderate ▾	10	35		22	SF	
☑ Thin Polymer Overlay ⓘ ⚠	Moderate ▾	7	15		8	SF	
☑ PPC Overlay ⓘ	High ▾	10	30		15	SF	
Deck Replacement: ⓘ	N/A	-	-	N/A	100	SF	

Previous   Auto-Select Maintenance Actions   Next

Decision Tree: NBI-58 of 9

In-depth data used:

✓ Crack width (need to address susceptible areas)

Decision Tree: NBI-58 of 8

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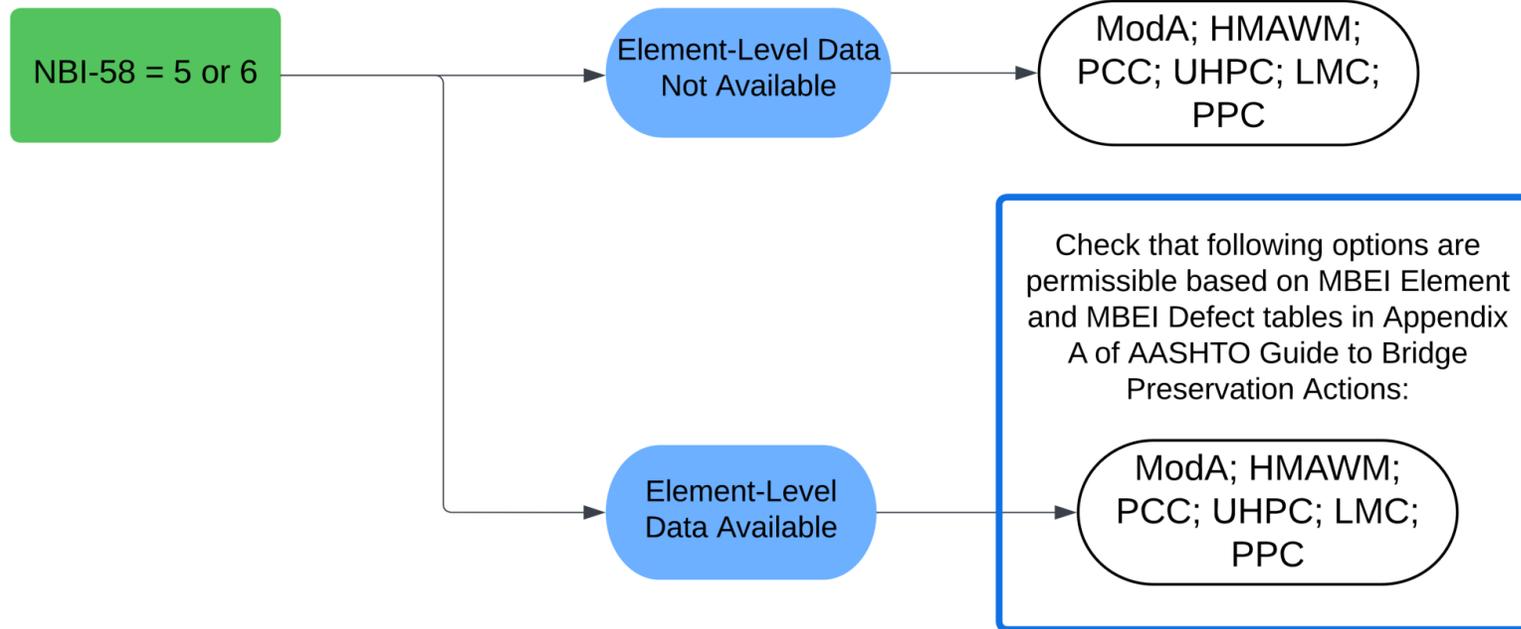
Decision Tree: NBI-58 of 7
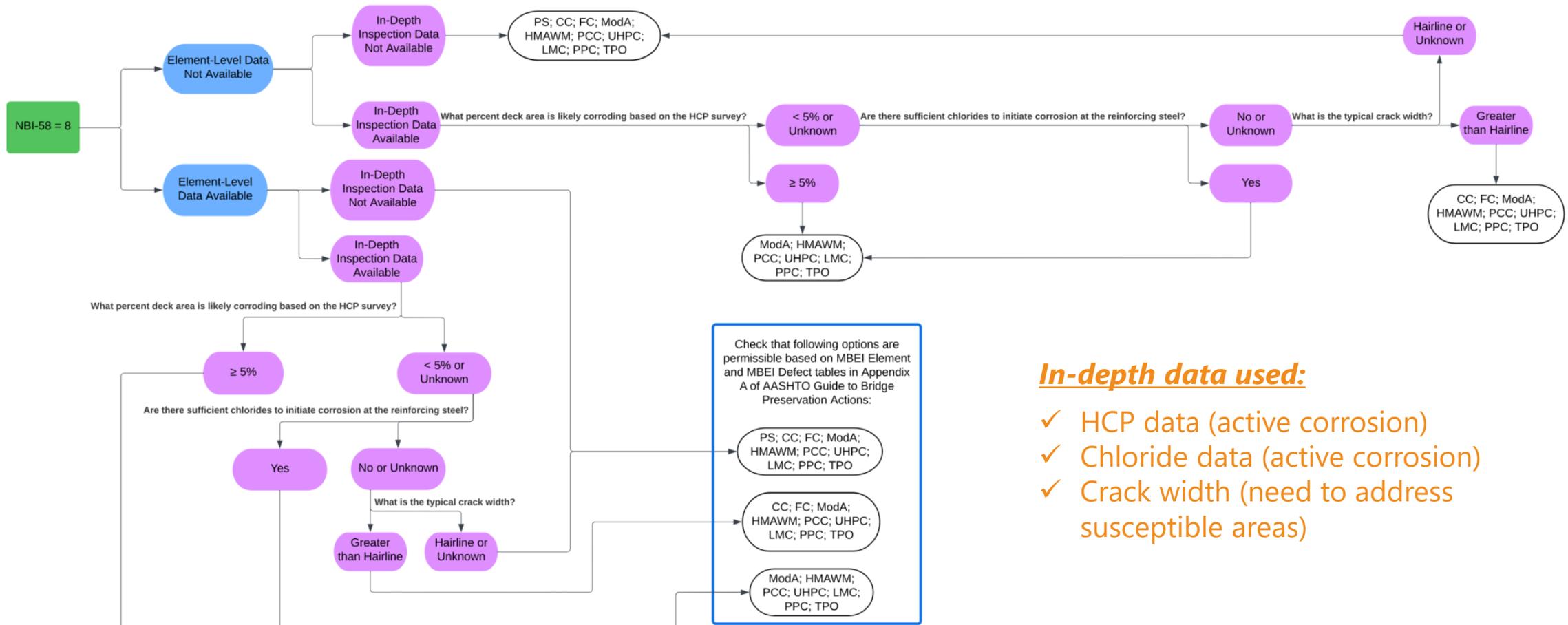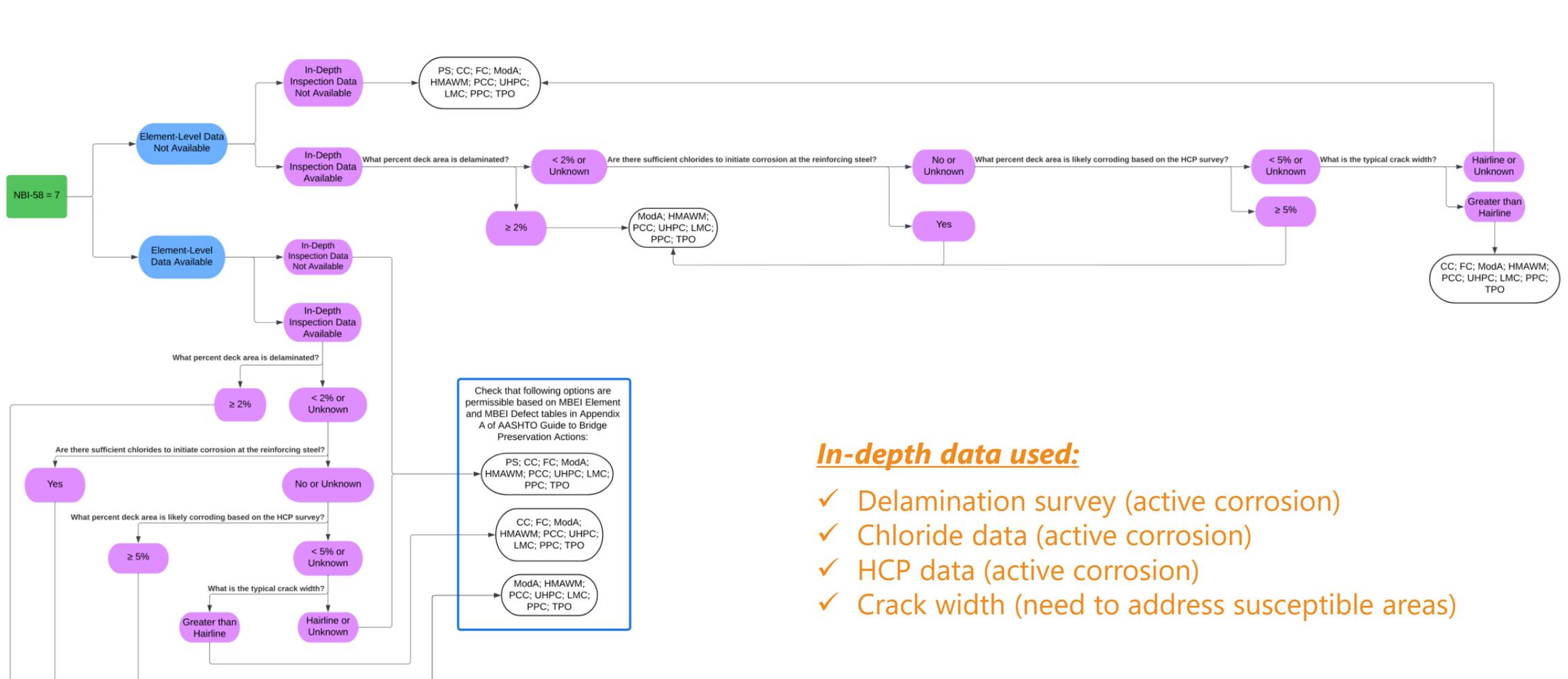
In-depth data used:

✓ Delamination survey (active corrosion)
✓ Chloride data (active corrosion)
✓ HCP data (active corrosion)
✓ Crack width (need to address susceptible areas)

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Decision Tree: NBI-58 of 5 or 6

```
NBI-58 = 5 or 6  ──┬──▶  Element-Level Data Not Available  ──▶  ( ModA; HMAWM; PCC; UHPC; LMC; PPC )

                   └──▶  Element-Level Data Available  ──▶  ┌─────────────────────────────────────────┐
                                                            │ Check that following options are        │
                                                            │ permissible based on MBEI Element       │
                                                            │ and MBEI Defect tables in Appendix      │
                                                            │ A of AASHTO Guide to Bridge             │
                                                            │ Preservation Actions:                   │
                                                            │                                         │
                                                            │   ( ModA; HMAWM; PCC; UHPC; LMC; PPC )  │
                                                            └─────────────────────────────────────────┘
```

Assume [Cl-]-induced corrosion is present → no need for detailed inspection data

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Bridge Properties

Deck Condition

Exposure Conditions

Analysis

Analysis Options

Maintenance Actions

Analysis Selection

Bridge Information

State Name: 19 - Iowa   Structure Number: 000000000036281   Owner Agency: State Highway Agency

Maintenance Actions

Consider Element Level Data: ○ Yes   ● No

Consider Detailed Inspection Data:

Use Default Service Life Extension (SLE) Estimate Alg

Use Default Maintenance Action Costs:

Augmentation Factor: ⓘ

Maintenance Actions

⚠ Penetrating Sealer   ✕

Caution: More Information Recommended.

While a penetrating sealer will protect the general deck area from chloride intrusion, penetrating sealers may not provide effective protection for cracks with widths greater than hairline (> 0.012 inches). Because such cracks will govern the time to repairs, the preventive maintenance action should address these cracks if they are present. Crack inspection recommended to determine if these conditions exist.

Caution: More Information Recommended.

Penetrating sealers are assumed to be ineffective at slowing deterioration if active corrosion is already occurring. Delamination survey recommended to determine if active corrosion is present.

Caution: More Information Recommended.

Penetrating sealers are assumed to be ineffective at slowing deterioration if active corrosion is already occurring. HCP survey recommended to determine if active corrosion is present.

Caution: More Information Recommended.

Penetrating sealers are assumed to be ineffective at slowing deterioration if active corrosion is already occurring or imminent due to advanced chloride contamination. Chloride testing recommended to determine if there are sufficient chlorides in the concrete cover to initiate corrosion.

Close

Maintenance Actions		Custom SLE (Years) ⓘ	Agency Cost ($/unit)	Unit	User Costs ($)
☑ Penetrating Sealer ⓘ ⚠			1.4	SF	
☐ Crack-Chasing of Concrete ⓘ 🚫			5	LF	
☑ Floodcoat ⓘ ⚠			3	SF	
☑ HMA Overlay with a Waterproofing Membrane ⓘ			10	SF	
☑ Modified Asphalt Overlay ⓘ			15	SF	
☑ PCC/HPC Overlay ⓘ			20	SF	
☑ UHPC Overlay ⓘ			56	SF	
☑ LMC Overlay ⓘ			22	SF	
☑ Thin Polymer Overlay ⓘ ⚠			8	SF	
☑ PPC Overlay ⓘ	High ▾	10	30	15	SF	
Deck Replacement: ⓘ	N/A	-	-	N/A	100	SF	

Previous   Auto-Select Maintenance Actions   Next

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HOME   DATA   ANALYTICS   TOOLS   LIBRARY

Bridge Information

Data Source

Bridge Properties

Deck Condition

Exposure Conditions

Analysis

Analysis Options

Maintenance Actions

Bridge Deck Preservation Tool

About

New Analysis   Open Analysis   Save Analysis

Bridge Information

State Name: 19 - Iowa   Structure Number: 000000000036281   Owner Agency: State Highway Agency

Deck Condition   ☐ Override

Current and Forecasted General Deck Condition Ratings ⓘ   ⬇ Save as Image   ⬇ Save as CSV

Detailed Inspection Data ⓘ

Is detailed inspection data available? ⓘ		🔵 Yes ⚪ No
Crack Map Information	Typical Crack Widths ⓘ	Hairline ⌄
	Crack Density (ft/ft^2) ⓘ	
Delamination Survey	Total Delaminated Area (%)	0
Half-Cell Potential Data	Area likely to be corroding (%) ⓘ	0
Chloride Data	Is the chloride concentration at the depth of the reinforcing steel sufficiently elevated such that corrosion is a risk? ⓘ	⚪ Yes 🔵 No or chloride testing not conducted

Element-Level Condition Data ⓘ

Is Element level data available?   🔵 Yes   ⚪ No

Element Type	CS1 (%)	CS2 (%)	CS3 (%)	CS4 (%)
12 - Reinforced Concrete Deck ⌄	99	0	0	0
510 - Wearing Surfaces ⌄				

Are quantities associated with each defect type known?   ⚪ Yes   🔵 No

Detailed Inspection Data ⓘ

Is detailed inspection data available? ⓘ   ⚪ Yes   🔵 No

Reset Form   Previous   Next

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HOME   DATA   ANALYTICS   TOOLS   LIBRARY

Bridge Properties

Deck Condition

Exposure Conditions

Analysis

Analysis Options

Maintenance Actions

Analysis Selection

Bridge Information

State Name: 19 - Iowa	Structure Number: 000000000036281	Owner Agency: State Highway Agency

Maintenance Actions

Consider Element Level Data:	○ Yes	● No
Consider Detailed Inspection Data:	● Yes	○ No
Use Default Service Life Extension (SLE) Estimate Algorithm: ⓘ	● Yes	○ No
Use Default Maintenance Action Costs:	● Yes	○ No

Augmentation Factor: ⓘ   `1`

Maintenance Actions	Construction Risk ⓘ	Default SLE Range (Years) ⓘ		Custom SLE (Years) ⓘ	Agency Cost ($/unit)	Unit	User Costs ($)
		Min	Max				
☑ Penetrating Sealer ⓘ	Low ⌄	3	6		1.4	SF	
☐ Crack-Chasing of Concrete ⓘ 🚫	Low ⌄	3	10		5	LF	
☑ Floodcoat ⓘ	Low ⌄	5	15		3	SF	
☑ HMA Overlay with a Waterproofing Membrane ⓘ	Moderate ⌄	7	20		10	SF	
☑ Modified Asphalt Overlay ⓘ	Moderate ⌄	6	15		15	SF	
☑ PCC/HPC Overlay ⓘ	Low ⌄	10	35		20	SF	
☑ UHPC Overlay ⓘ	High ⌄	25	45		56	SF	
☑ LMC Overlay ⓘ	Moderate ⌄	10	35		22	SF	
☑ Thin Polymer Overlay ⓘ	Moderate ⌄	7	15		8	SF	
☑ PPC Overlay ⓘ	High ⌄	10	30		15	SF	
Deck Replacement: ⓘ	N/A	-	-	N/A	100	SF	

Previous   Auto-Select Maintenance Actions   Next

HOME   DATA   ANALYTICS   TOOLS   LIBRARY

Bridge Properties

Deck Condition

Exposure Conditions

Analysis

Analysis Options

Maintenance Actions

Analysis Selection

Bridge Information

State Name: 19 - Iowa	Structure Number: 000000000036281	Owner Agency: State Highway Agency

Maintenance Actions

Consider Element Level Data: ○ Yes   ● No

Consider Detailed Inspection Data: ○ Yes   ● No

Use Default Service Life Extension (SLE) Estimate Algorithm: ⓘ   ○ Yes   ● No

Use Default Maintenance Action Costs: ● Yes   ○ No

Augmentation Factor: ⓘ   [1.2]

Maintenance Actions	Construction Risk ⓘ	Default SLE Range (Years) ⓘ		Custom SLE (Years) ⓘ	Agency Cost ($/unit)	Unit	User Costs ($)
		Min	Max				
☑ Penetrating Sealer ⓘ ⚠	Low ˅	3	6	10	1.4	SF	
☐ Crack-Chasing of Concrete ⓘ 🚫	Low ˅	3	10		5	LF	
☑ Floodcoat ⓘ ⚠	Low ˅	5	15		3	SF	
☑ HMA Overlay with a Waterproofing Membrane ⓘ	Moderate ˅	7	20		10	SF	
☑ Modified Asphalt Overlay ⓘ	Moderate ˅	6	15		15	SF	
☑ PCC/HPC Overlay ⓘ	Low ˅	10	35		20	SF	
☑ UHPC Overlay ⓘ	High ˅	25	45		56	SF	
☑ LMC Overlay ⓘ	Moderate ˅	10	35		22	SF	
☑ Thin Polymer Overlay ⓘ ⚠	Moderate ˅	7	15		8	SF	
☑ PPC Overlay ⓘ	High ˅	10	30		15	SF	
Deck Replacement: ⓘ	N/A	-	-	N/A	100	SF	

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[Previous]   [Auto-Select Maintenance Actions]   [Next]

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About   Programs   Resources   Briefing Room   Contact   Search FHWA

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HOME   DATA   ANALYTICS   TOOLS   LIBRARY

Bridge Information

Data Source

Bridge Properties

Deck Condition

Exposure Conditions

Analysis

Analysis Options

Maintenance Actions

Analysis Selection

Bridge Deck Preservation Tool   About

New Analysis   Open Analysis   Save Analysis

Bridge Information

State Name: 19 - Iowa   Structure Number: 000000000036281   Owner Agency: State Highway Agency

Analysis Selection

◉ Analyze Single Maintenance Actions ⓘ

○ Auto-Generate Maintenance Action Plans ⓘ

○ Analyze User-Defined Maintenance Action Plans ⓘ

Previous   Start Analysis

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InfoBridge™ : Tools

Help ▼ | FHWA InfoHighway ▼

HOME   DATA   ANALYTICS   **TOOLS**   LIBRARY

Bridge Information	Bridge Deck Preservation Tool	About

Data Source

Bridge Properties

Deck Condition

Exposure Conditions

| New Analysis | Open Analysis | Save Analysis |

Bridge Information

State Name: 19 - Iowa   Structure Number: 000000000036281   Owner Agency: State Highway Agency

Analysis

Analysis Options

Maintenance Actions

Analysis Selection

Analysis Selection

◉ Analyze Single Maintenance Actions ⓘ

○ Auto-Generate Maintenance Action Plans ⓘ

○ Analyze User-Defined Maintenance Action Plans ⓘ

Previous   **Start Analysis**

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About Programs Resources Briefing Room Contact Search FHWA

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Help ▼ | FHWA InfoHighway ▼

HOME   DATA   ANALYTICS   **TOOLS**   LIBRARY

Bridge Information

Data Source

Bridge Properties

Deck Condition

Exposure Conditions

Analysis

Analysis Options

Maintenance Actions

Analysis Selection

Results

Summary

Action #1

Action #2

Action #3

Action #4

Action #5

Action #6

Action #7

Action #8

Action #9

Bridge Deck Preservation Tool

About

New Analysis   Open Analysis   Save Analysis

Bridge Information

State Name: 19 - Iowa   Structure Number: 000000000036281   Owner Agency: State Highway Agency

Analysis Summary

⬇ Save Graph Images   ⬇ Save as CSV

Maintenance actions highlighted in red exceed the provided budget.

Analysis Outputs	Action #1	Action #2	Action #3	Action #4	Action #5	Action #6	Action #7	Action #8	Action #9	No Maintenance
Undiscounted Sum ($):			582,914	655,375	584,150	690,701	624,833	717,288	738,319	784,612
Present Value ($):			156,085	147,673	183,341	148,633	202,019	407,378	195,794	158,980
Remaining Service Life (Years):			62	54	64	50	62	73	50	38
Service Life Extension (Years):			24	16	26	12	24	35	12	0
Initial Cost ($):	5,550	20,122	100,608	67,072	134,143	53,657	147,558	375,602	100,608	-
Optimization Rank: ⓘ	0.829	0.797	0.780	0.743	0.745	0.715	0.702	0.637	0.624	N/A

⚠ Warning ✕

Recommended Maintenance Over Budget
Maintenance actions highlighted in red exceed the provided budget.

Close

Action #1: Penetrating Sealer

Action #2: Floodcoat

Action #3: PPC Overlay

Action #4: HMA Overlay with a Waterproofing Membrane

Action #5: PCC/HPC Overlay

Action #6: Thin Polymer Overlay

Action #7: LMC Overlay

Action #8: UHPC Overlay

Action #9: Modified Asphalt Overlay

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Bridge Information

Data Source

Bridge Properties

Deck Condition

Exposure Conditions

Analysis

Analysis Options

Maintenance Actions

Analysis Selection

Results

Summary

Action #1

Action #2

Action #3

Action #4

Action #5

Action #6

Action #7

Action #8

Action #9

Bridge Deck Preservation Tool

About

New Analysis   Open Analysis   Save Analysis

Bridge Information

State Name: 19 - Iowa   Structure Number: 000000000036281   Owner Agency: State Highway Agency

Analysis Summary

⬇ Save Graph Images   ⬇ Save as CSV

Maintenance actions highlighted in red exceed the provided budget.

Analysis Outputs	Action #1	Action #2	Action #3	Action #4	Action #5	Action #6	Action #7	Action #8	Action #9	No Maintenance
Undiscounted Sum ($):	693,521	726,757	634,440	688,091	715,523	641,122	678,134	717,288	758,670	784,612
Present Value ($):	127,335	135,056	167,356	157,096	156,772	194,814	213,545	407,378	202,437	158,980
Remaining Service Life (Years):	47	43	58	51	48	60	58	73	48	38
Service Life Extension (Years):	9	5	20	13	10	22	20	35	10	0
Initial Cost ($):	20,122	9,390	100,608	67,072	53,657	134,143	147,558	375,602	100,608	-
Optimization Rank: ⓘ	0.820	0.768	0.776	0.754	0.733	0.737	0.696	0.656	0.643	N/A

Action #1: Floodcoat

Action #2: Penetrating Sealer

Action #3: PPC Overlay

Action #4: HMA Overlay with a Waterproofing Membrane

Action #5: Thin Polymer Overlay

Action #6: PCC/HPC Overlay

Action #7: LMC Overlay

Action #8: UHPC Overlay

Action #9: Modified Asphalt Overlay

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HOME   DATA   ANALYTICS   **TOOLS**   LIBRARY

Bridge Information

Data Source

Bridge Properties

Deck Condition

Exposure Conditions

Analysis

Analysis Options

Maintenance Actions

Analysis Selection

Results

Summary

Action #1

Action #2

Action #3

Action #4

Action #5

Action #6

Action #7

Action #8

Action #9

Bridge Deck Preservation Tool   About

New Analysis   Open Analysis   Save Analysis

Bridge Information

State Name: 19 - Iowa   Structure Number: 000000000036281   Owner Agency: State Highway Agency

Action #1 - Floodcoat   ⬇ Save Graph Image   ⬇ Save as CSV

Floodcoat

Optimization Rank: ⓘ   0.820
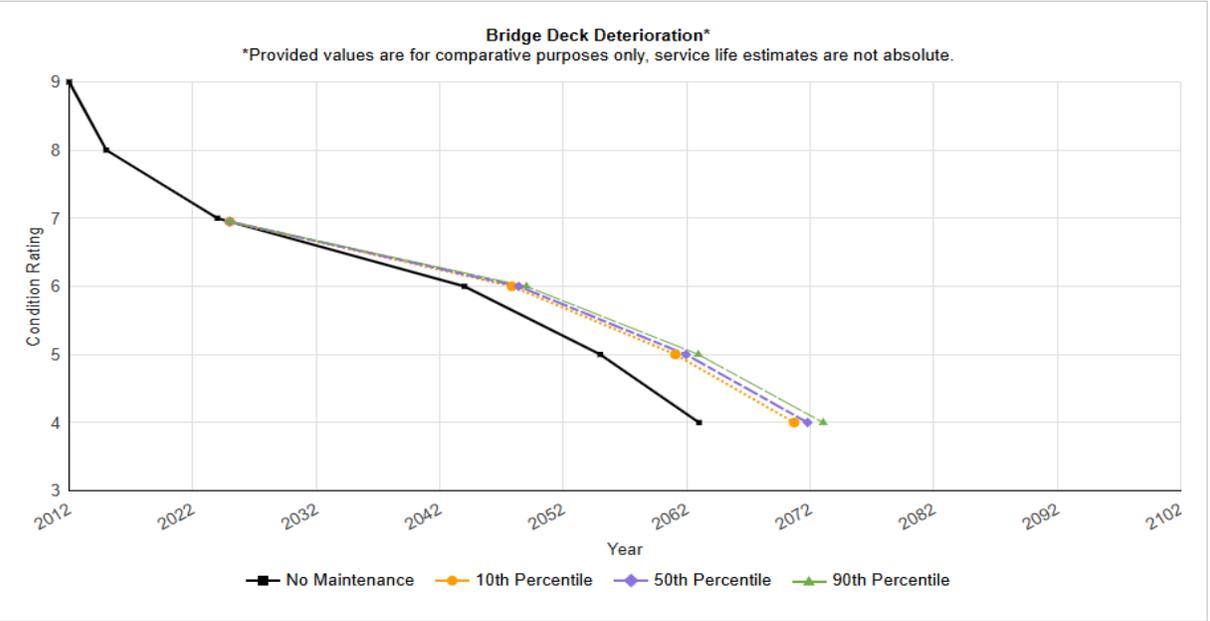
Initial Cost ($):   20,122

Percentile Data

	10th	50th	90th
Undiscounted Sum ($):	707,236	693,521	677,548
Present Value ($):	132,836	127,335	121,737
Remaining Service Life (Years):	46	47	48
Service Life Extension (Years):	8	9	10

Best Ranked Maintenance Action Based on Inputs and Assumptions

Bridge Deck Deterioration*
*Provided values are for comparative purposes only, service life estimates are not absolute.

Legend: ■ No Maintenance   ● 10th Percentile   ● 50th Percentile   ▲ 90th Percentile

X-axis: Year (2012–2102)
Y-axis: Condition Rating (3–9)

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- Our partner iEngineering

Wiss, Janney, Elstner Associates

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Michigan Bridge Week 2026

SLEE, DM and LCCA Algorithms

- Service Life Extension Estimate (SLEE) Algorithm:
  - ~~Estimates service life extensions offered to the deck by the maintenance actions~~ Unless user gave estimate; then SLEE Algorithm not needed

- Deterioration Model (DM) Algorithm:
  - Updates deterioration model/forecasted conditions to reflect maintenance
    - Assume no condition improvement, but slowed deterioration rates

- Results from both algorithms are used to calculate life-cycle cost

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SLEE Algorithm

$$SLEE_{deck} \approx SLE_{ma} = max\{SL_{upb} * f_{pec} * f_{Cl-} * f_{ADTT} * f_{FT} * f_{CR}, SL_{lob}\} * f_{bar}$$

$SLEE_{deck}$ = service life extension estimate experienced by deck

SLE_{ma} = service life estimate of the maintenance action

SL_{upb} = upper bound considered for the service life extension

SL_{lob} = lower bound considered for the service life extension

f_{pec} = reduction factor for pre-existing condition of the deck

f_{Cl-} = reduction factor for severity of chloride exposure

f_{ADTT} = reduction factor for traffic exposure

f_{FT} = reduction factor for freeze-thaw cycling

f_{CR} = reduction factor for contractor experience & construction challenge

f_{bar} = "augmentation" factor for corrosion-resistant rebar

Probabilistic SLEE

- SLEE represented by a distribution rather than an exact number

- Monte Carlo simulation
  - Probabilistic inputs give probabilistic outputs
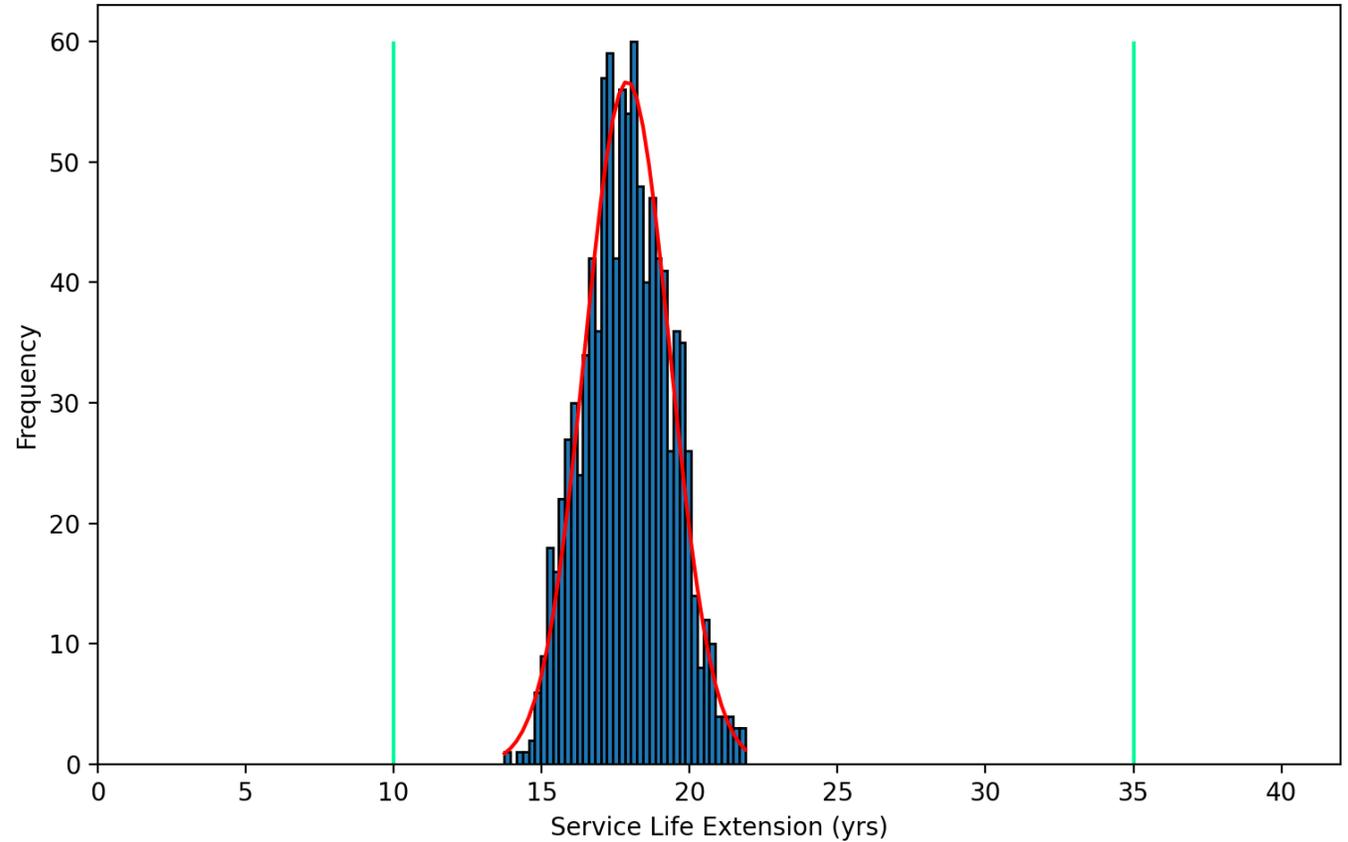
Deck Maintenance Action	Feasible Range
Portland cement concrete or high performance concrete overlay	10 to 35 years

# DM Algorithm: Calculating Slowed Rates
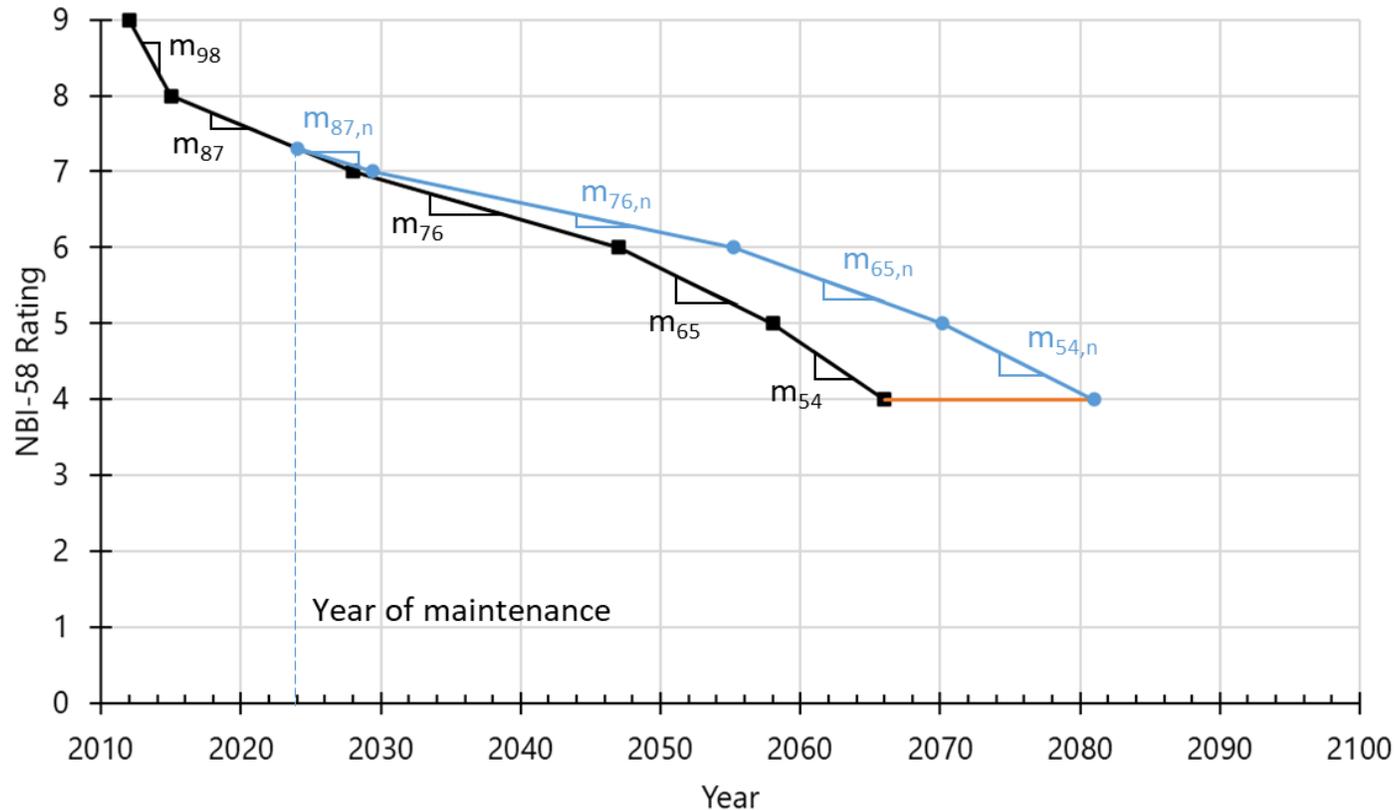
1. Add SLEE to end of deck life.
2. Calculate adjustment ratio.
3. Draw DM of maintained deck using adjusted deterioration rates.

LCCA Overview

- Defined cash flow:
  - Agency costs
    - Maintenance, rehabilitation costs
    - Replacement costs
    - Salvage value
  - User costs
    - E.g., travel delays

- Analysis period to make options comparable
- Future values discounted to present value:

$$PV = FV_n * \frac{1}{(1+r)^n}$$

n = age
r = discount rate

Maintenance 1

Maintenance 2

Replacement

Bridge Age

Activity/Maintenance Profile
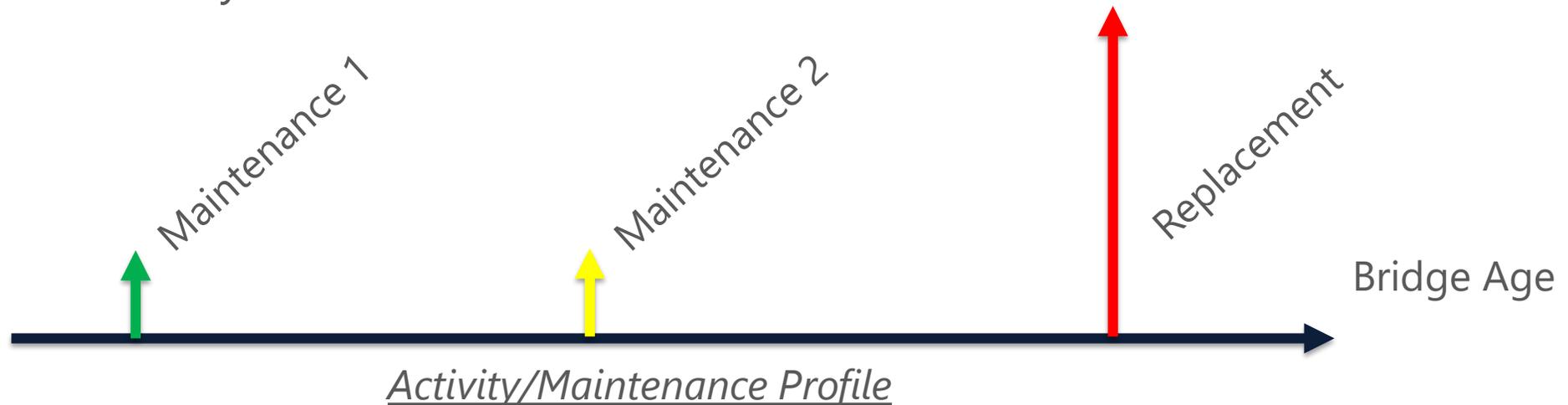
Optimization Module

- Linear Weighted Sum Method
  - Minimize agency life cycle costs
  - Maximize remaining service life of the deck
  - Minimize user life cycle costs

$$maximize\ Z_i = W_{LCCa}\left(1/S_{LCCa,i}\right) + W_{LCCu}\left(1/S_{LCCu,i}\right) + W_{RSL}S_{RSL,i}$$

Scaled values:

$$S_{LCCa,i} = \frac{LCCa_i}{min\{LCCa_1, LCCa_2, \dots, LCCa_N\}}$$

$$S_{RSL,i} = \frac{RSL_i}{max\{RSL_1, RSL_2, \dots, RSL_N\}}$$

Auto-MAPs: The MAP Loop

Assumption:

Next maintenance action occurs at end of life of previous maintenance action.

1. F&T Module relies on NBI forecasted by DM Algorithm.

2. SLEE Algorithm:
   - Relies on F&T Module to select next maintenance actions to analyze.
   - Relies on forecasted NBI.

3. DM Algorithm relies on SLEE.

looped analysis of maintenance action plans
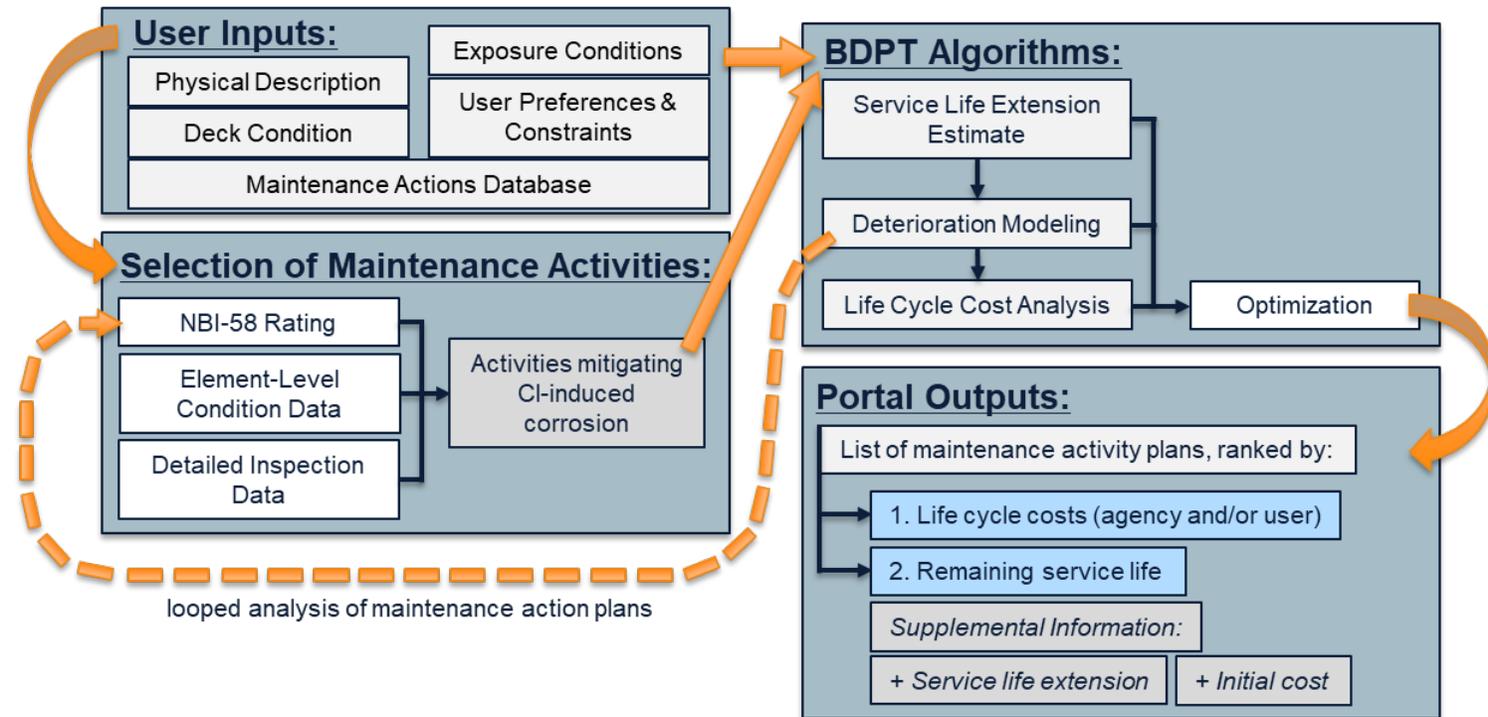
Note: Full life cycle must be characterized before conducting LCCA.

User-Defined MAPs: Sequence & Timing

~~Same assumption:~~

~~Next maintenance action occurs at end of life of previous maintenance action.~~

~~1. F&T Module relies on NBI forecasted by DM Algorithm.~~

2. SLEE Algorithm:
   - ~~Relies on F&T Module to select next maintenance actions to analyze.~~

   - Relies on forecasted NBI.

3. DM Algorithm relies on SLEE.

User Inputs:
- Physical Description
- Deck Condition
- Exposure Conditions
- User Preferences & Constraints
- Maintenance Actions Database

Selection of Maintenance Activities:
- NBI-58 Rating
- Element-Level Condition Data
- Detailed Inspection Data
- Activities mitigating Cl-induced corrosion

looped analysis of maintenance action plans

BDPT Algorithms:
- Service Life Extension Estimate
- Deterioration Modeling
- Life Cycle Cost Analysis
- Optimization

Portal Outputs:
List of maintenance activity plans, ranked by:
1. Life cycle costs (agency and/or user)
2. Remaining service life

Supplemental Information:
+ Service life extension   + Initial cost