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BrM 7.1 Optimization 101

2025 Bridge Management User Group Meeting Providence, RI | September 9-10, 2025

CONTACT

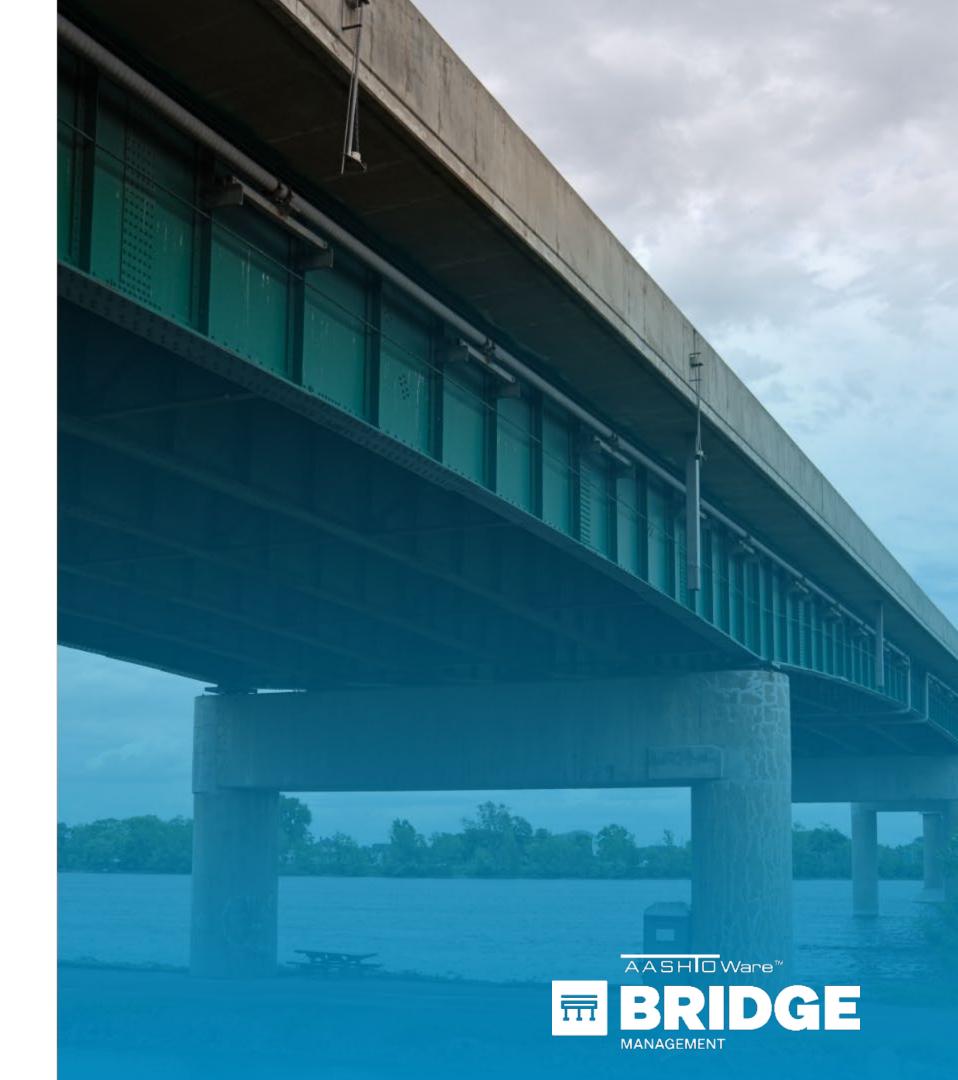


Kevin Murata

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Course Overview

TODAY

Before Break

- BrM 7.1 Navigation
- Inspection Data
- Utility
- Deterioration
- Benefits Groups

After Break

- Actions
- Costs
- Advanced Formulas

TOMORROW

Before Break

- Network Policies
- Life Cycle Policies
- Programs
- Scenarios
- Funding Allocation
- Performance Measures

After Break

- Optimization
- Results
- Projects
- LCCA Plans







Version 7.1

Login with SSO

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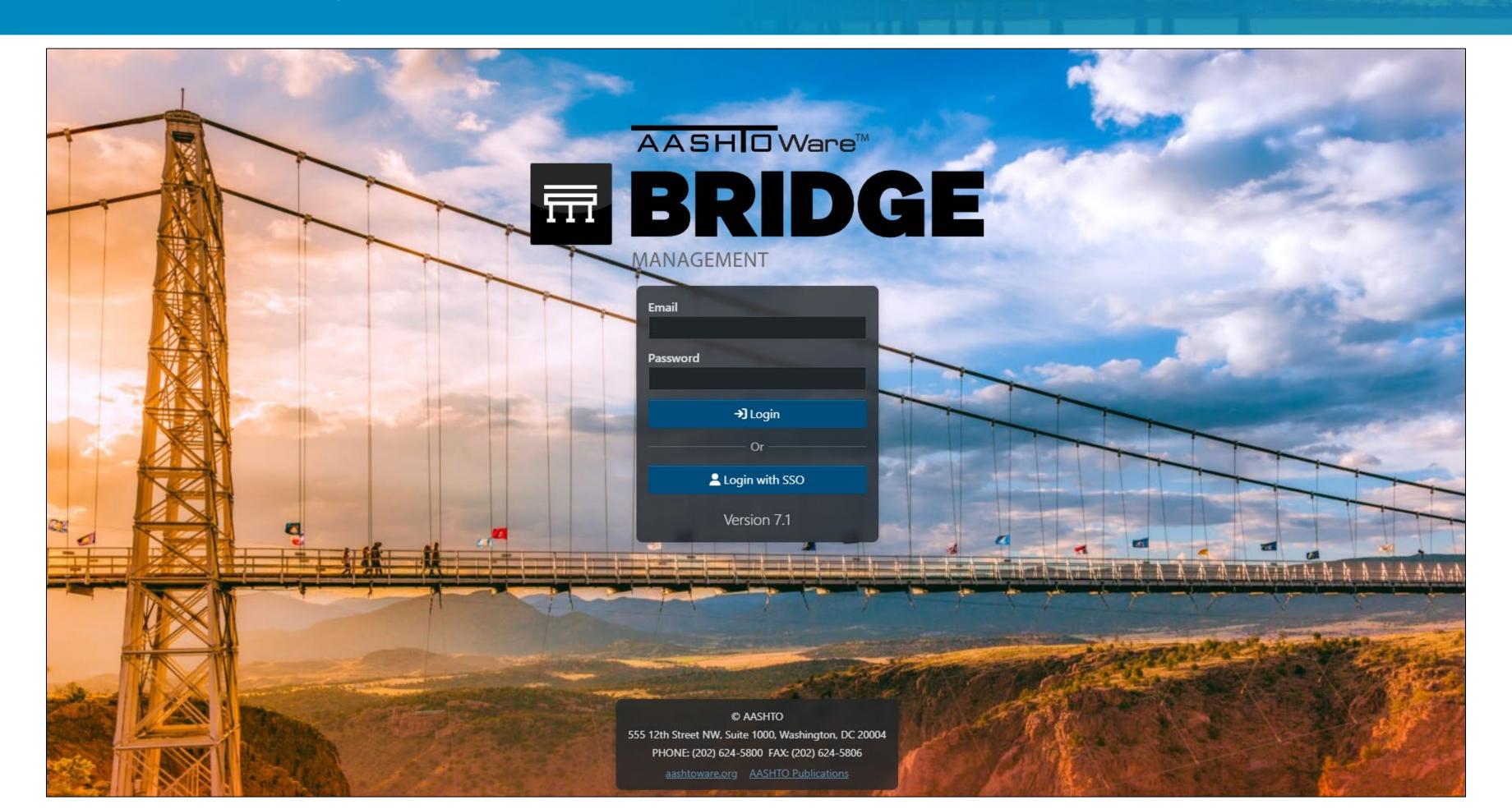
Email
Password
→) Login
Or
Login with SSO

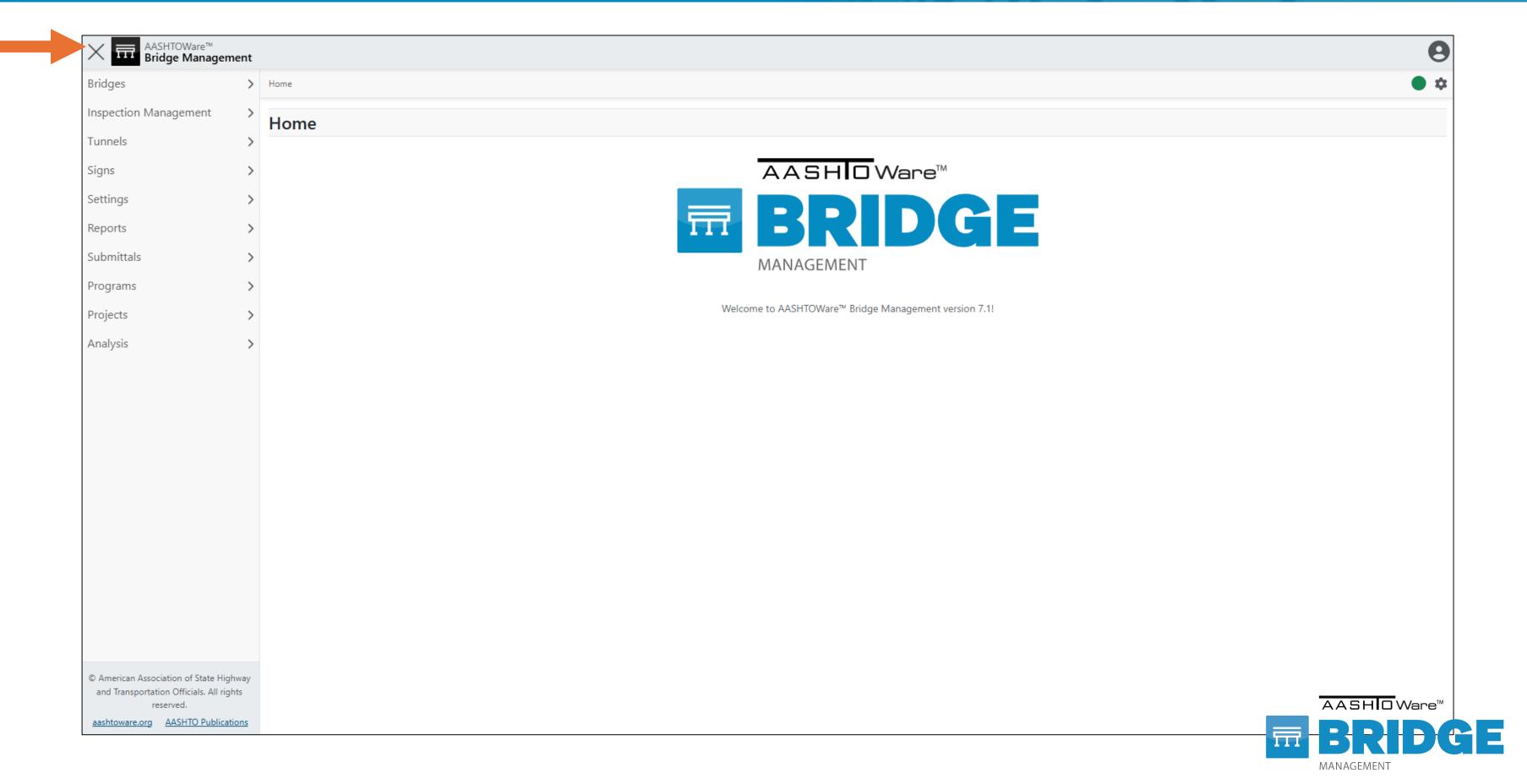
Version 7.1

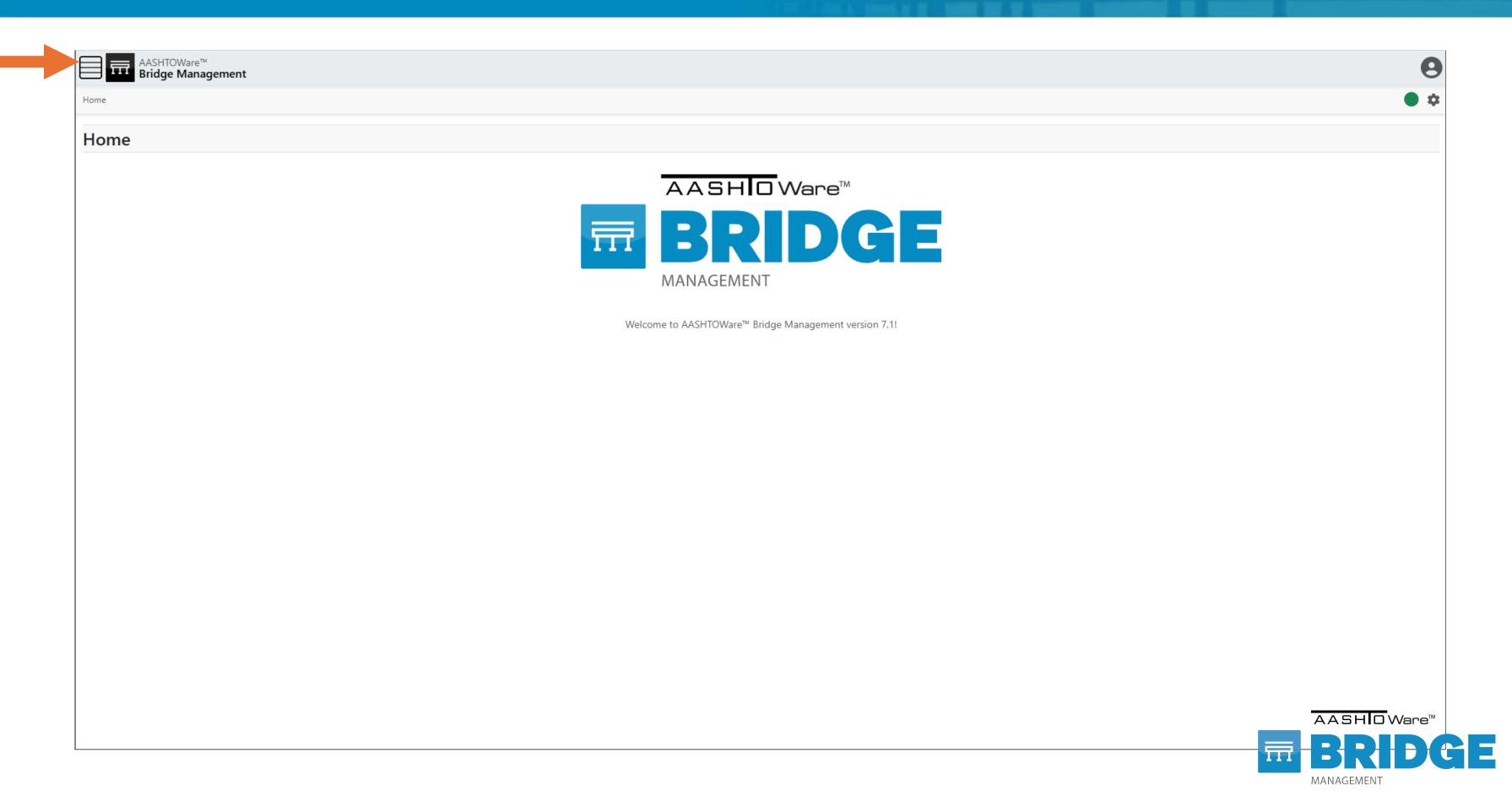
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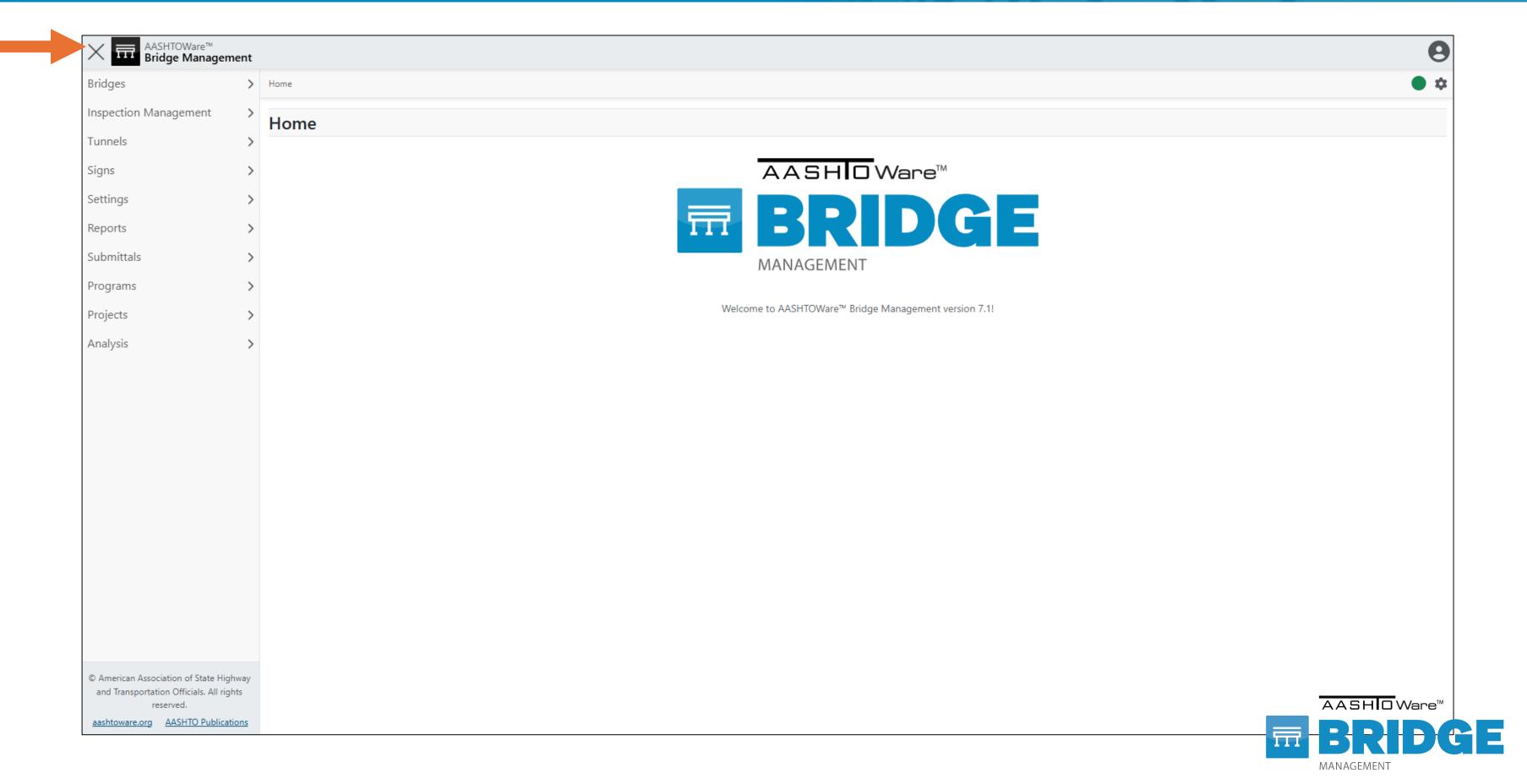
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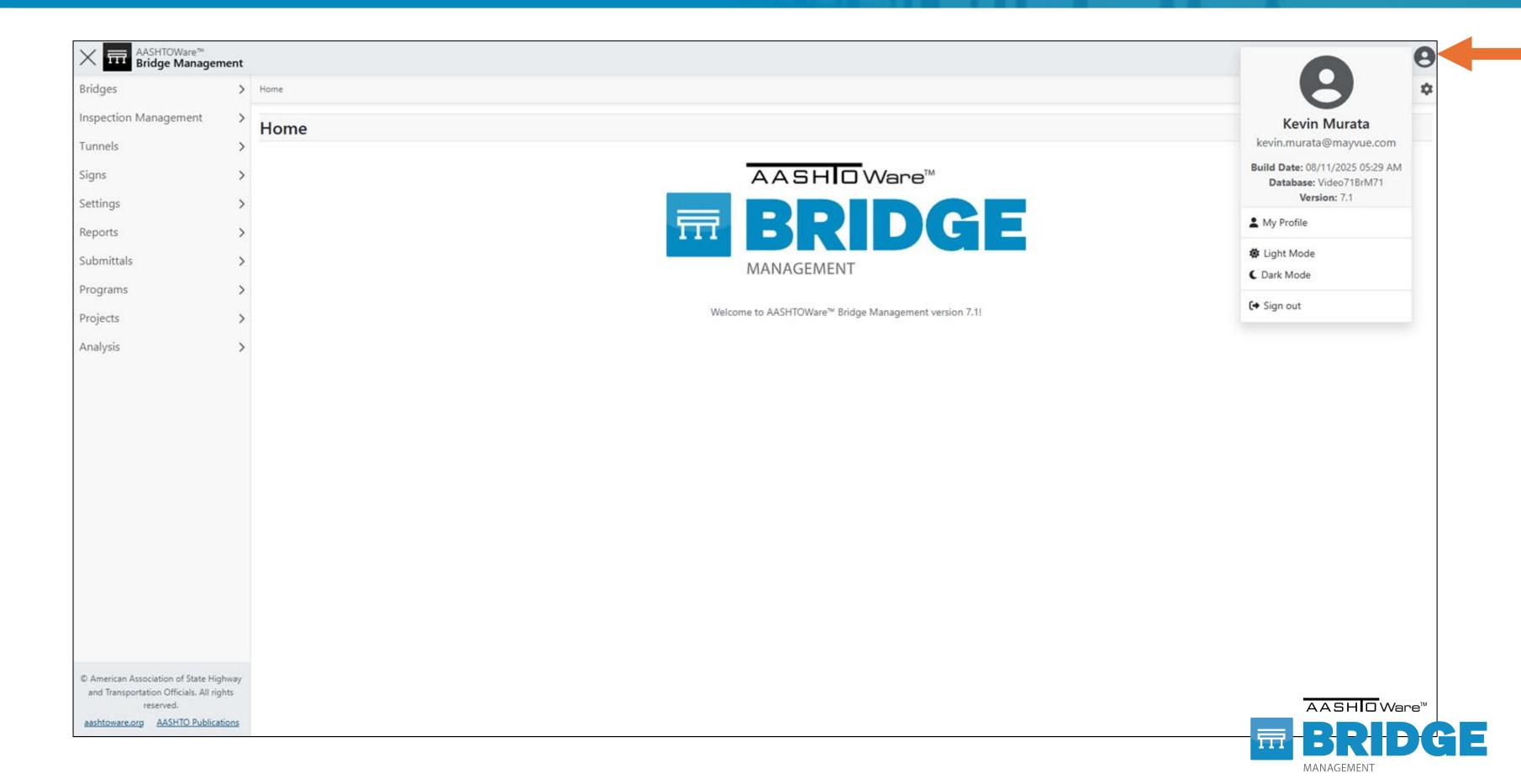
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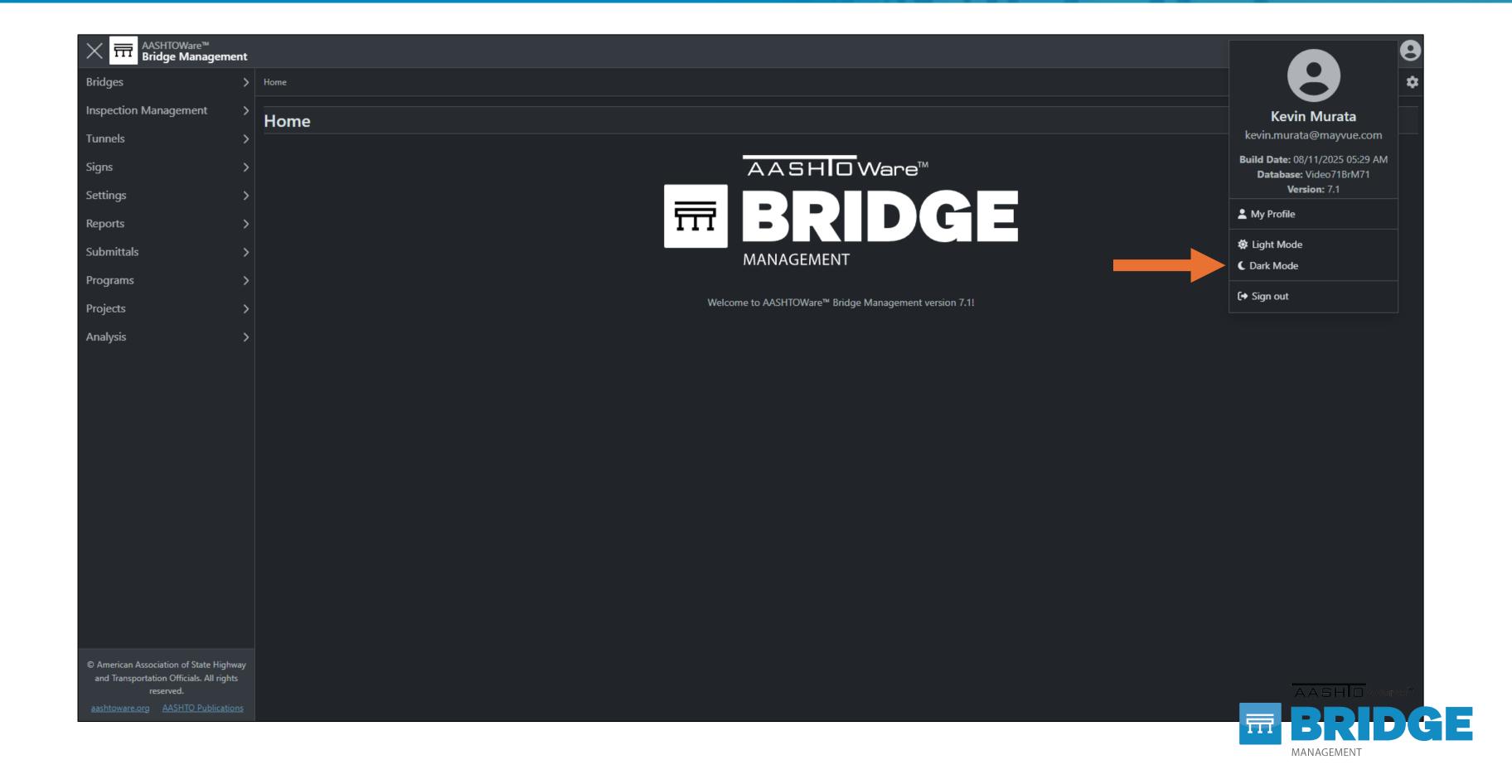


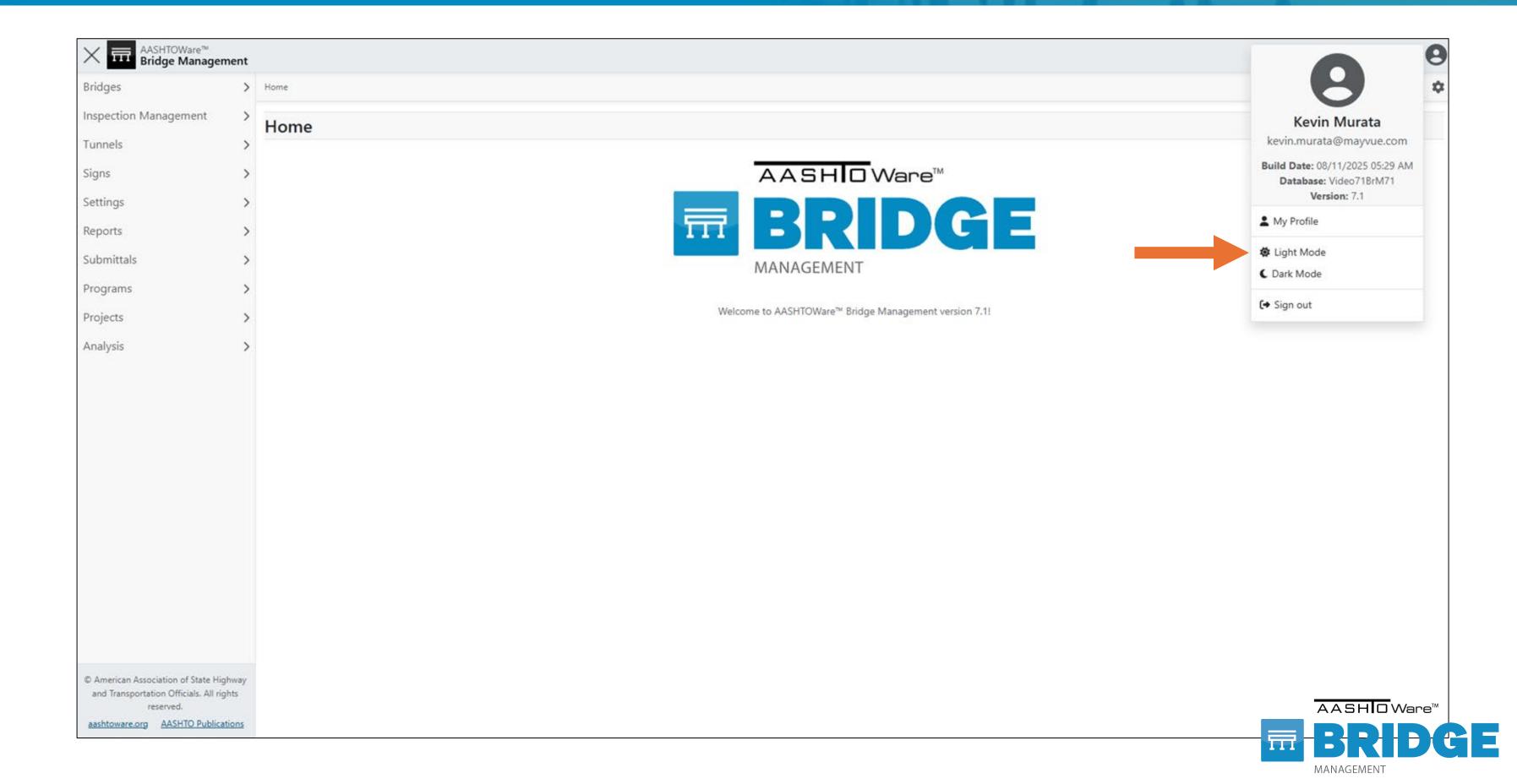


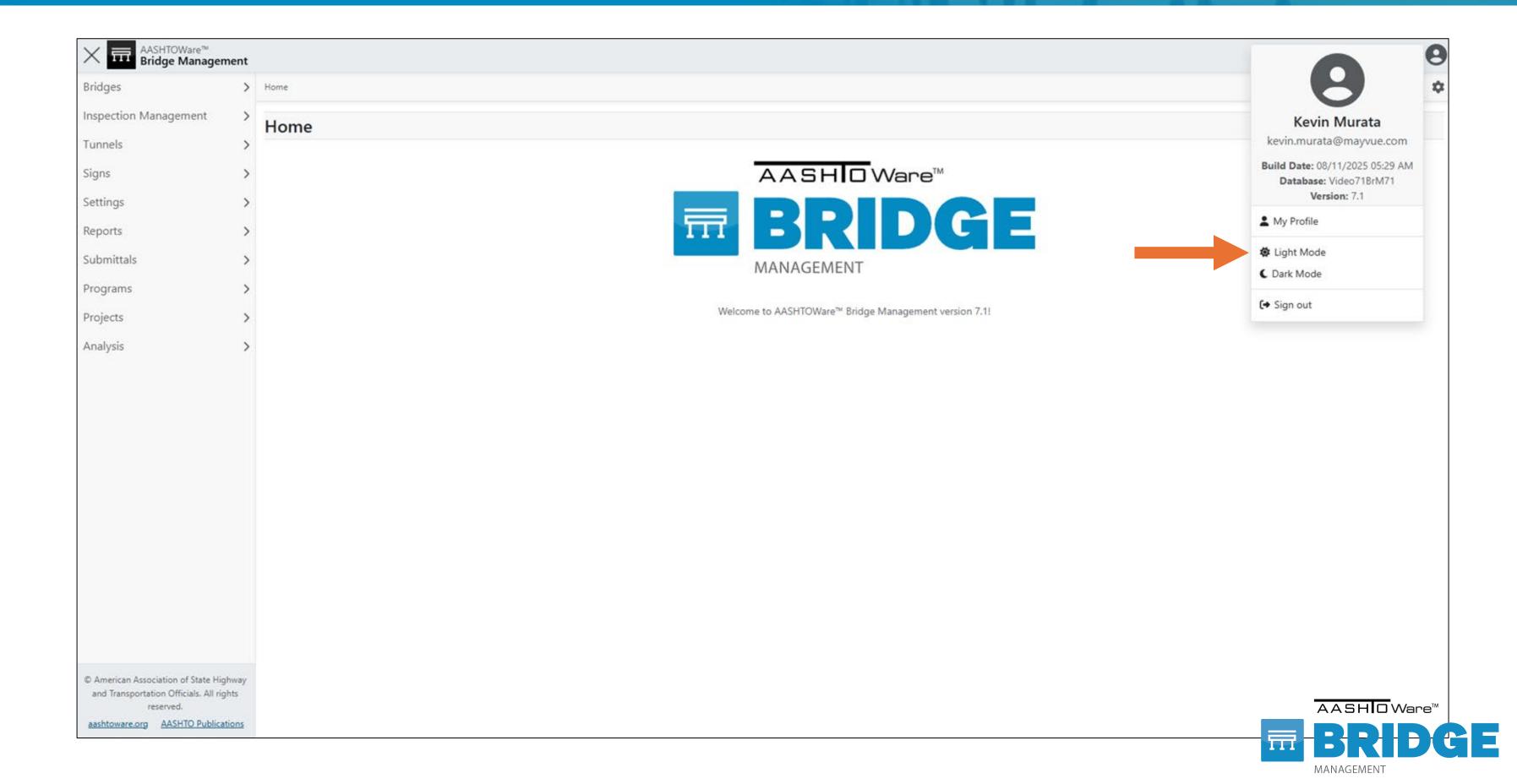


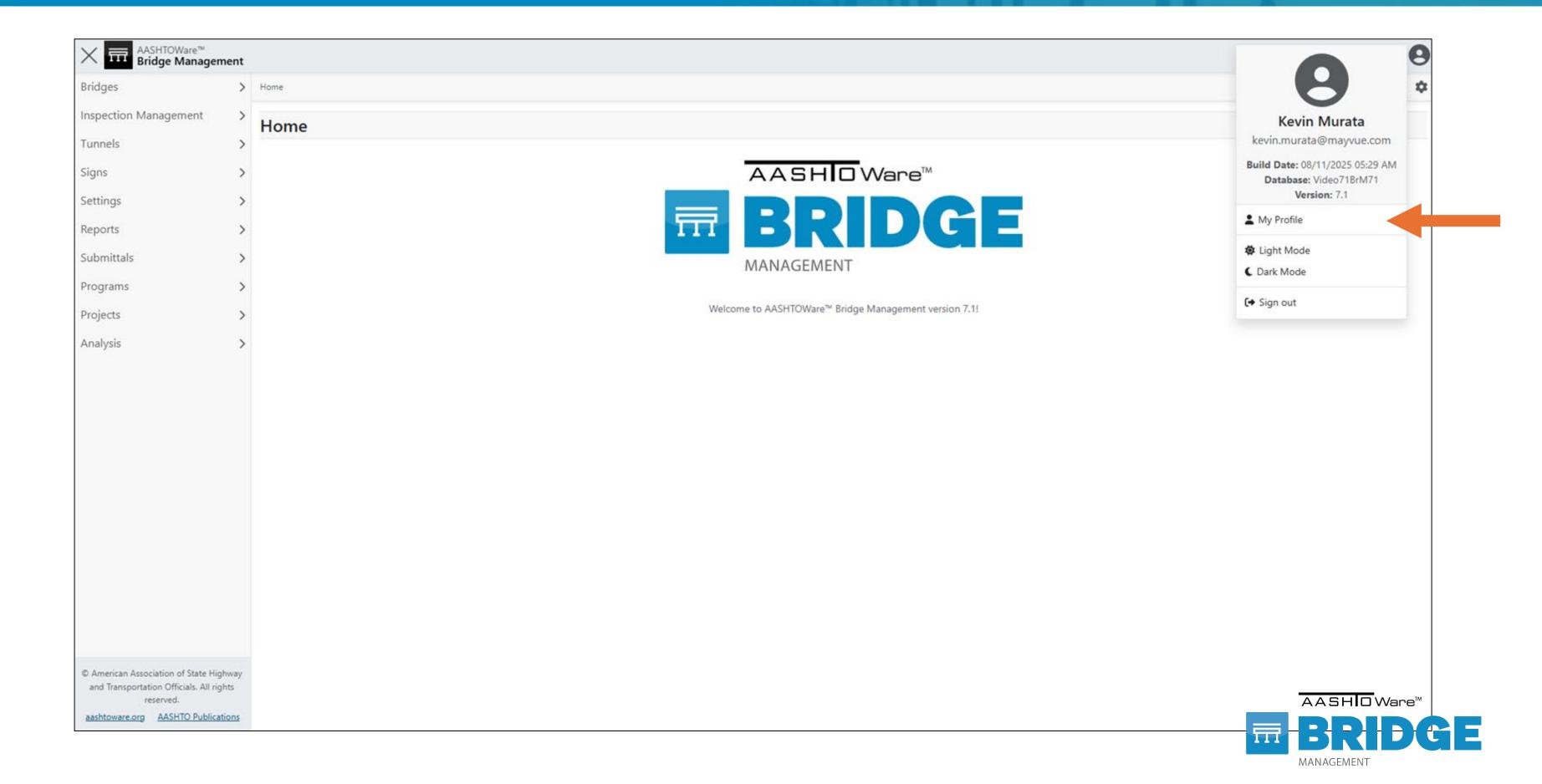


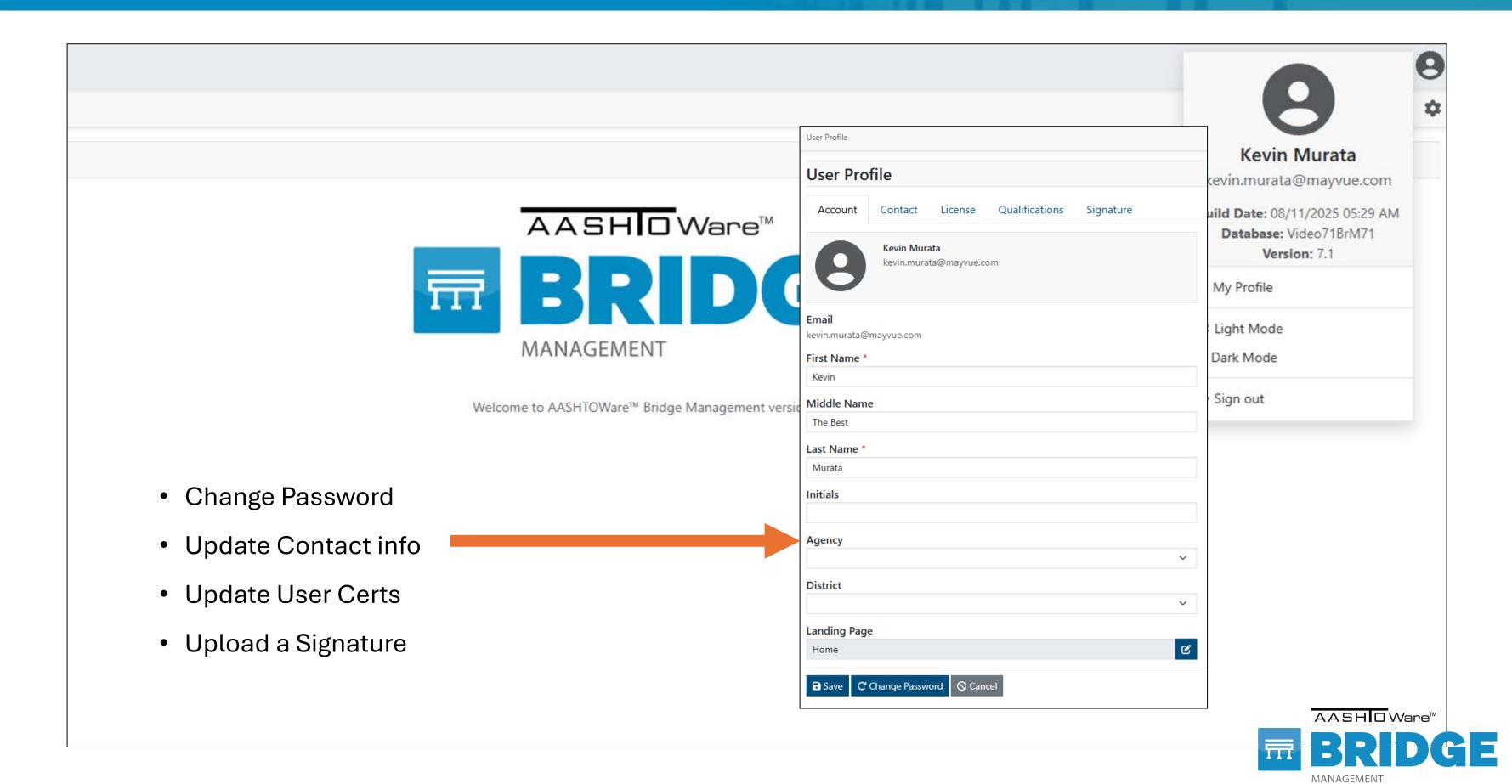


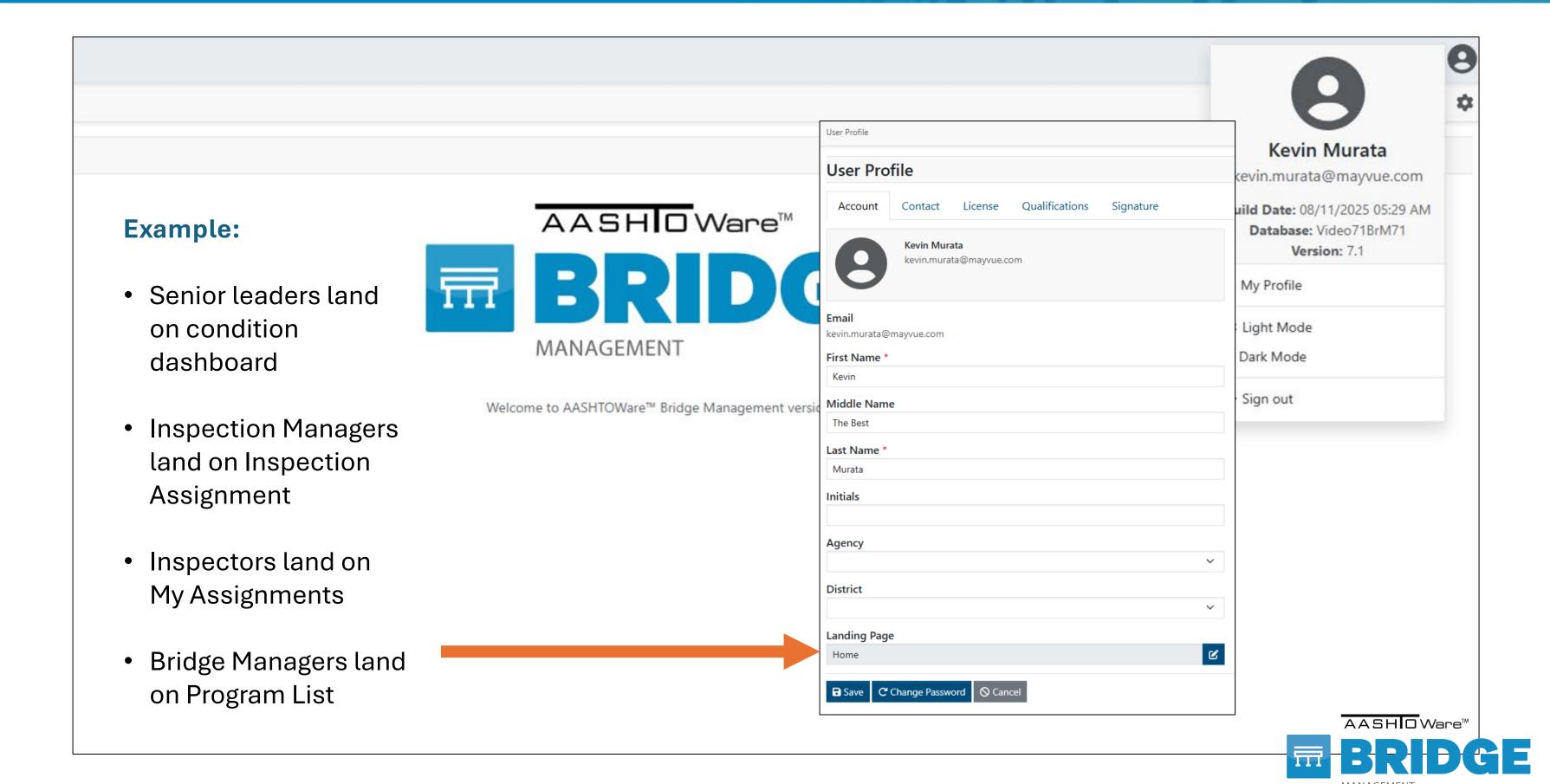


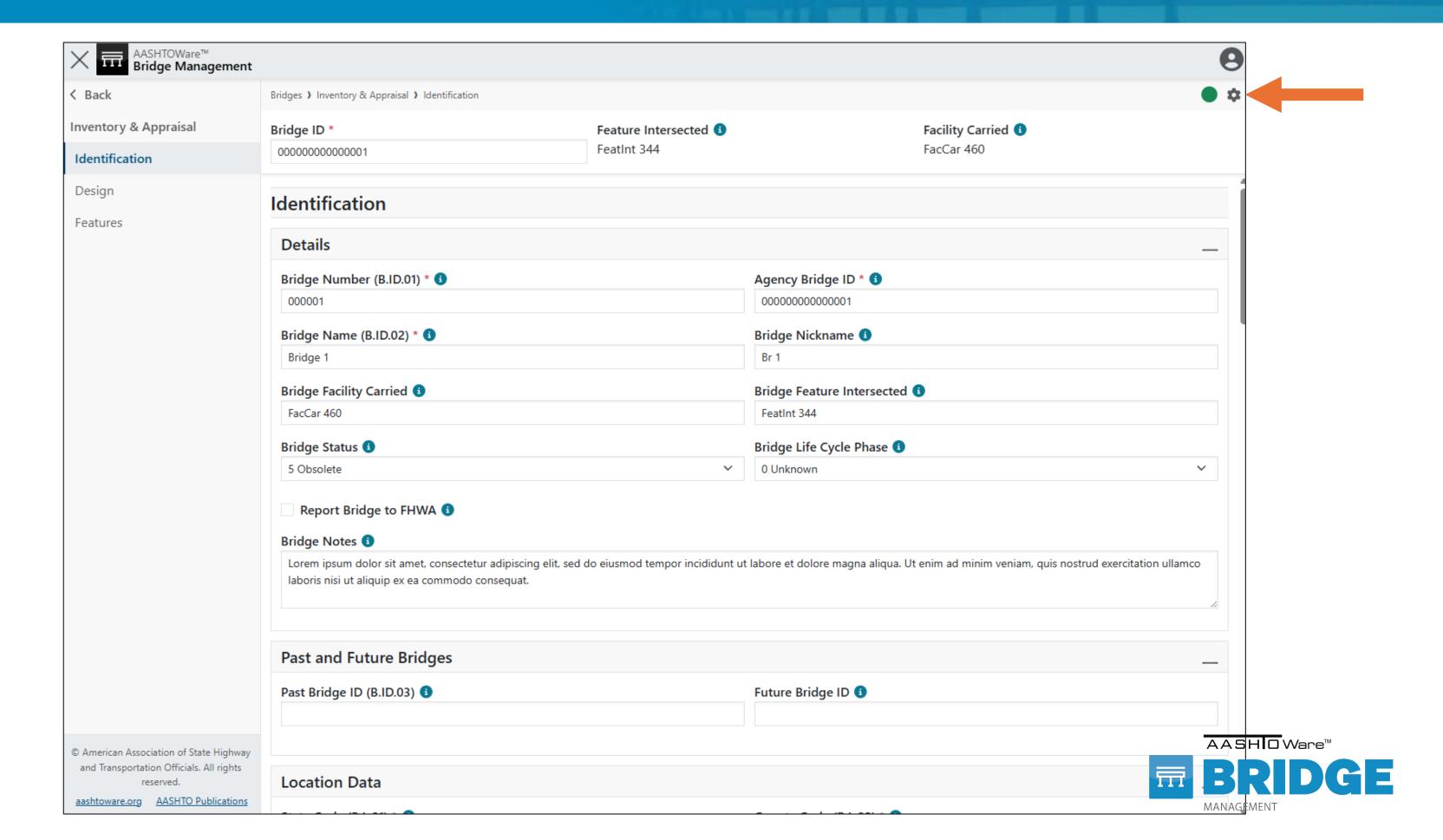


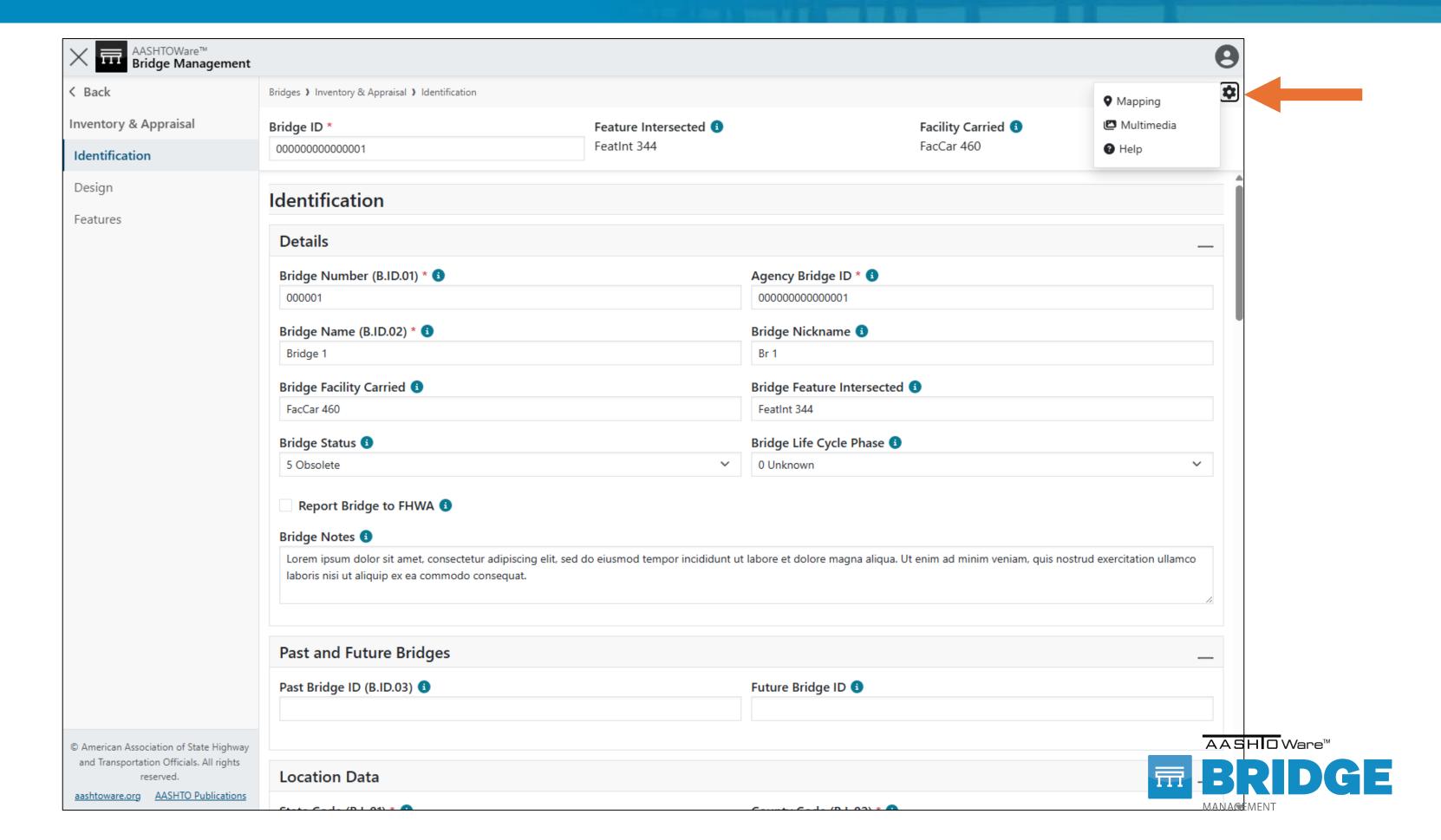


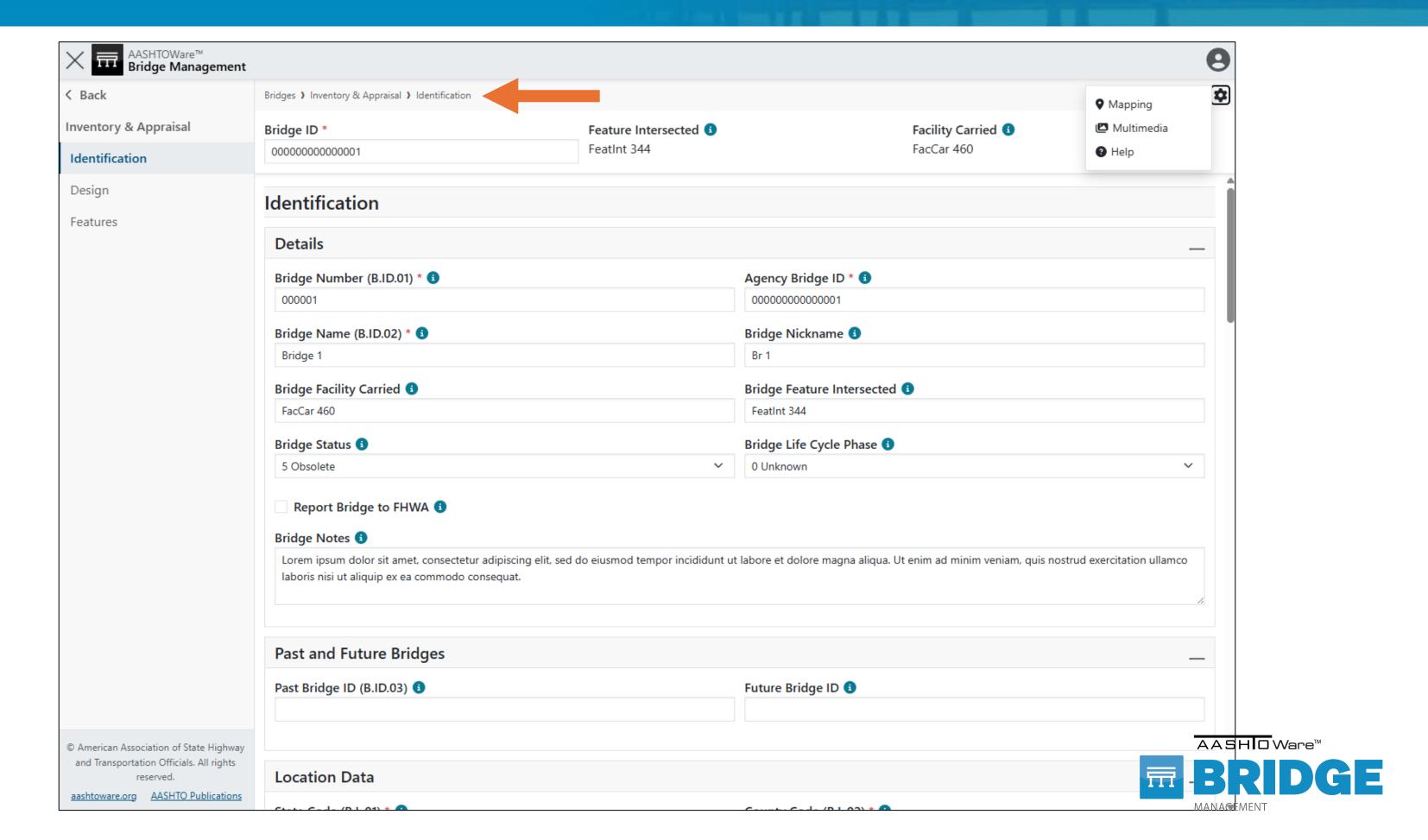






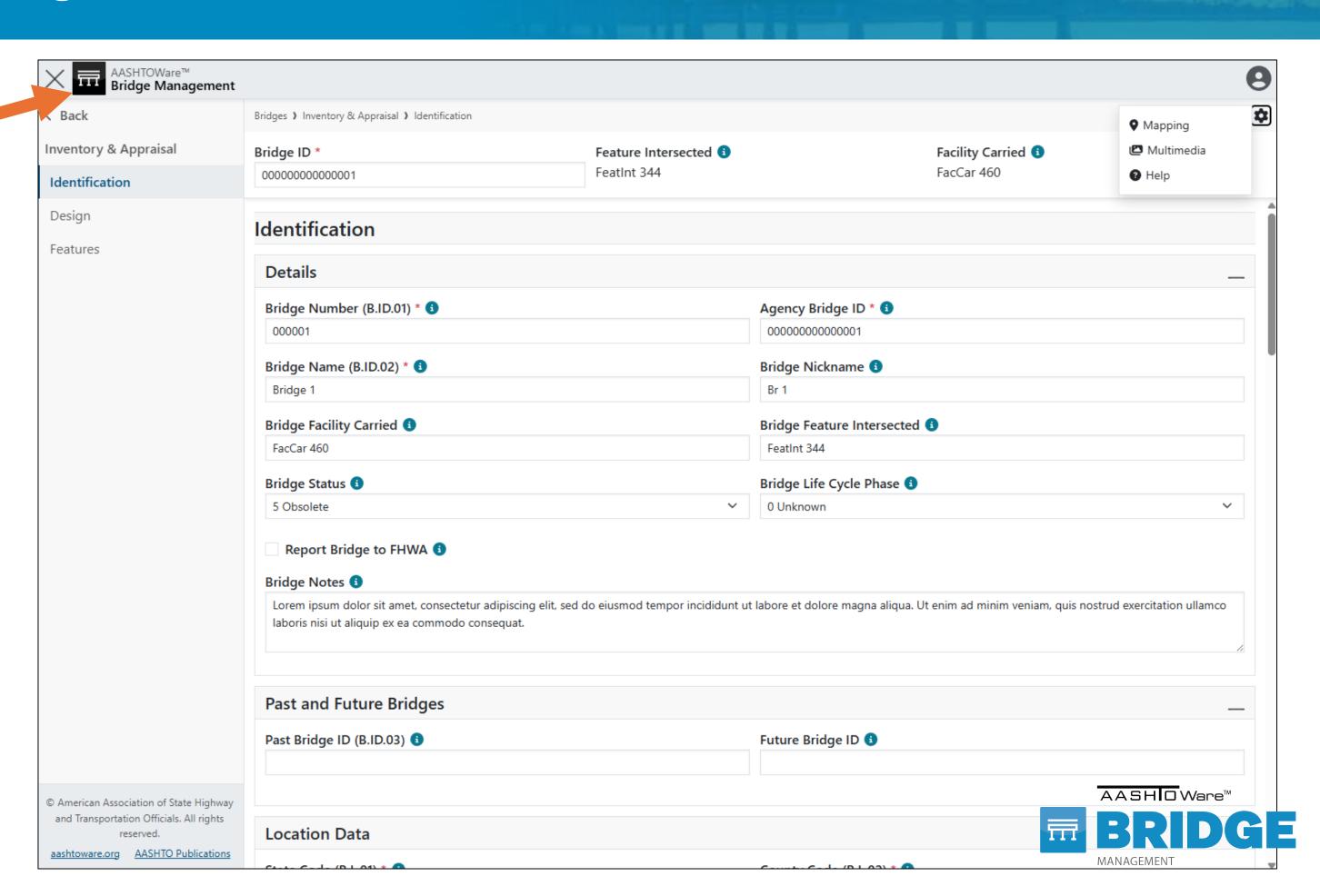


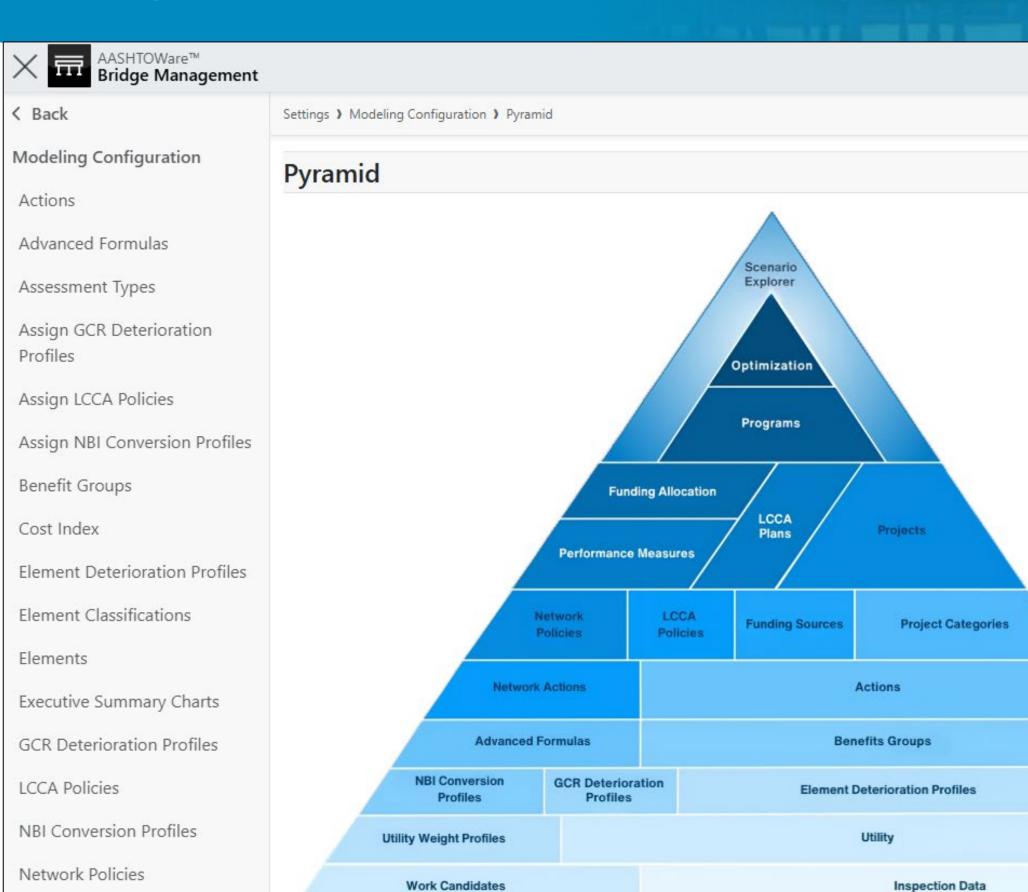




Pro Tip:

- Clicking this button will take you to your landing page.
- By default, it is set to the Home page

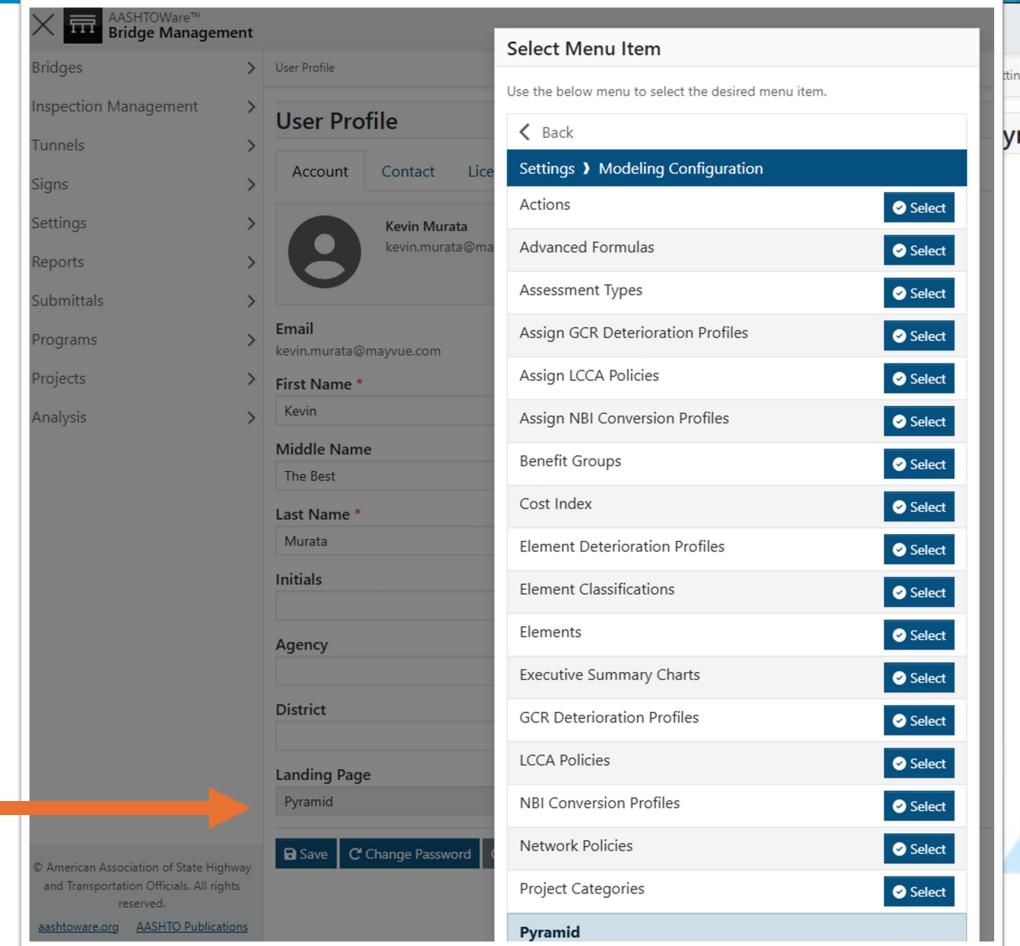








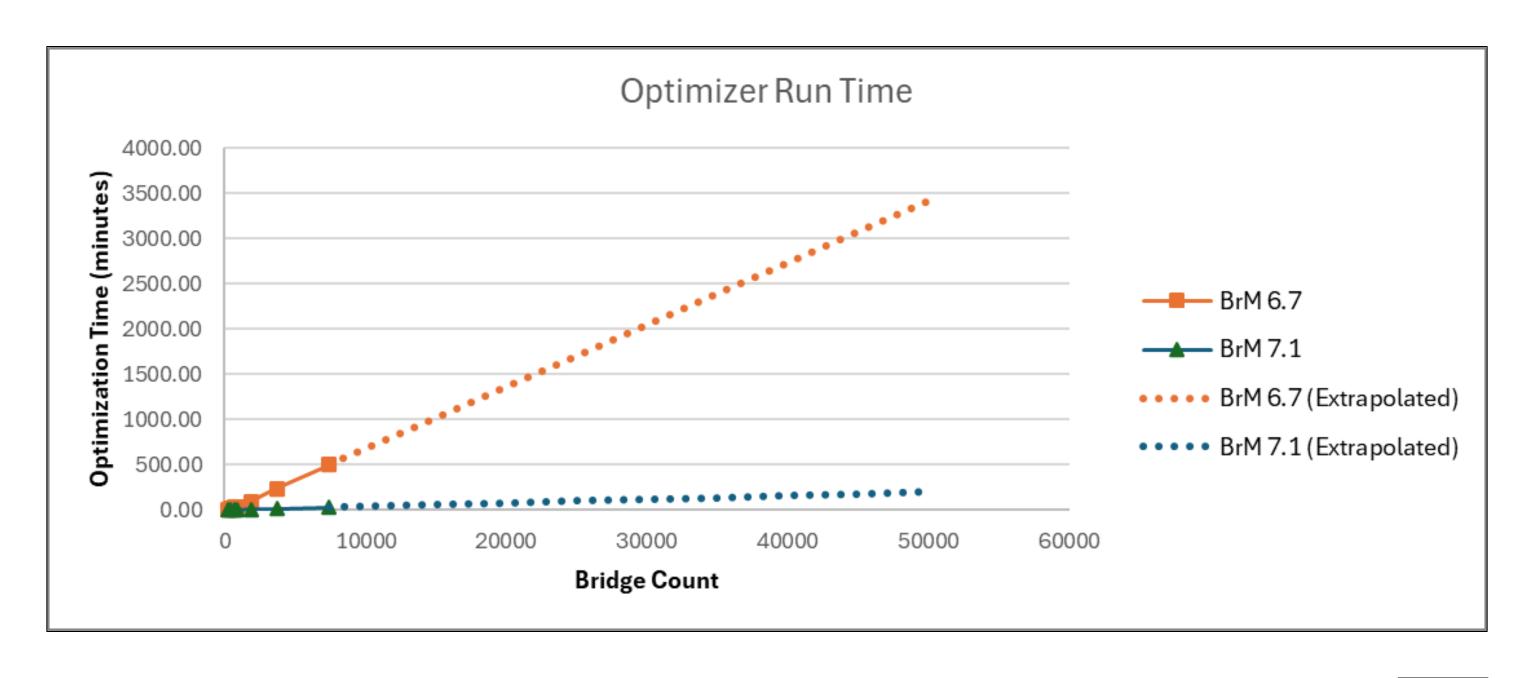
Project Categories



tings) Modeling Configuration) Pyramid yramid Scenario Explorer Optimization Programs **Funding Allocation** LCCA Projects Plans **Performance Measures** LCCA Network **Project Catego Funding Sources** Policies **Policies Network Actions** Actions **Advanced Formulas Benefits Groups NBI** Conversion **GCR Deterioration Element Deterioration Profiles Profiles Profiles** Utility **Utility Weight Profiles** AASHIO Ware™ **Work Candidates** Inspection Data

MANAGEMENT

The Optimizer is now up to 15x FASTER BrM 7.1!!!





15







FASTER



15



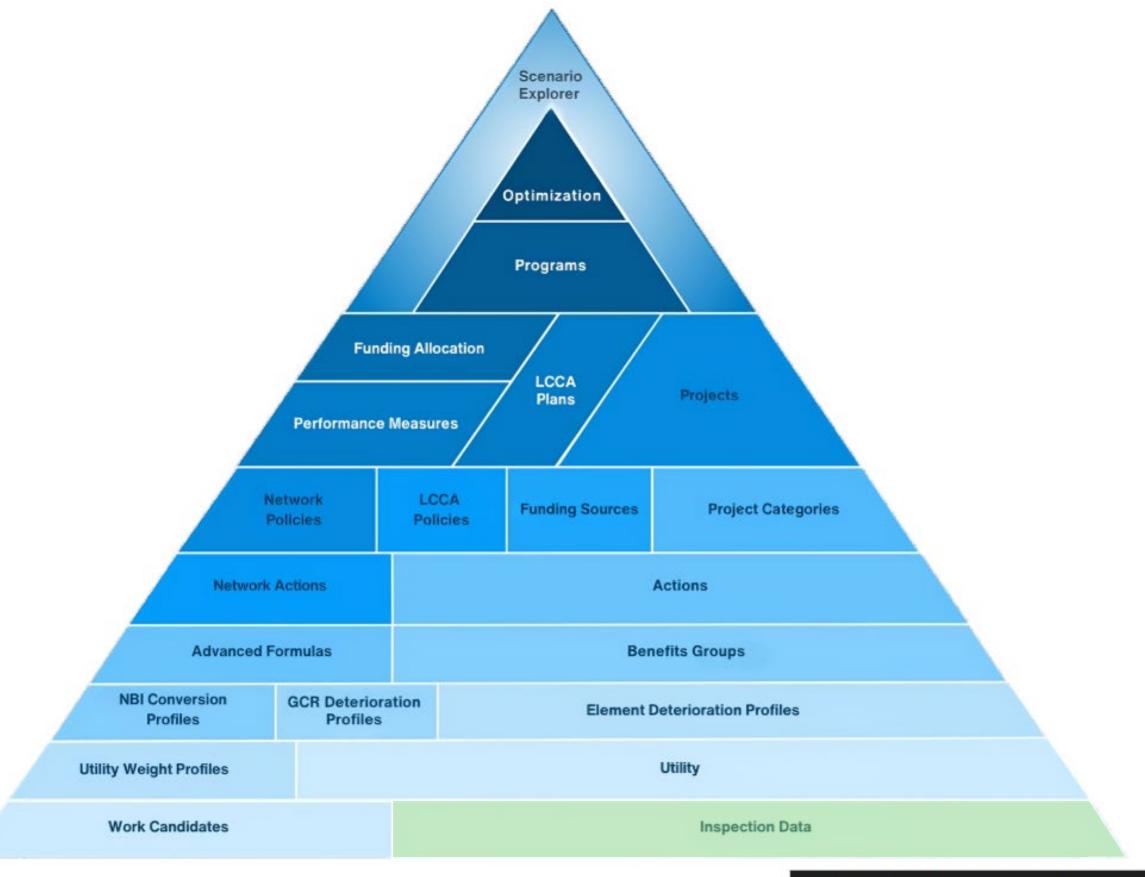




FASTER

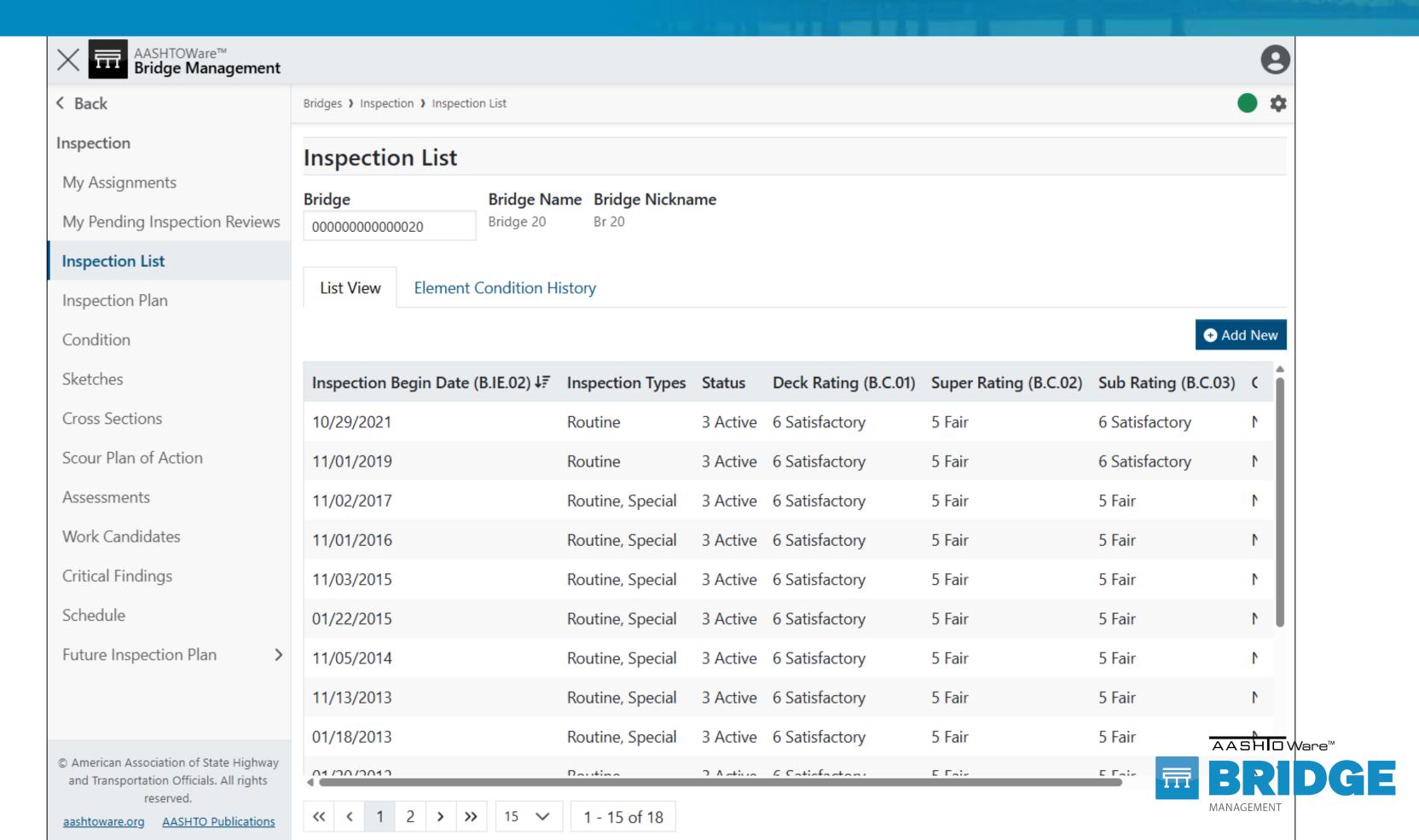


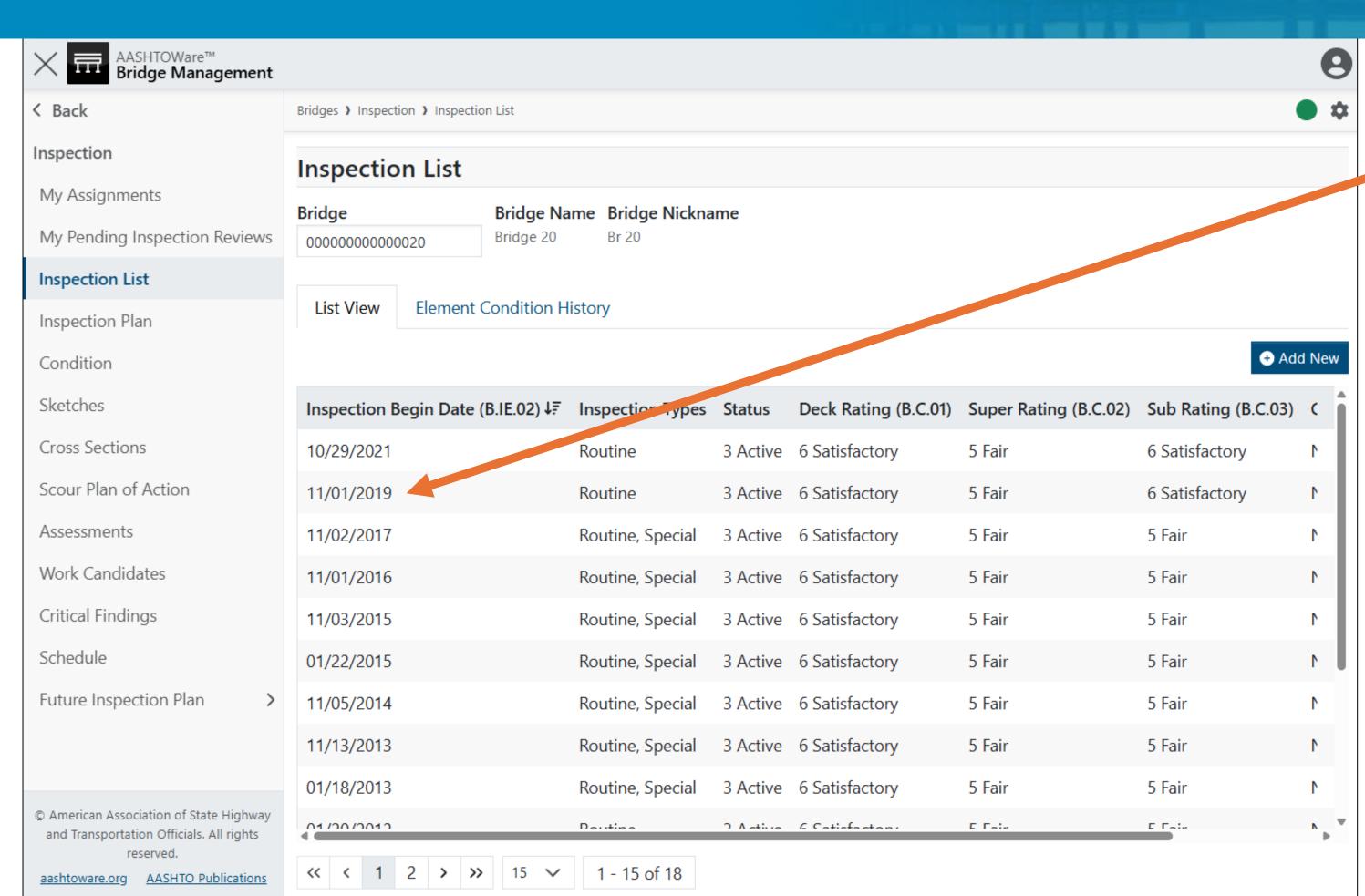




Inspection data for the current condition of a structure.

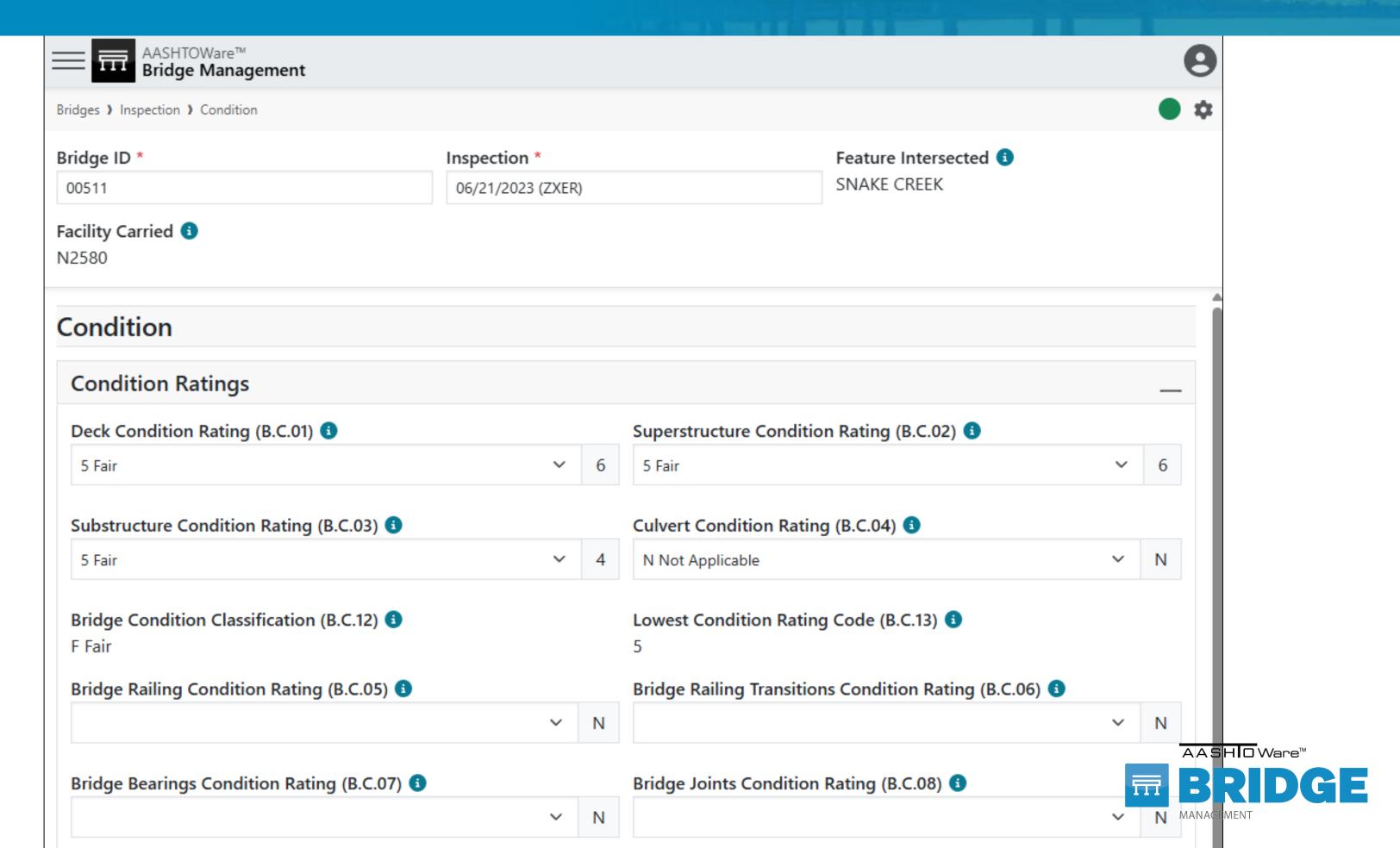


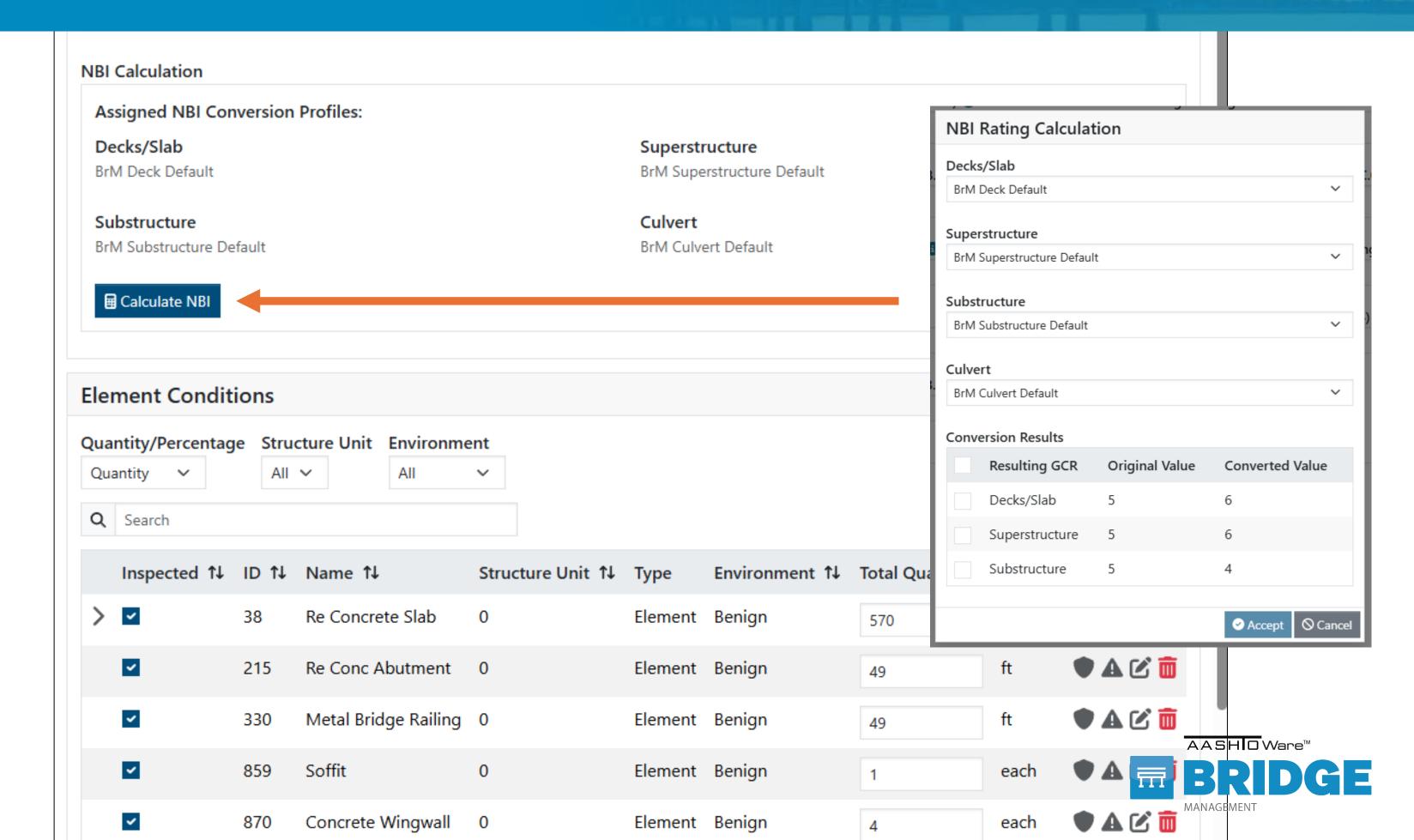


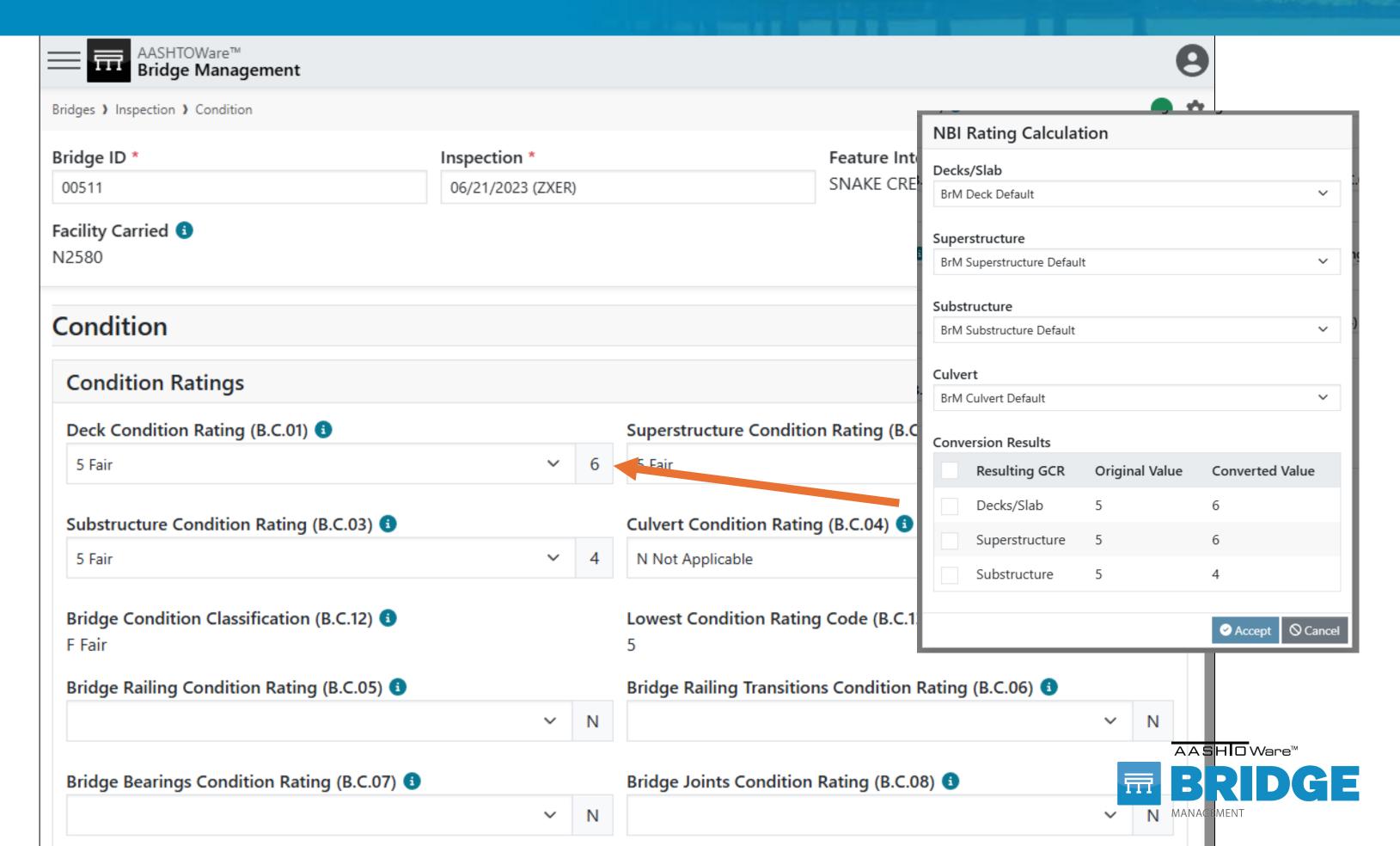


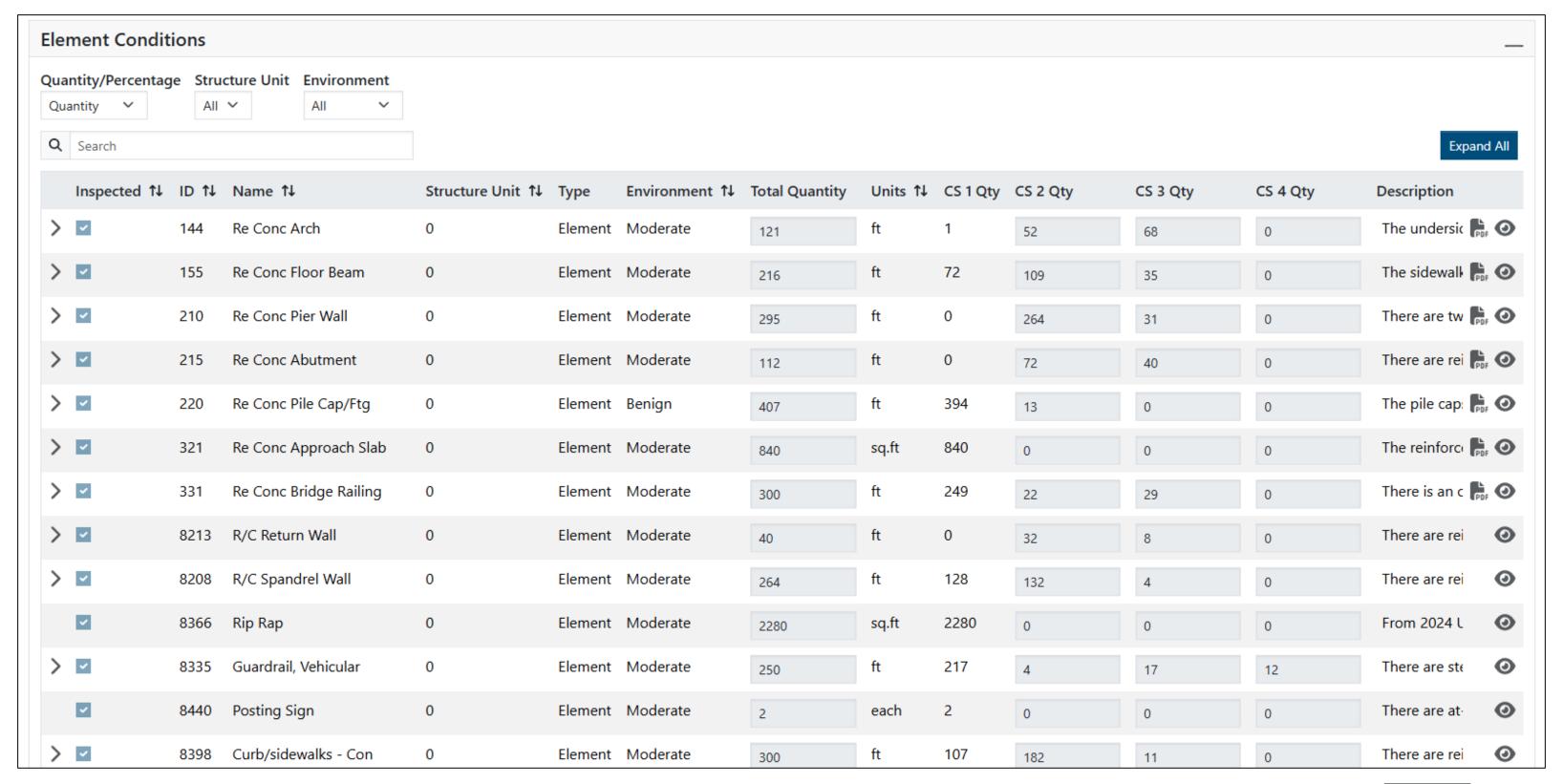
To use GCR Deterioration, you will need a history of GCR values. The more history, the better.





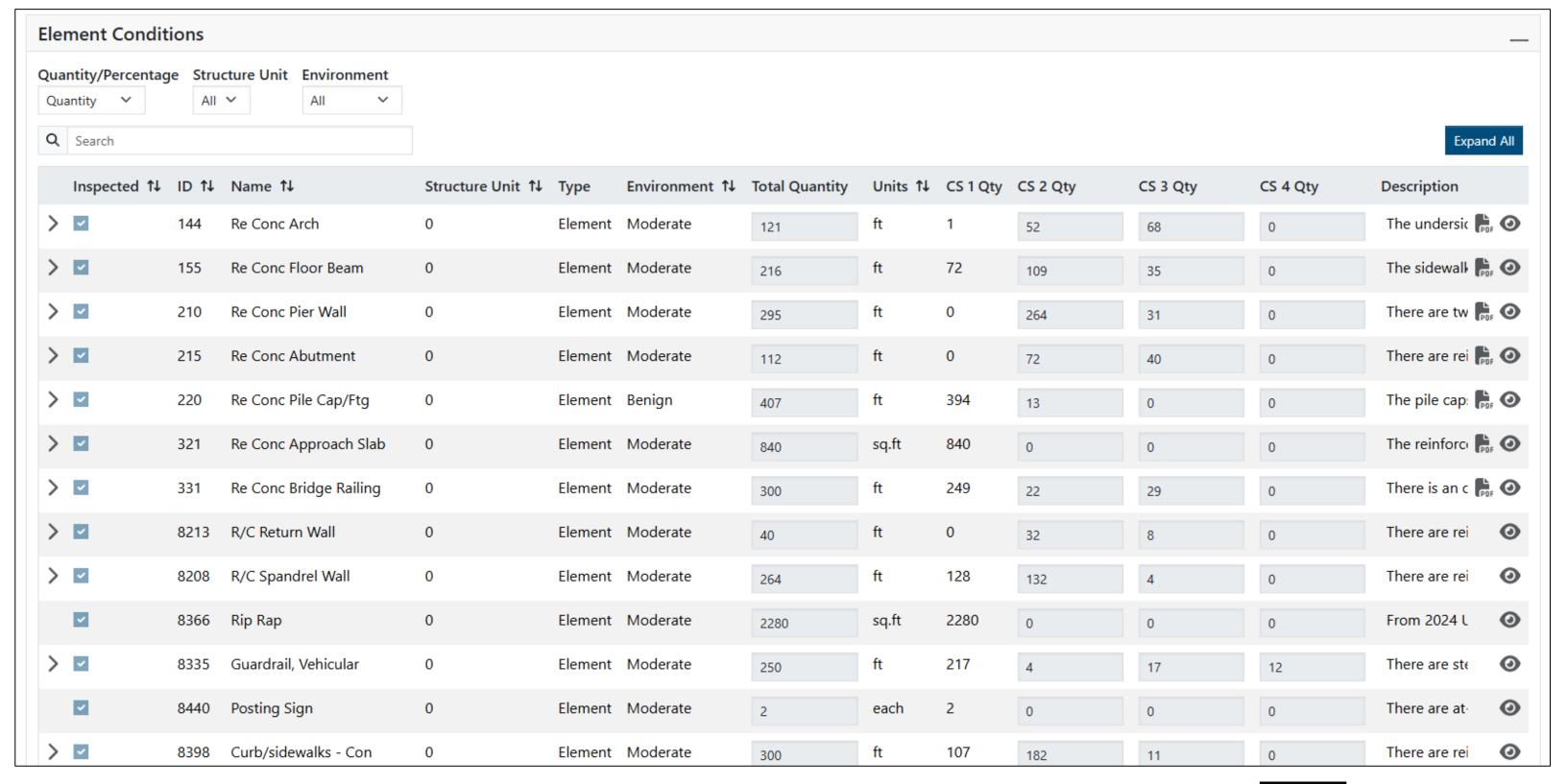






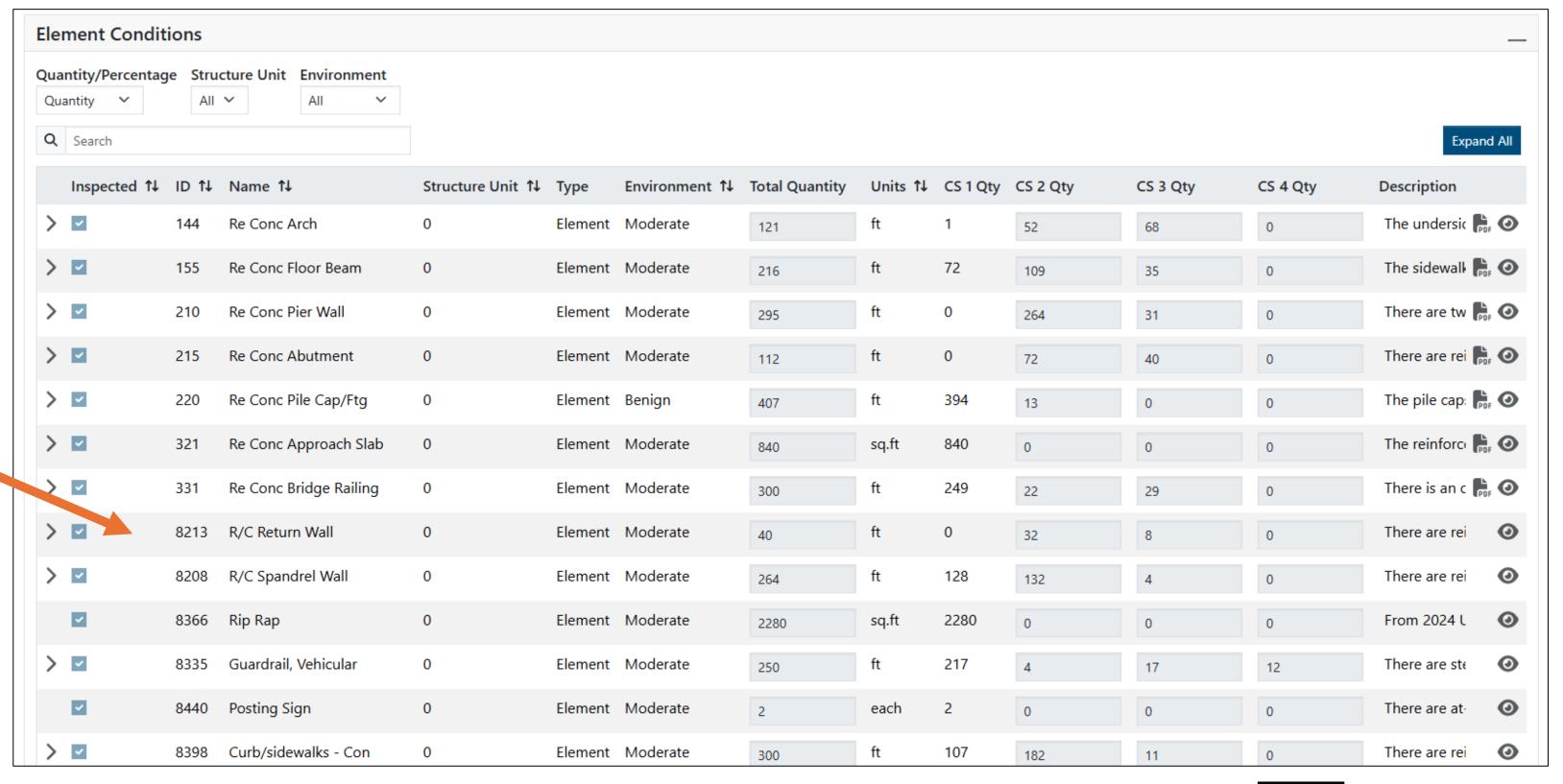


To use Element Deterioration, you only need the latest element inspection.

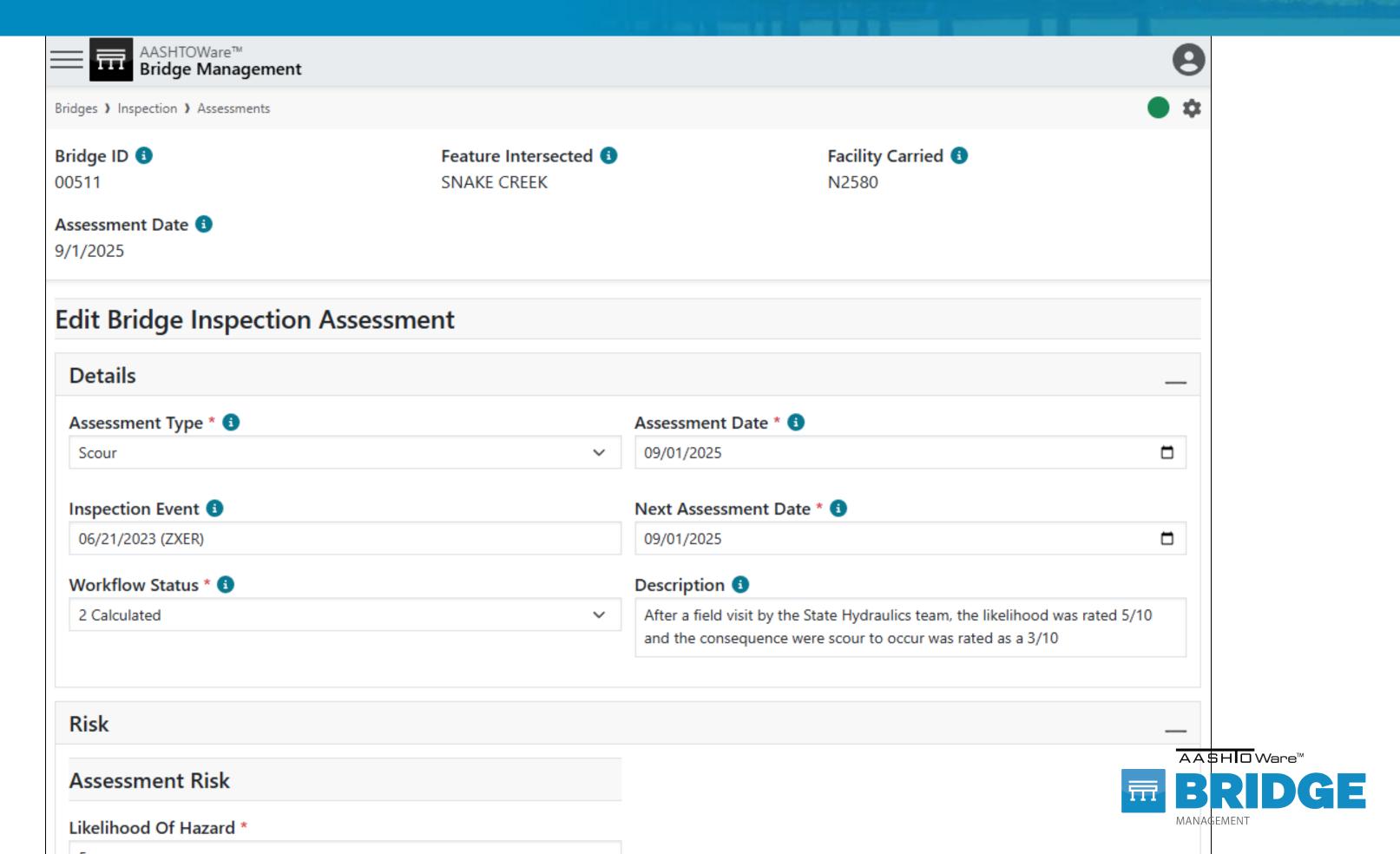


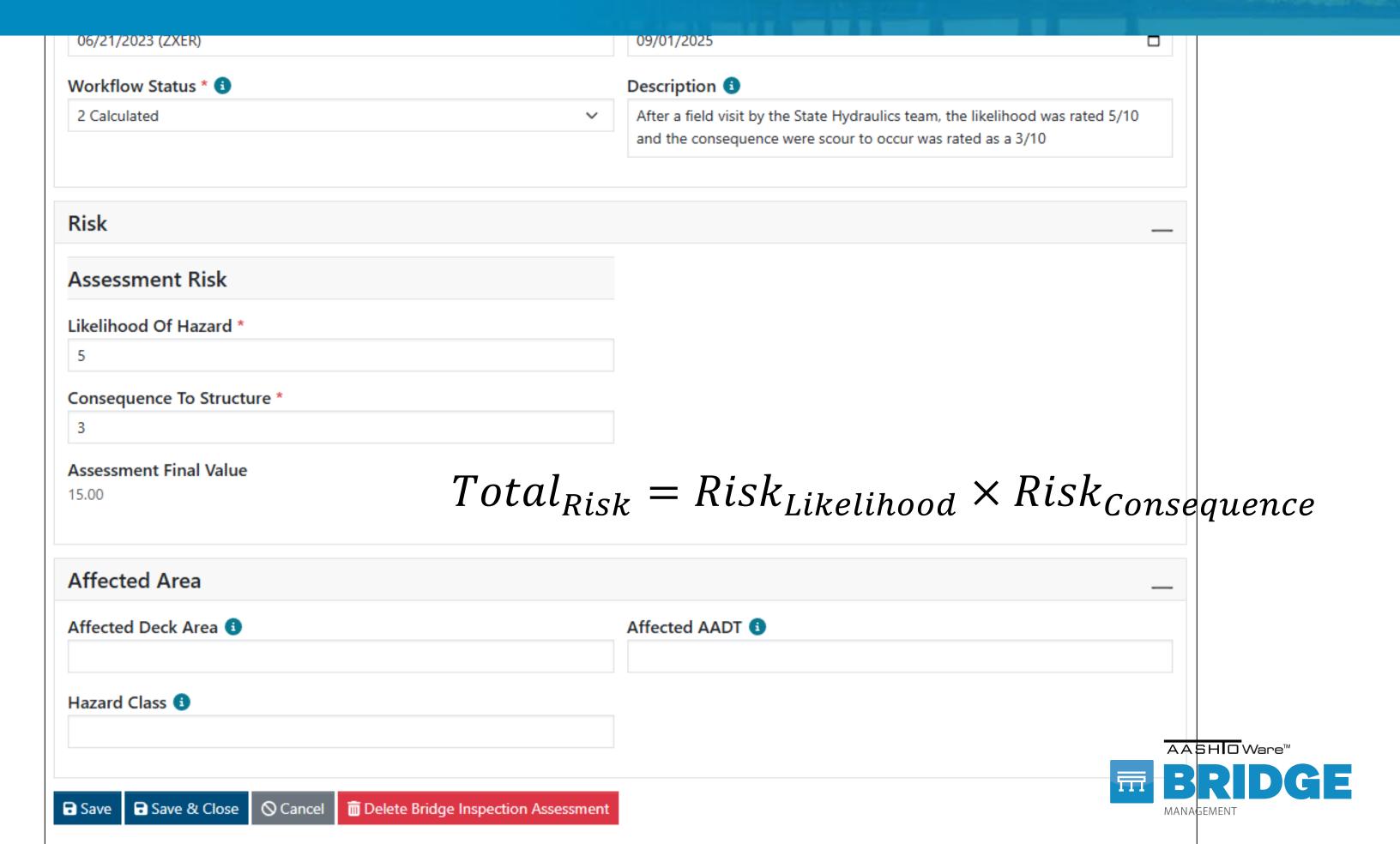


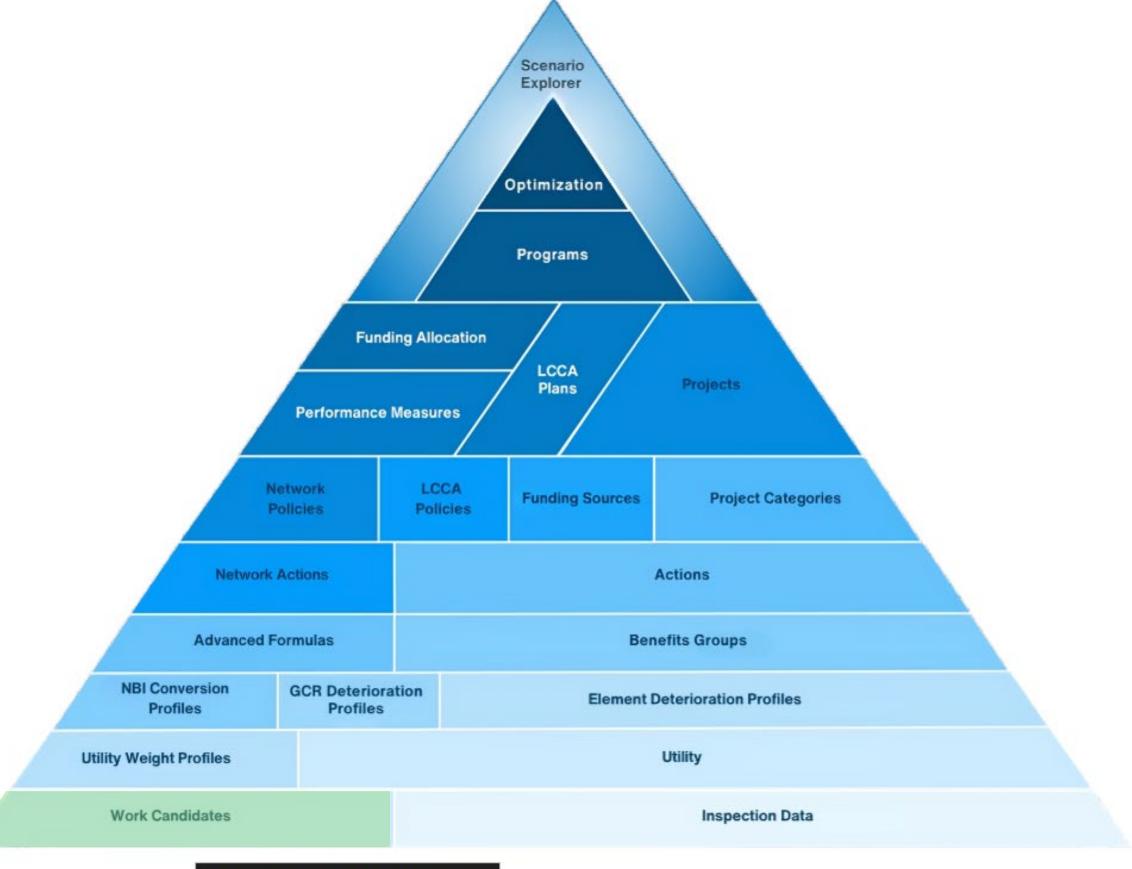
Consider
Agency Defined
Elements
(ADE's) that
best support
project actions.
(Examples:
beam ends,
sub wingwalls,
culvert
wingwalls,
joint headers)





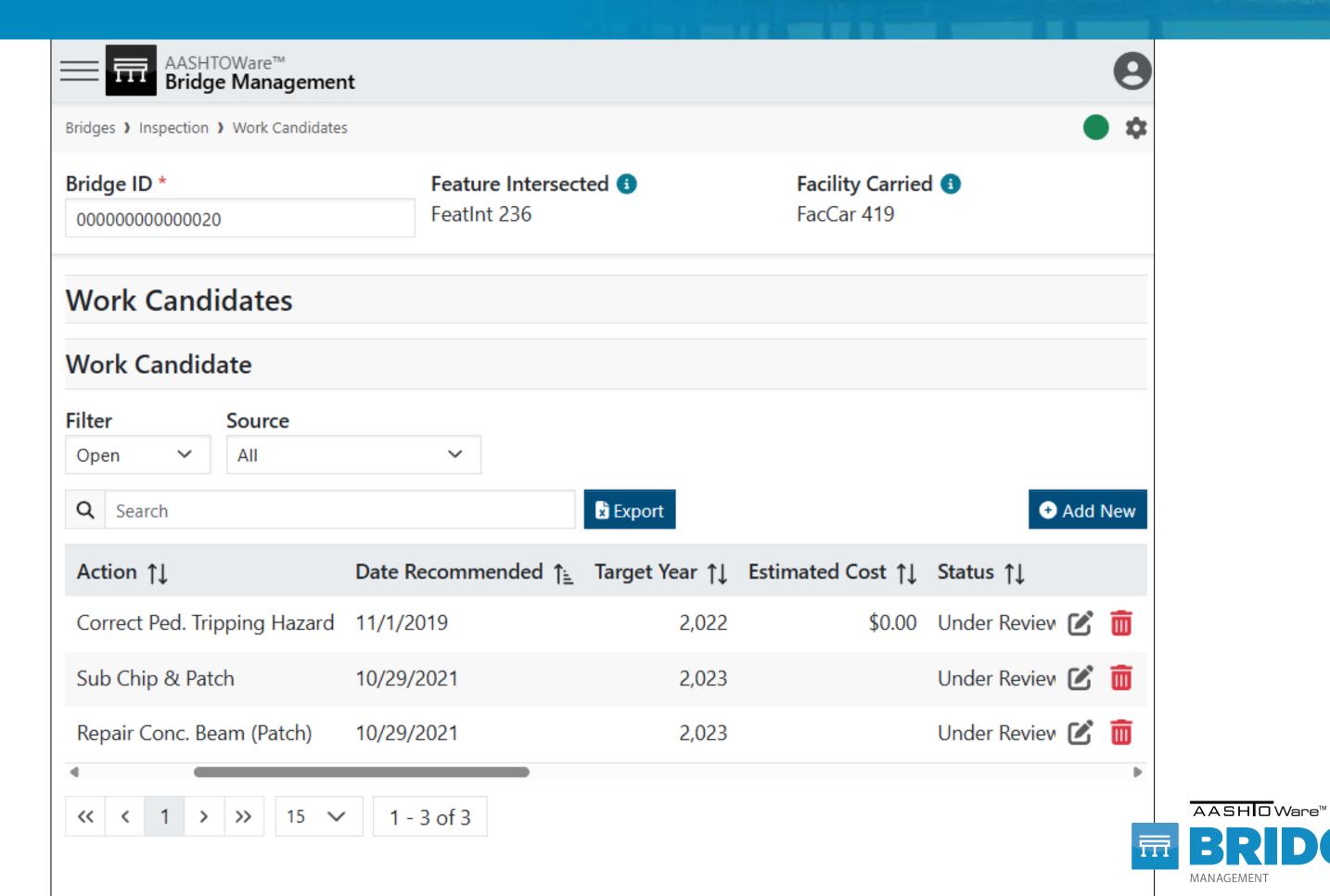


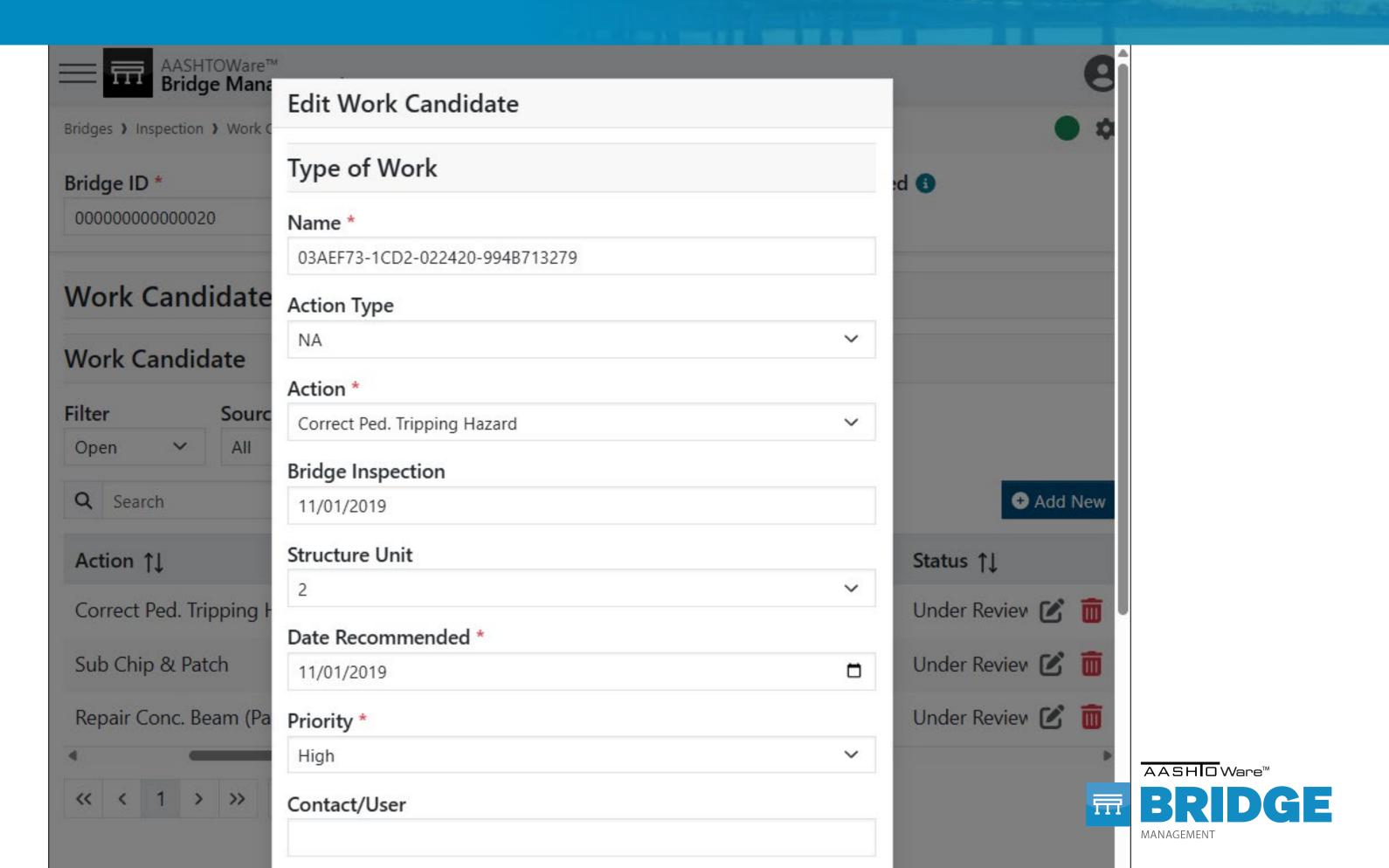


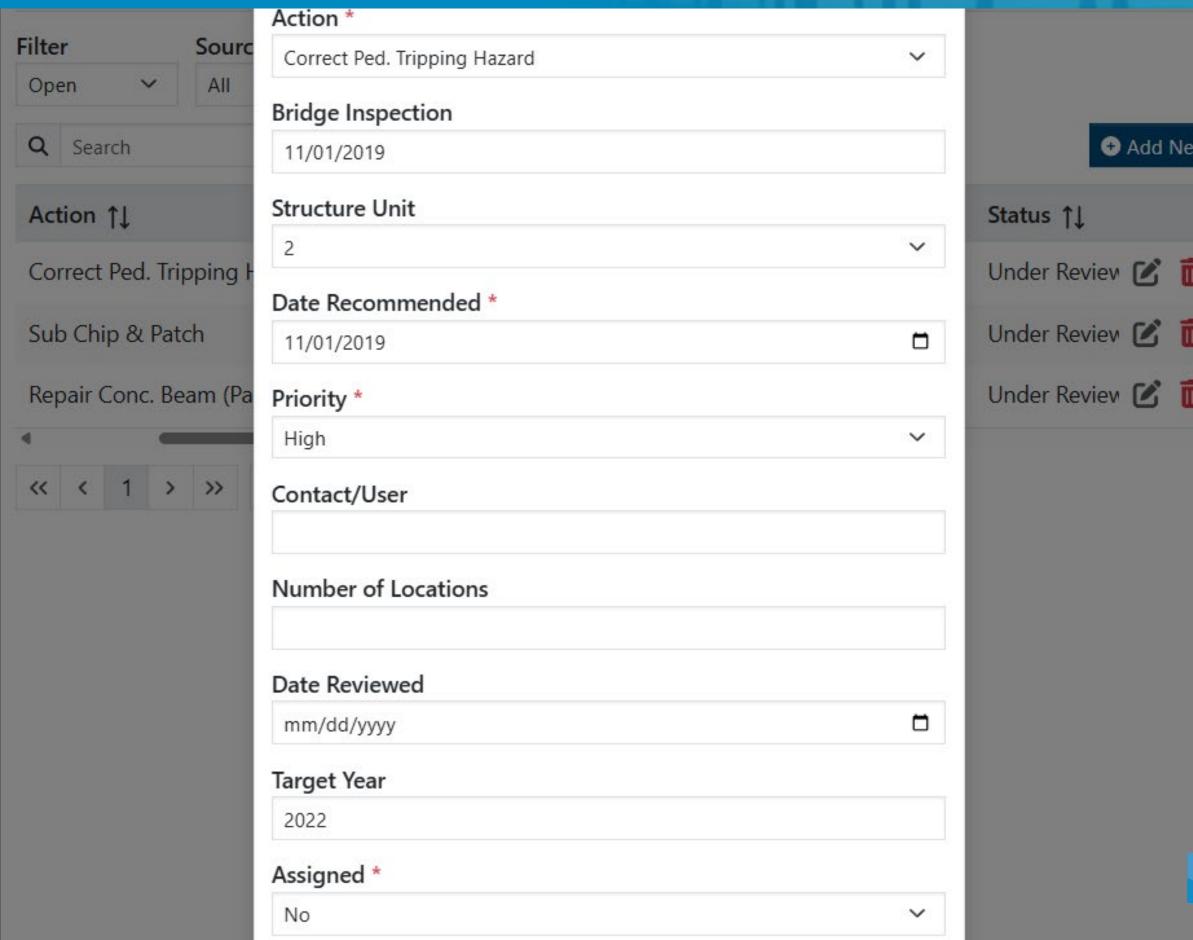


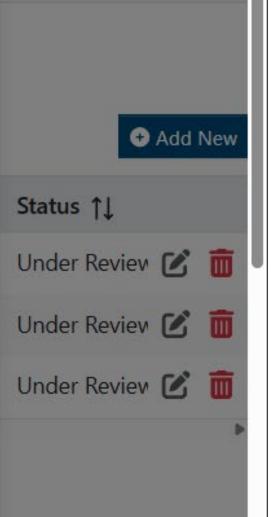
Inspector-recommended work for a structure.





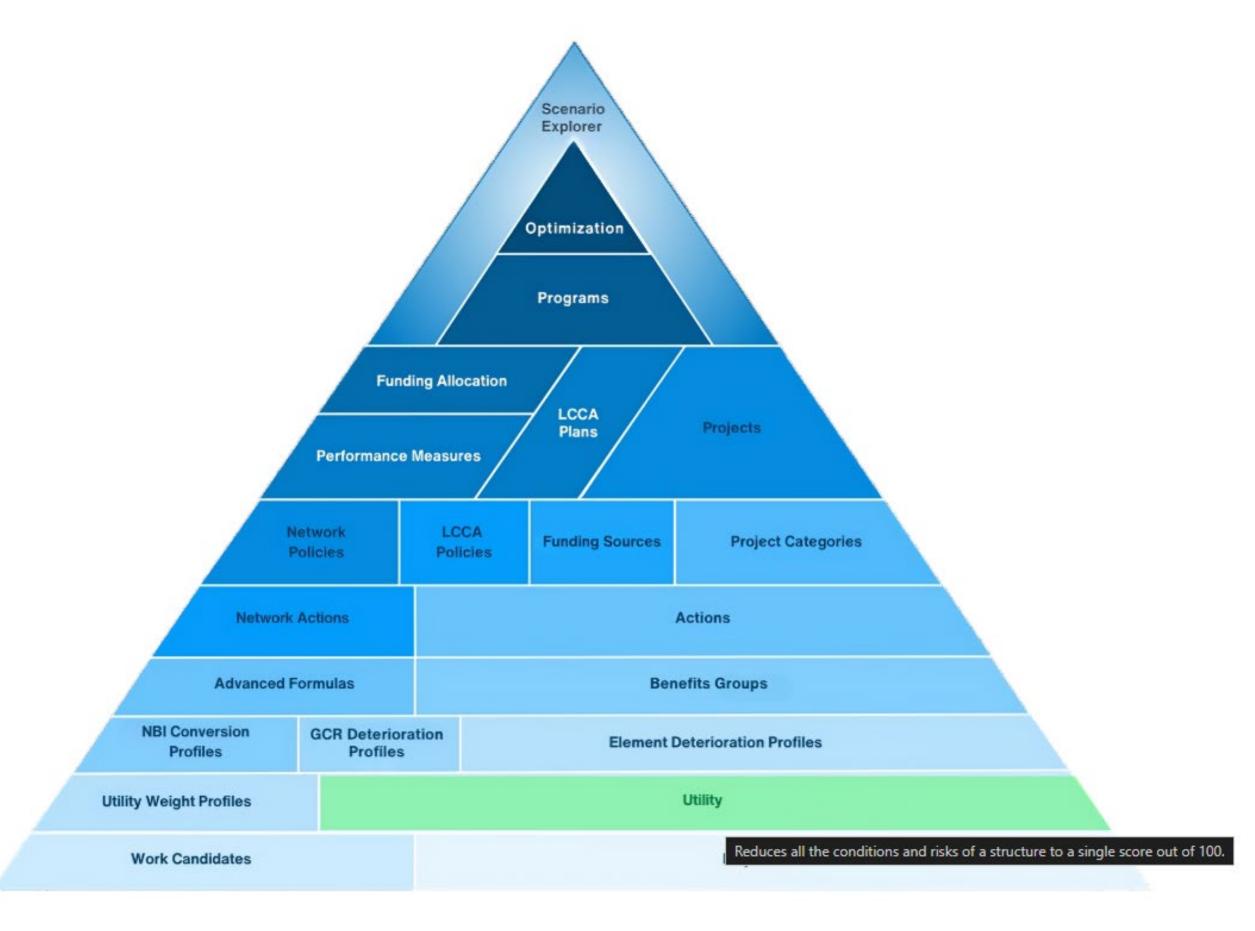














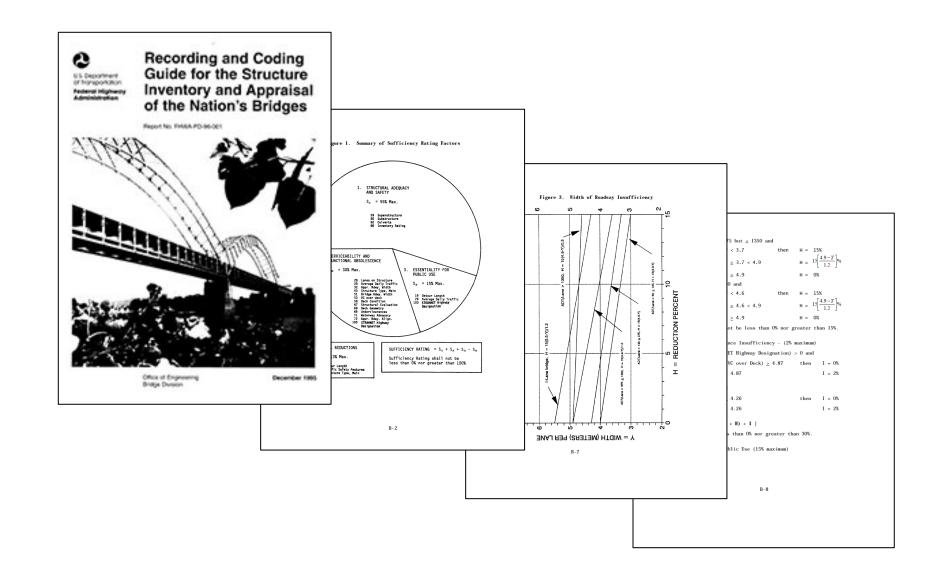
Sufficiency Rating (1980's – 2012)

Rank and condition score used by laws before MAP-21. See old coding guide Appendix B for calculation.

Health Index (2000's - present)

Element only weighted average.

Economic indicator of remaining value.

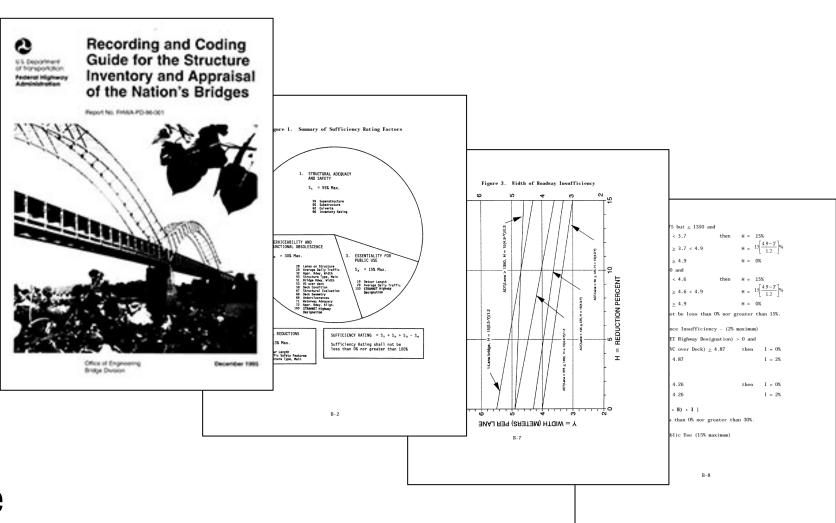


$$= \frac{\sum_{All\ Elements} W_{Relative} (C_{CS1}Q_{CS1} + C_{CS2}Q_{CS2} + C_{CS3}Q_{CS3} + C_{CS4}Q_{CS4})}{\sum_{All\ Elements} W_{Relative}Q_{Total}}$$

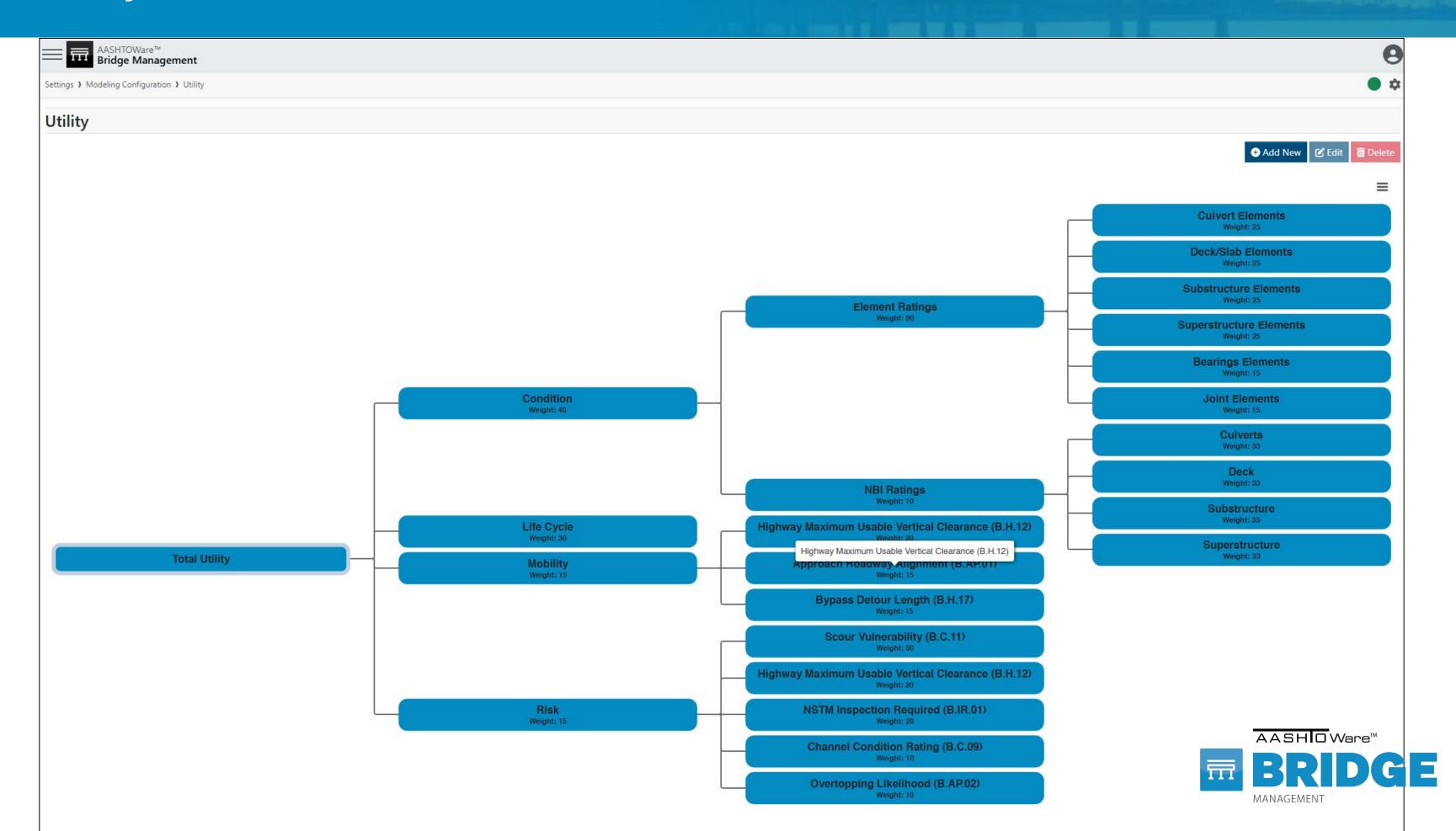


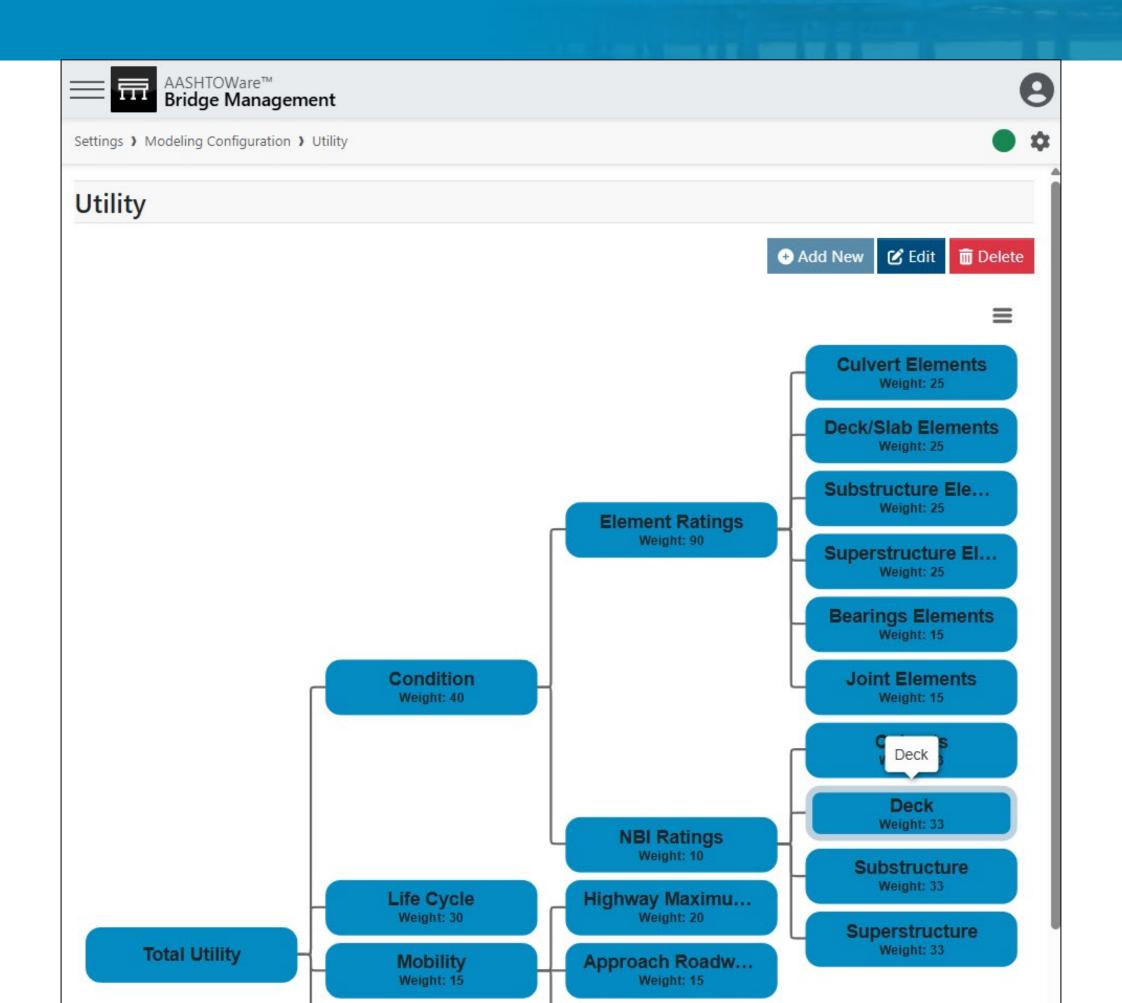
Utility (2015 - present)

Multi-objective scaled and weighted average Used to calculate benefit of actions.





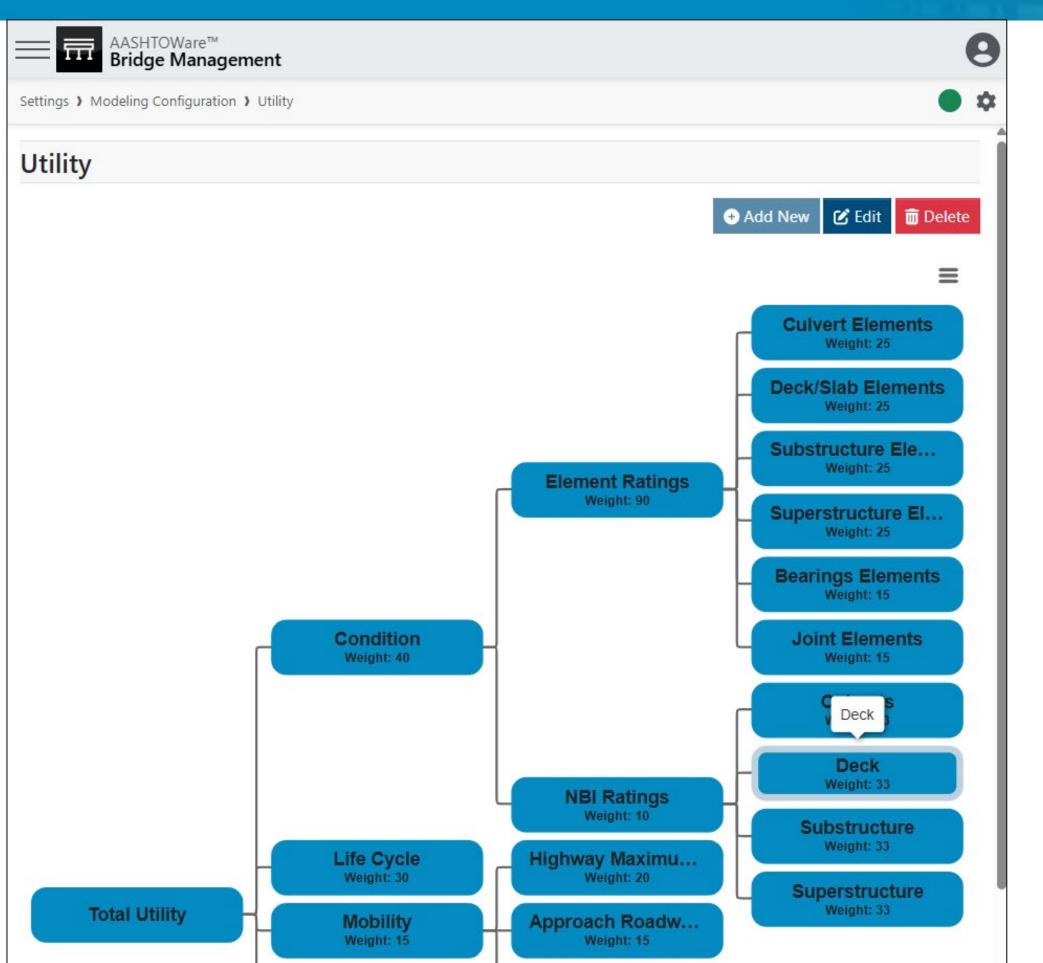


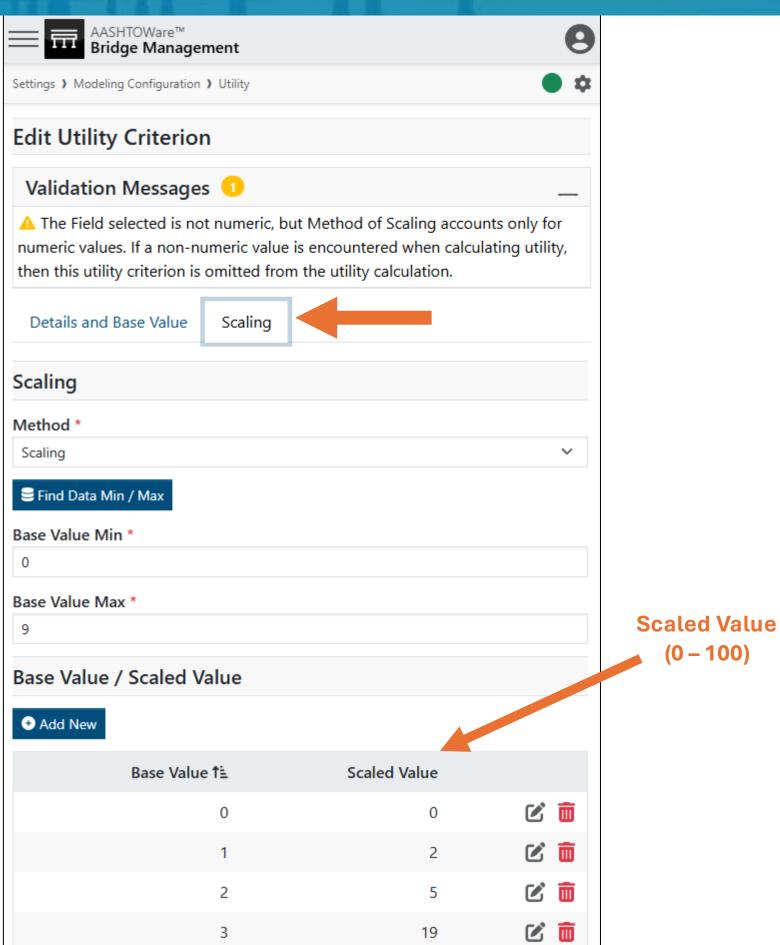


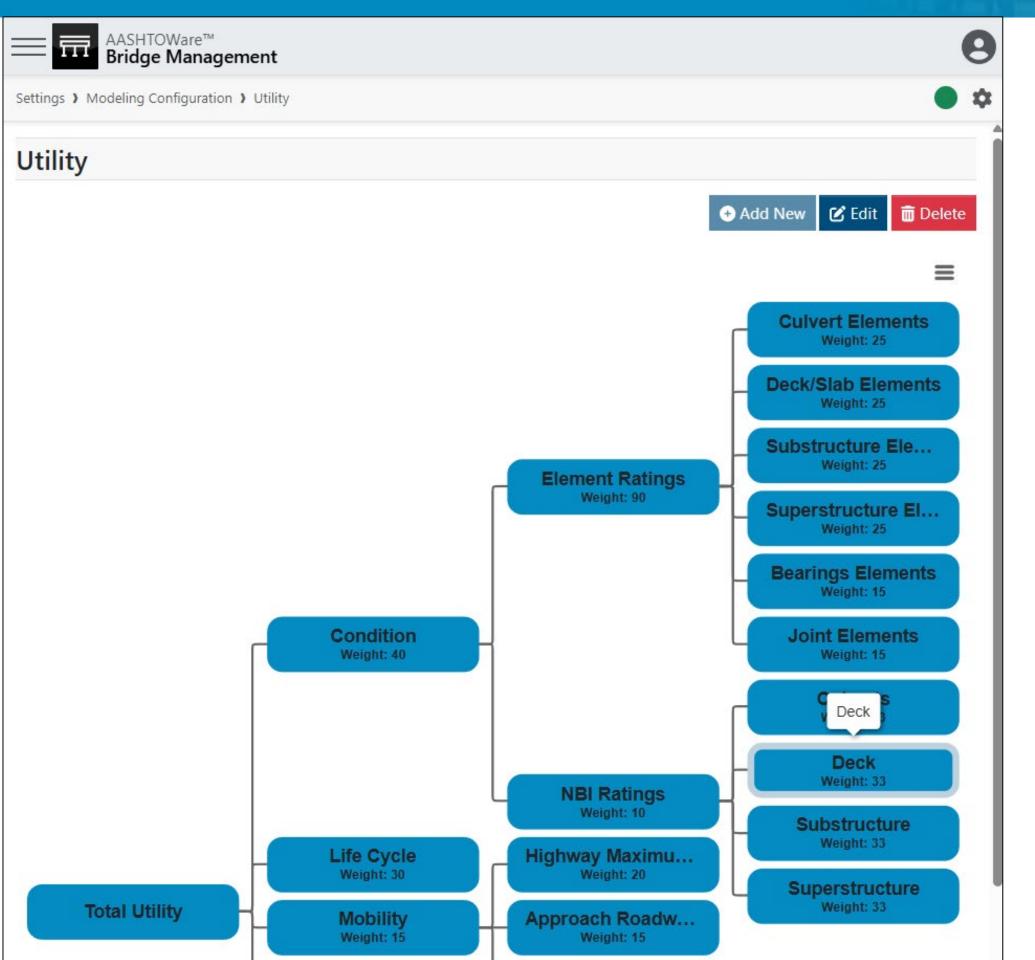


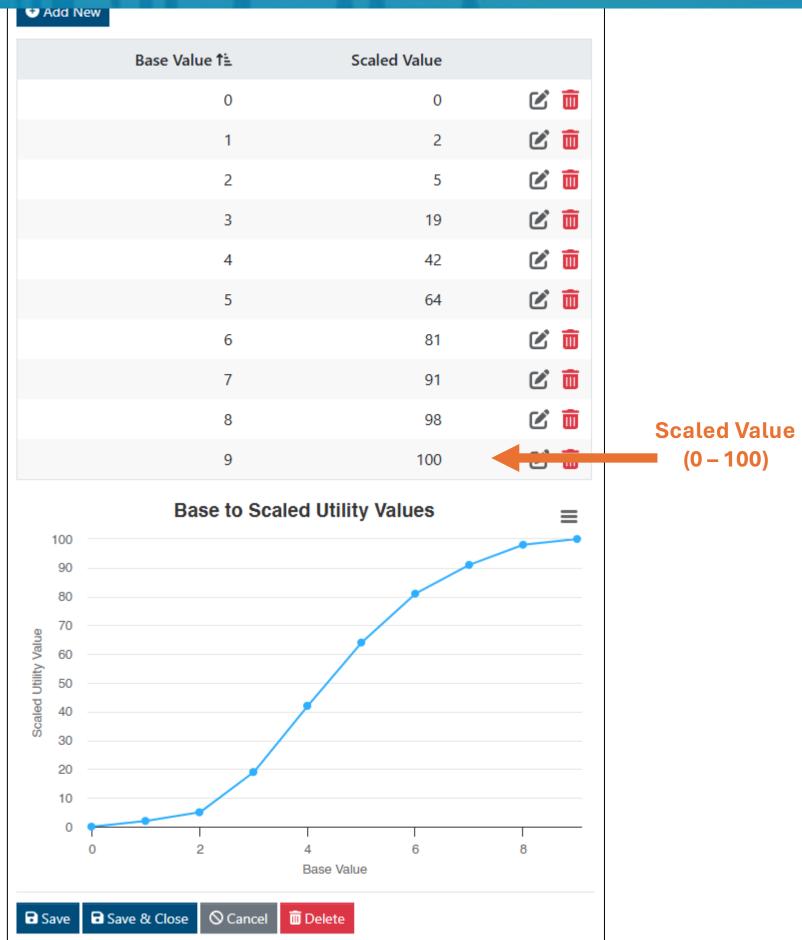


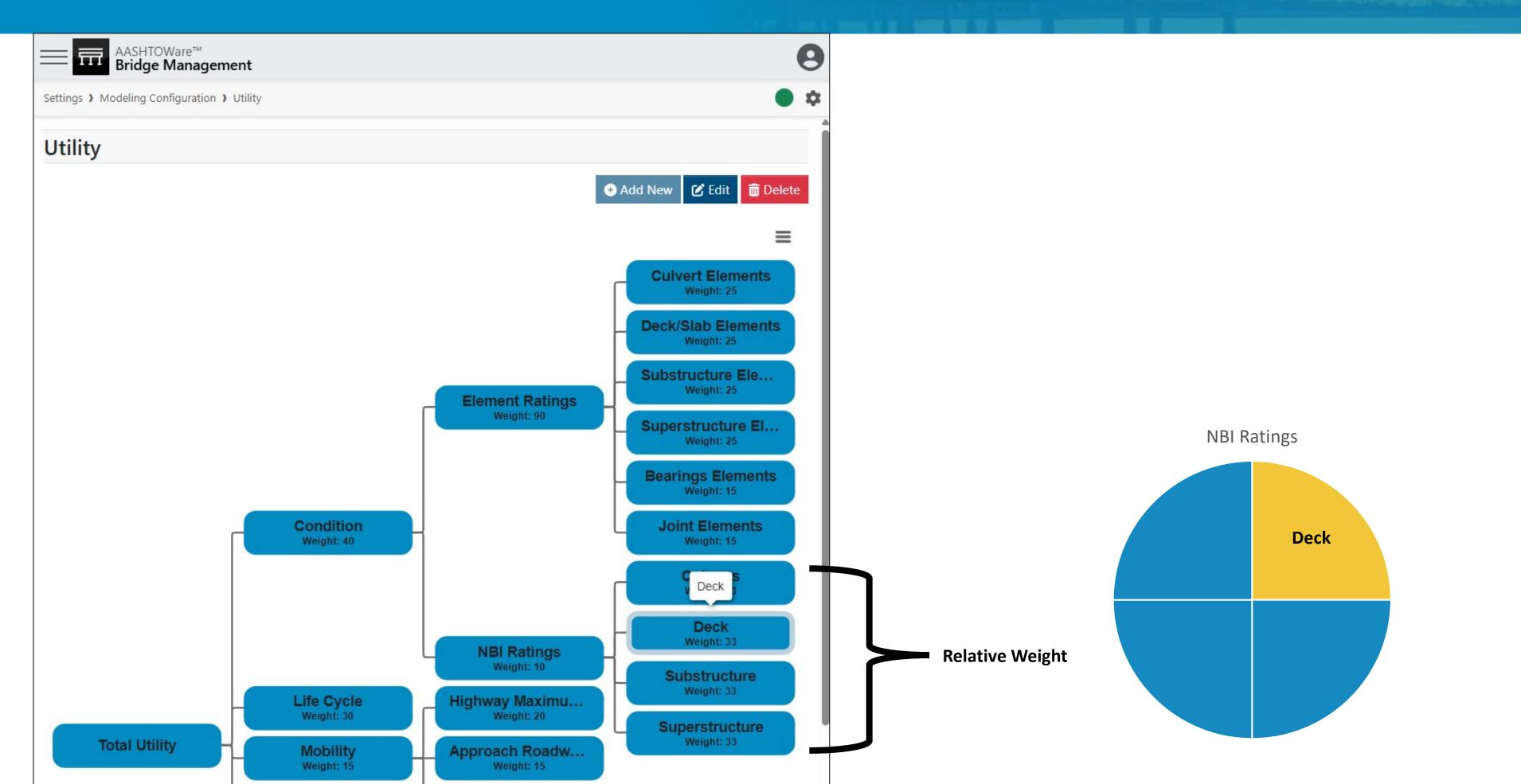
AAGUTOU		
AASHTOWare™ Bridge Manage	ment	8
Settings) Modeling Configuration) Utility	*
Edit Utility Criterio	า	
Validation Message	s 1	_
numeric values. If a non-nu	t numeric, but Method of Scaling accounts only fo umeric value is encountered when calculating utili omitted from the utility calculation.	
Details and Base Value	Scaling	
Details		
Name *		
Deck		
Weight *		
33		
Base Value		
Base Value Type *		
Field		~
Type *		
Bridge Inspection		~
Field *		
DeckRating		~
☐ Save & Close	○ Cancel	

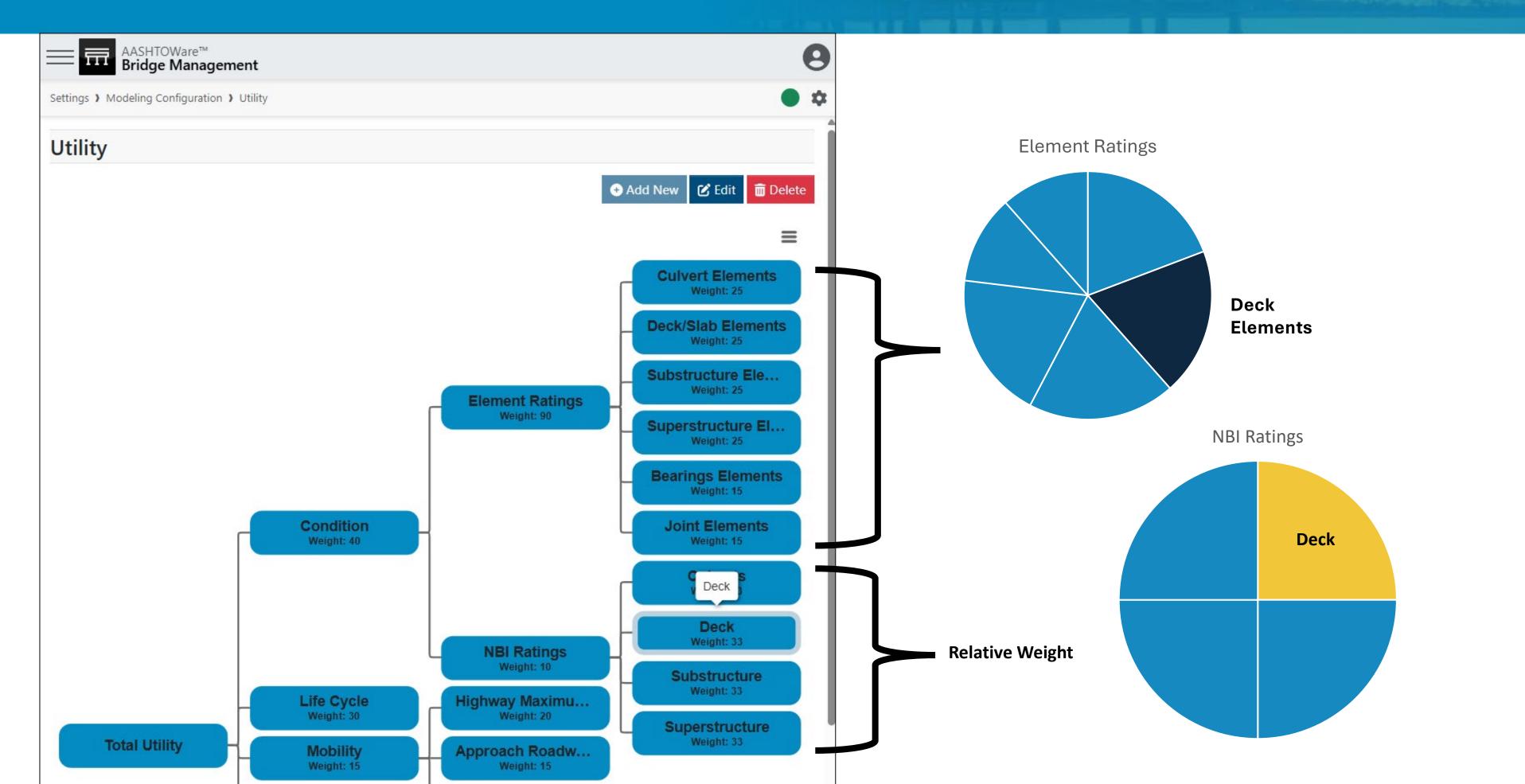


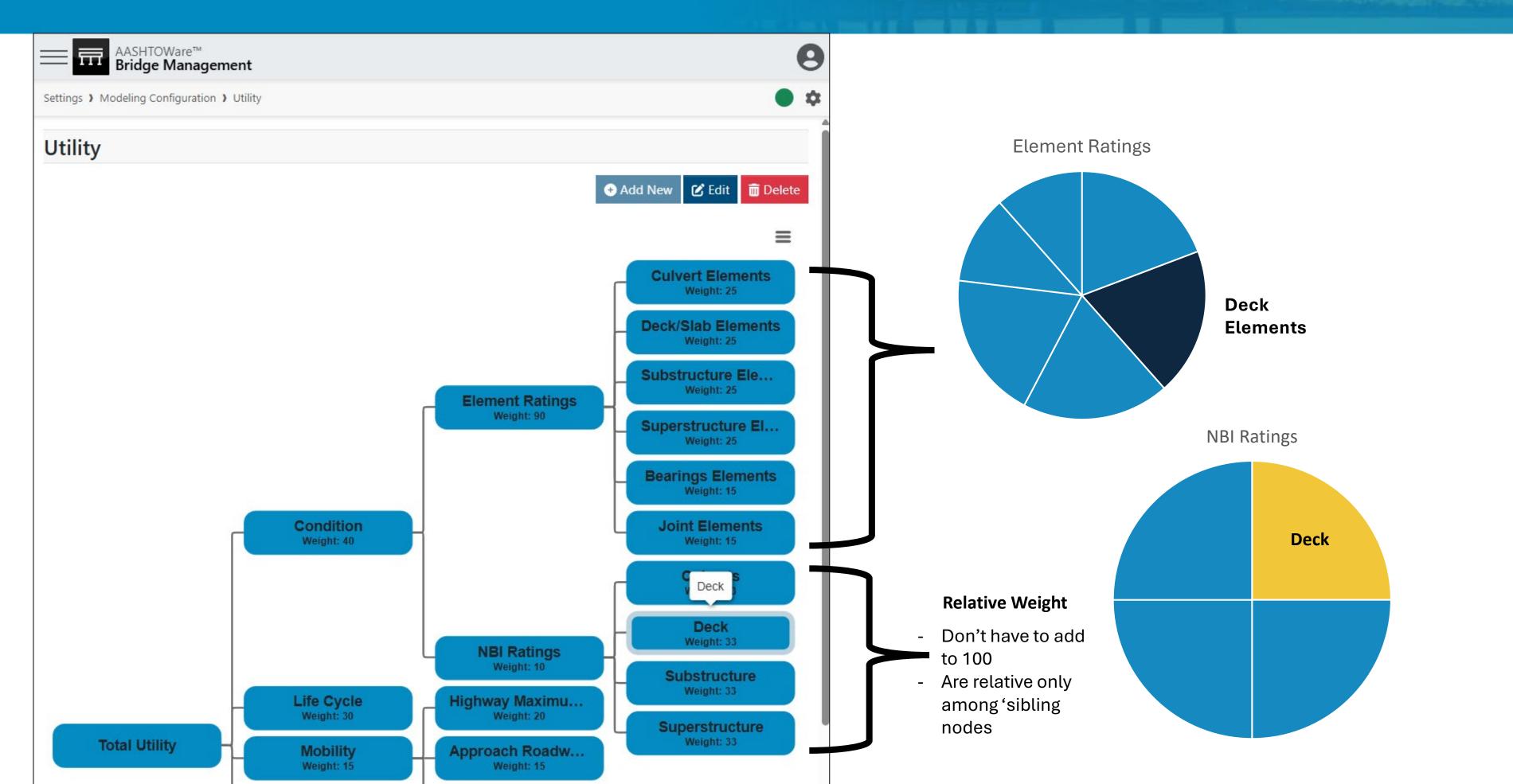










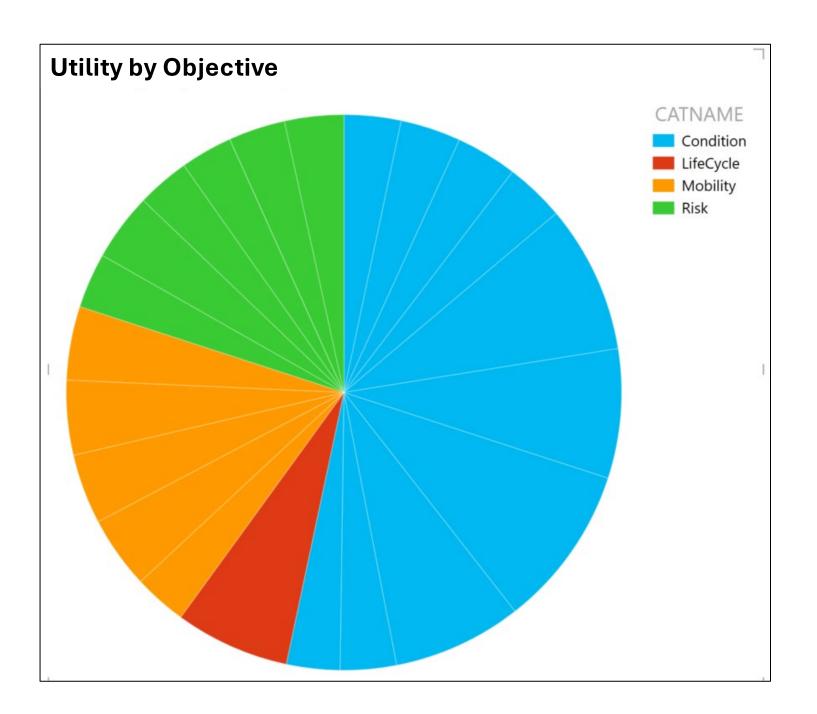


When configuring your Utility for the first time:

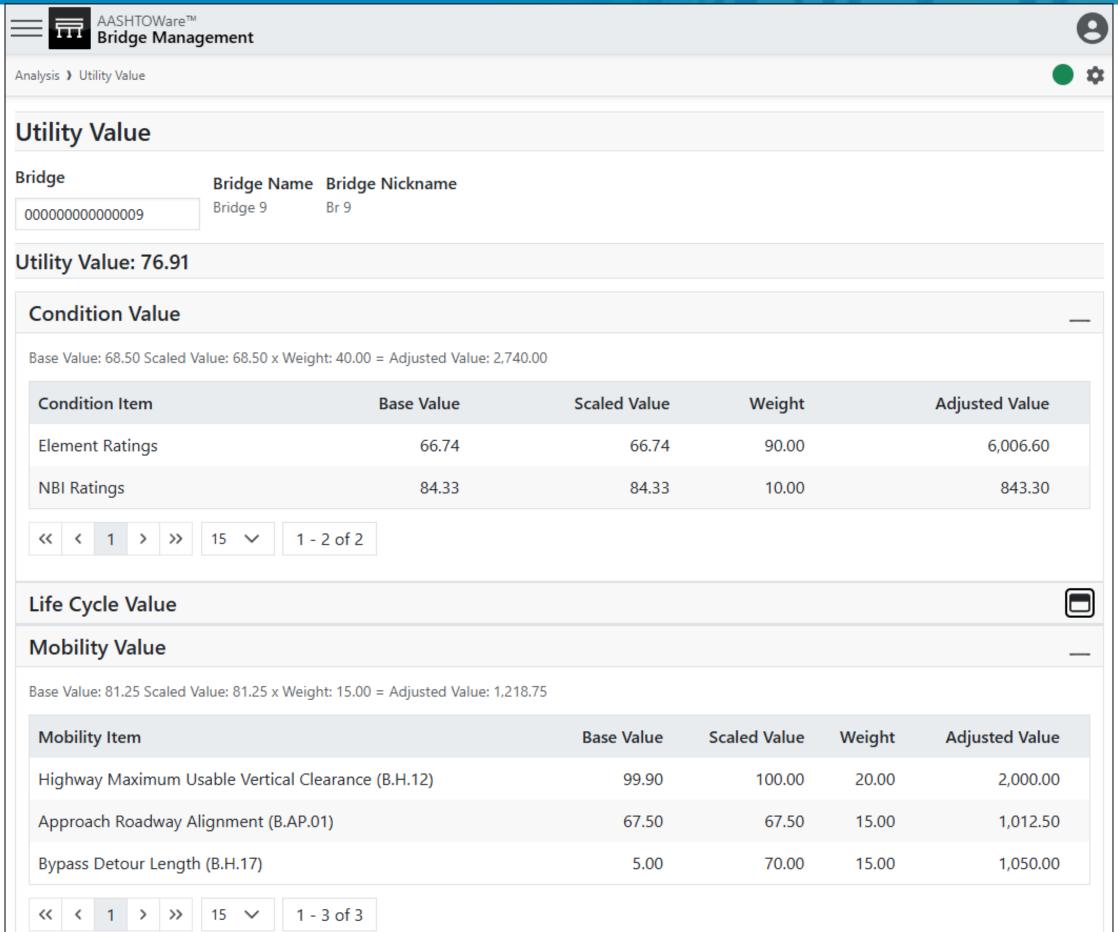
- How much does this steer our project type selection normally?
- Do we have data for it?
- Consider relative weights as a part of the whole.

Easy mode:

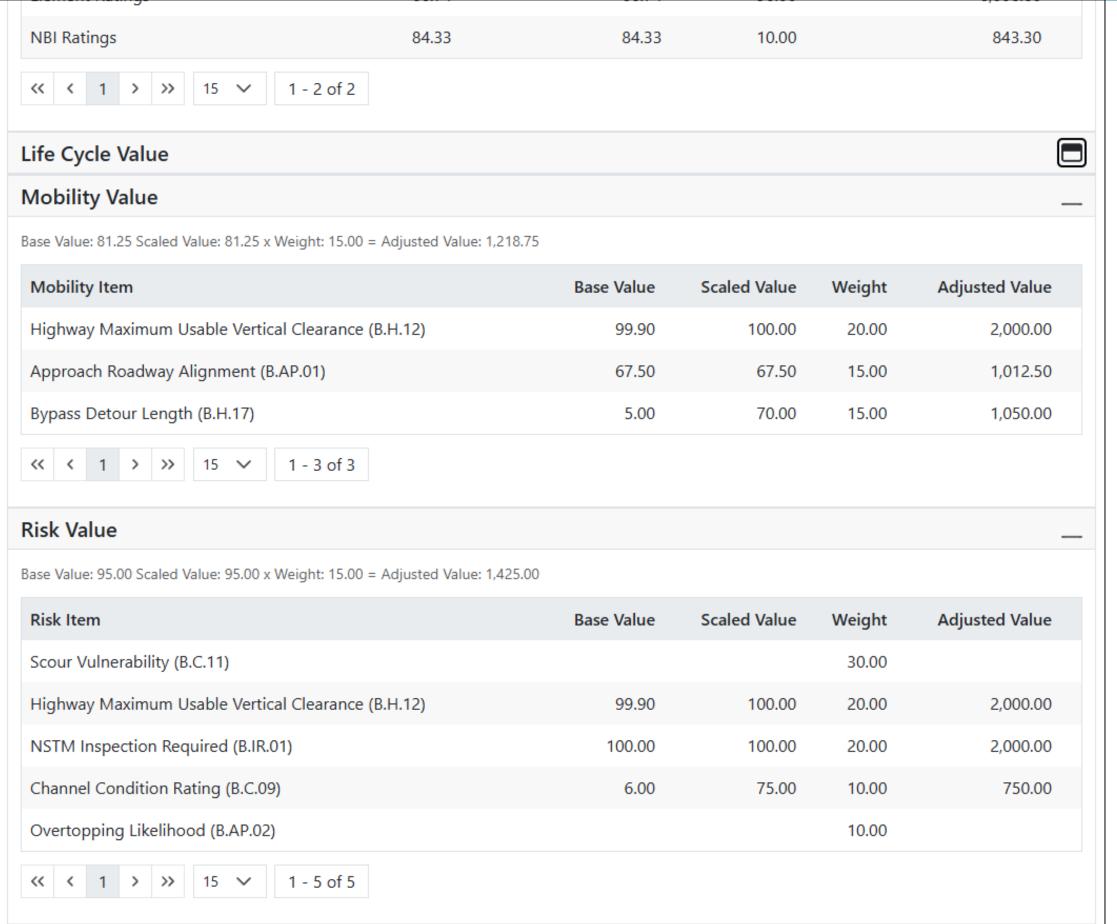
- Start with just Condition or Condition and Risk
 - Turn the other weights to 0 to inactivate their parts.
 - Do you use / trust your GCR or Element data more?
- Add Lifecycle and Mobility as you become comfortable.



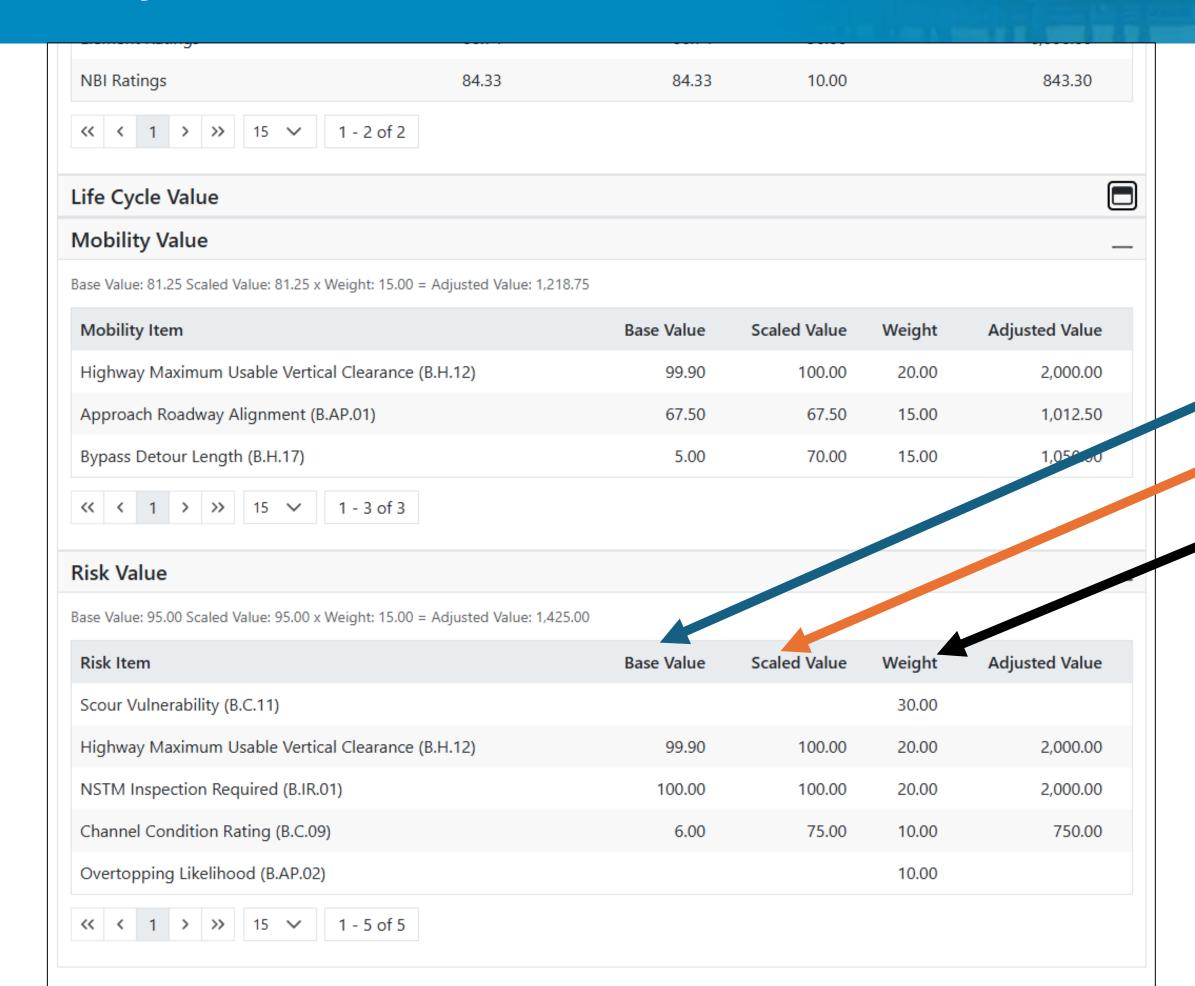










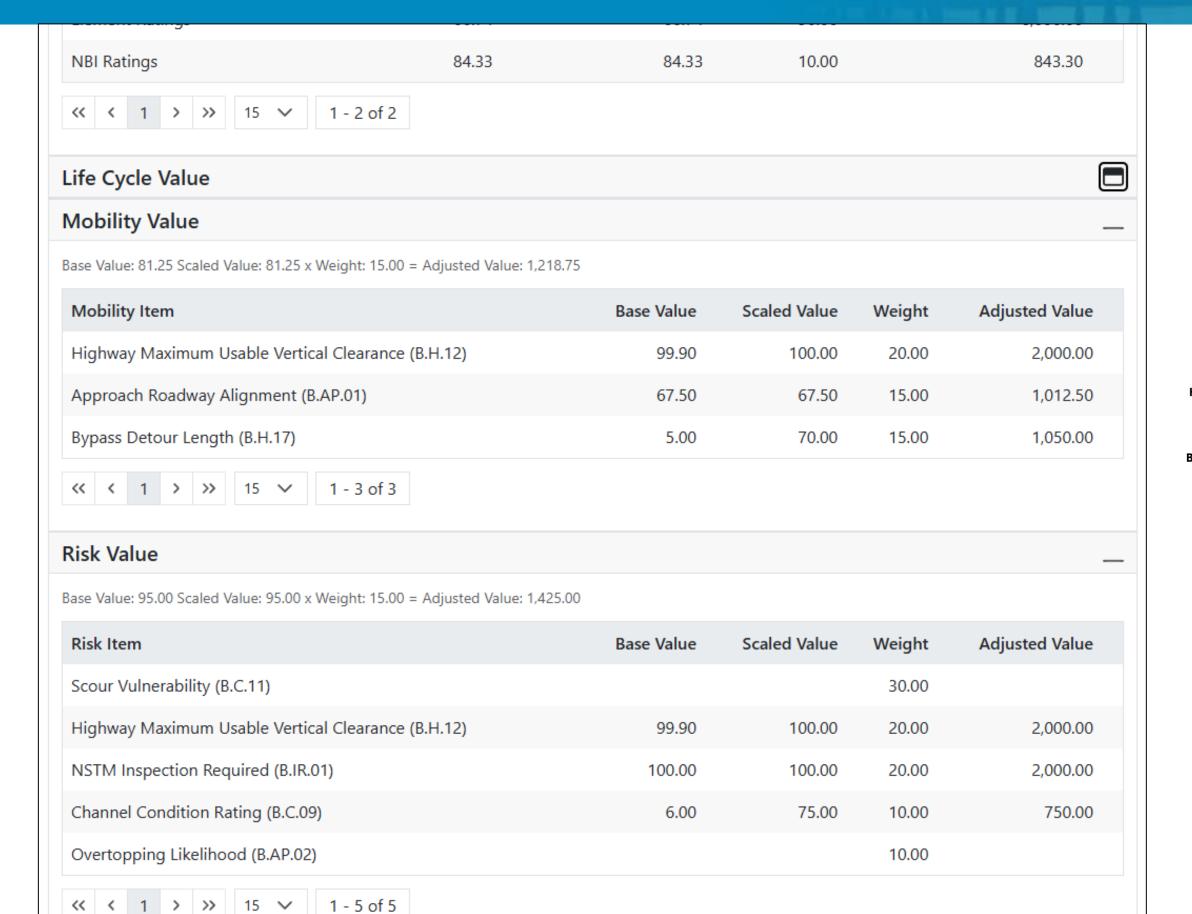


Base Value (0 – 9)

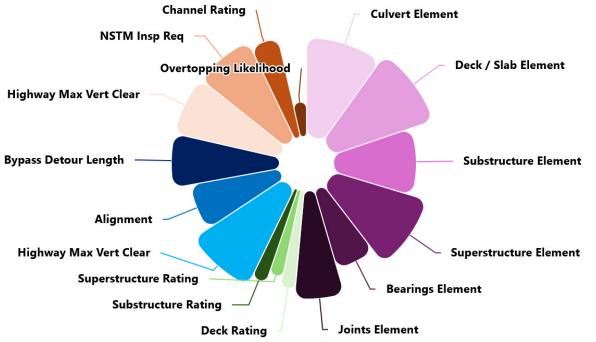
Scaled Value (0 – 100)

Relative Weight



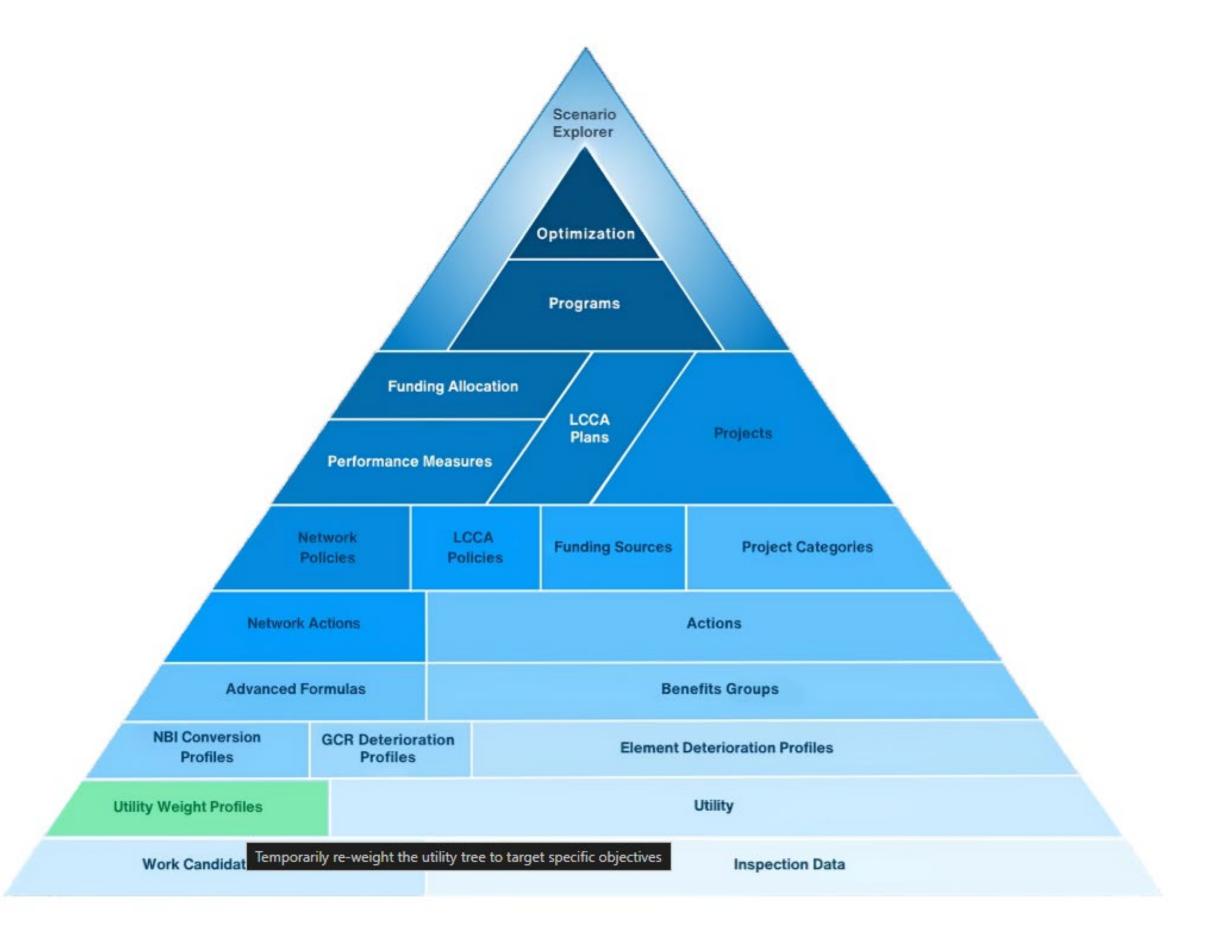


Utility of Bridge 20 - 80.97

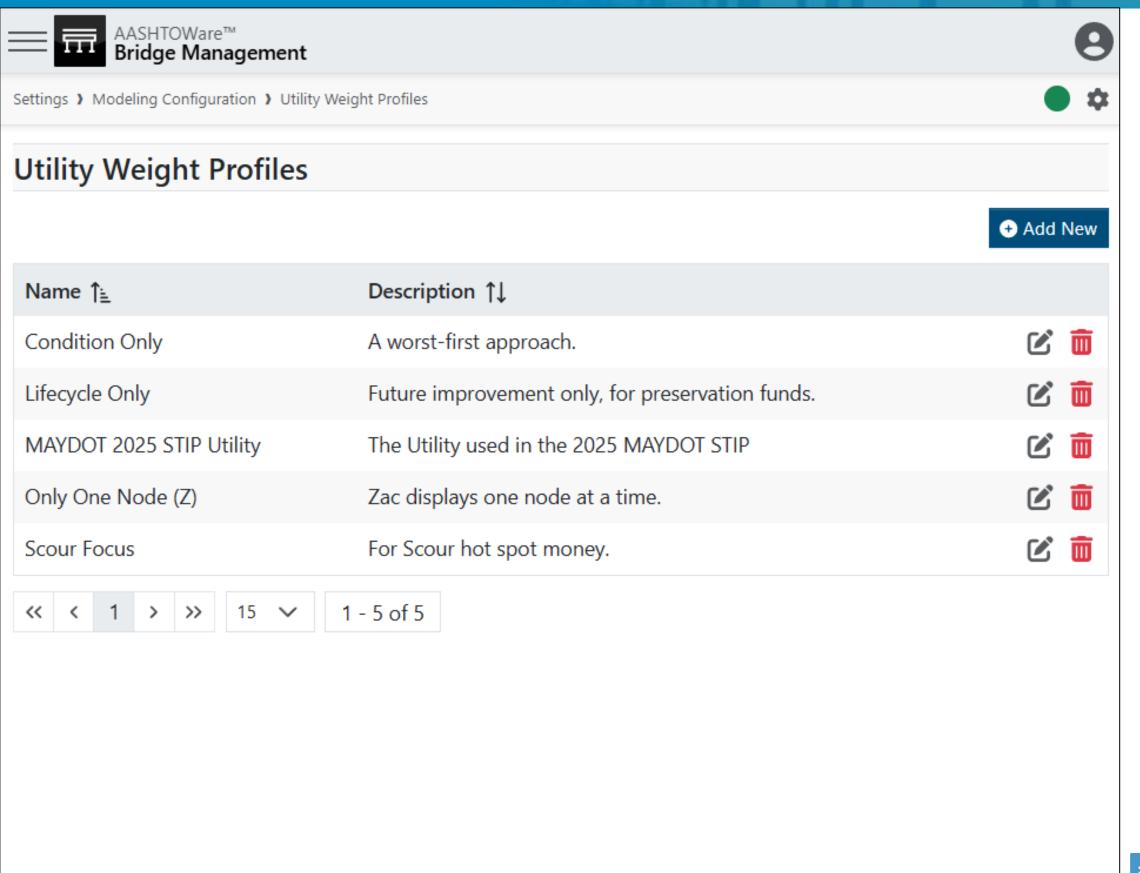




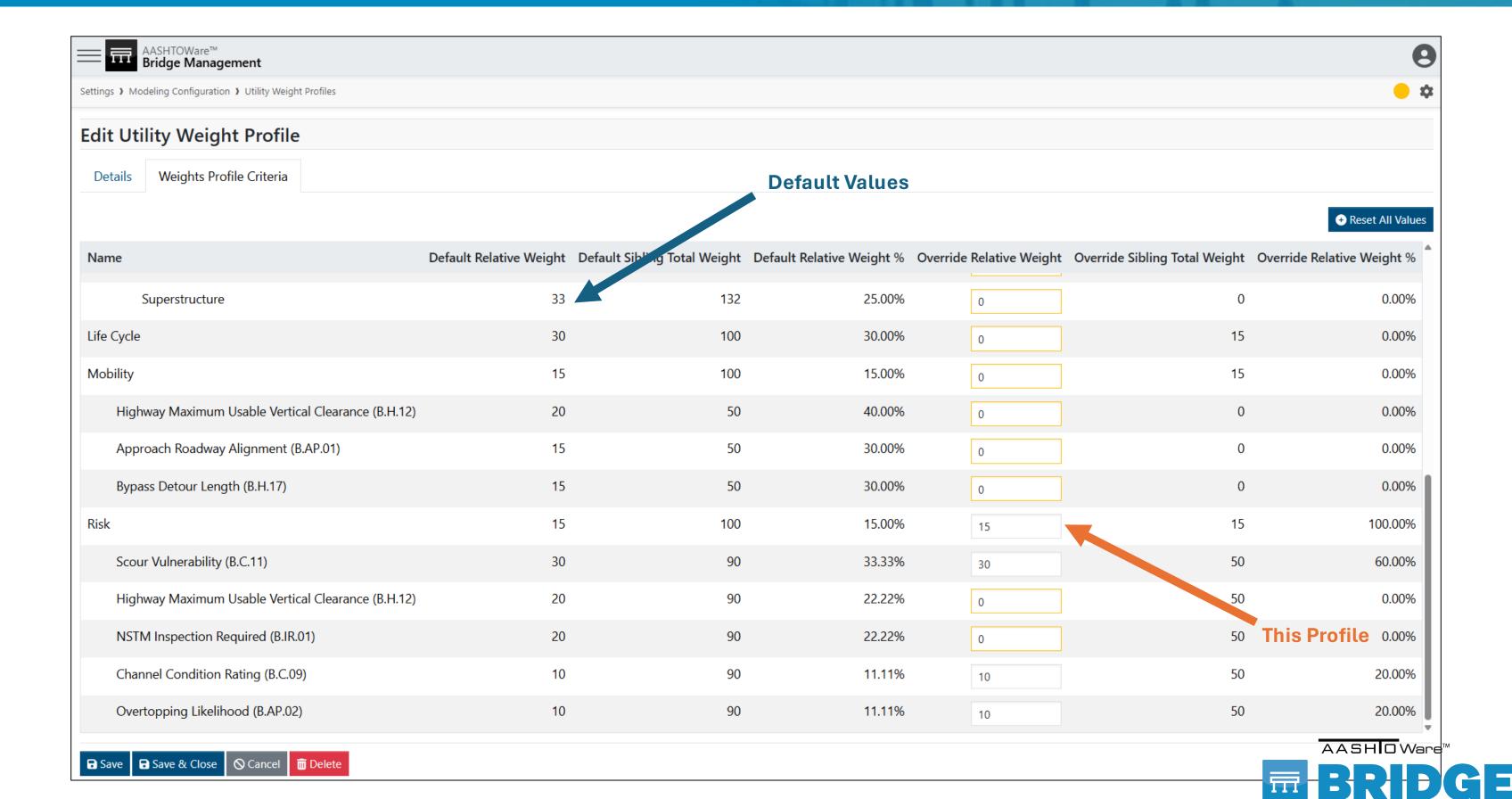
Highcharts.com



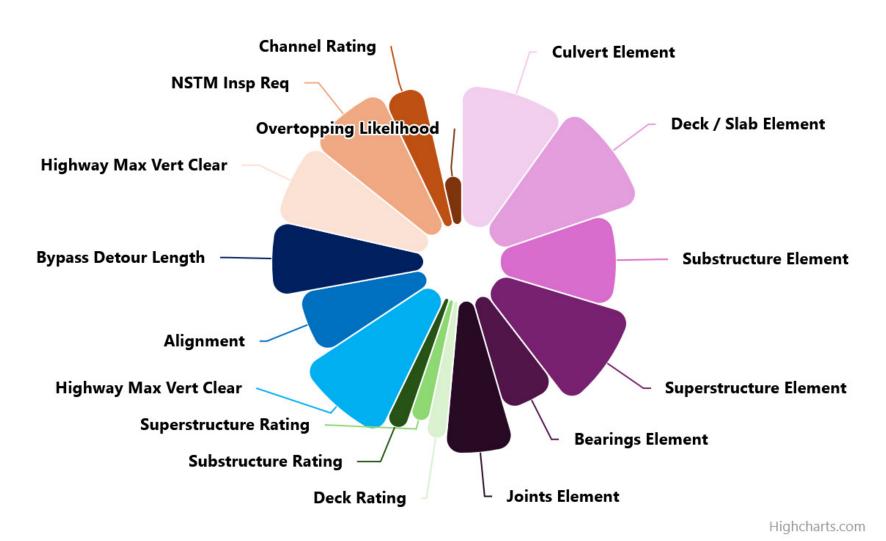




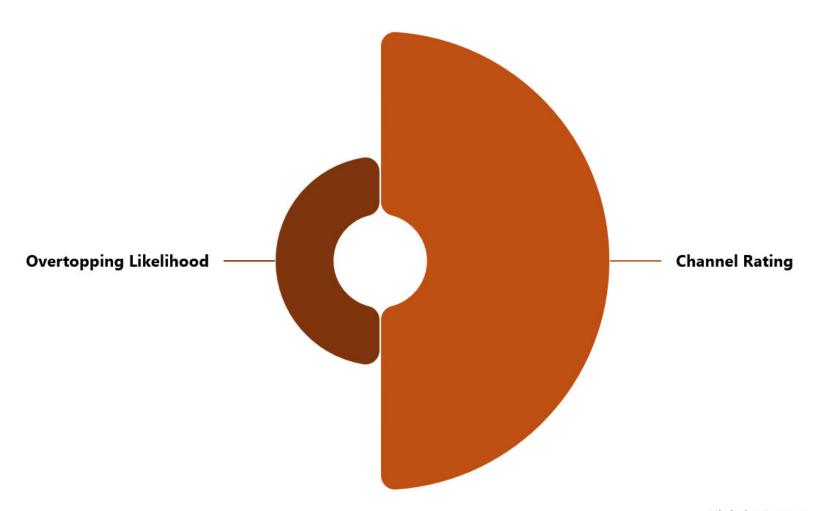




Utility of Bridge 20 - 80.97



Utility of Bridge 20 - 46.5

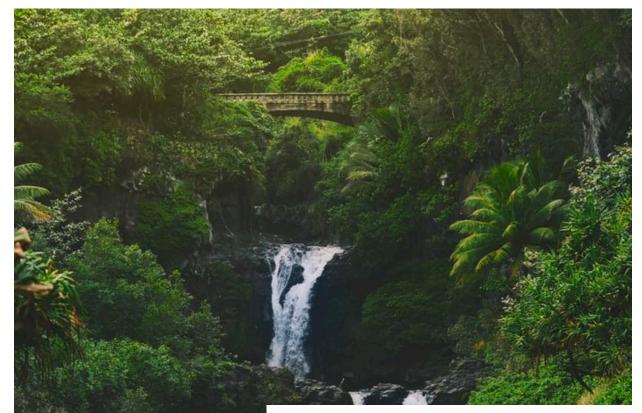






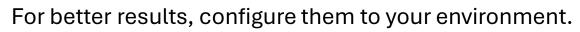


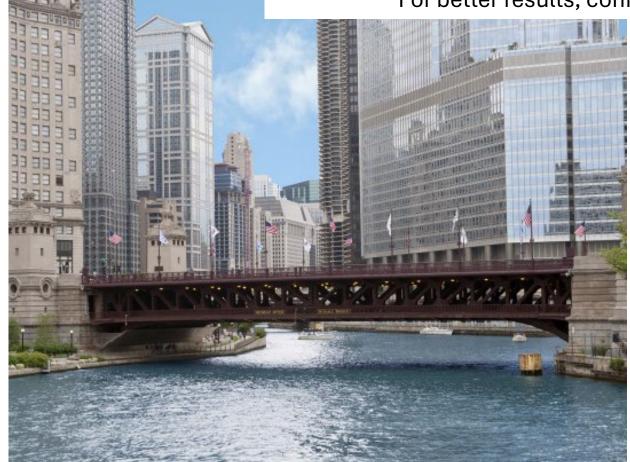
Deterioration





The default values are an average.









Deterioration

Variable impact on optimization results

(From most to least impactful)

- 1. Action costs
- 2. Network Policies
- 3. Utility Criteria
- 4. Performance Measures
- 5. Criticality (Structure Weight)
- 6. Deterioration rates
- 7. Frozen Projects
- 8. Lifecycle Plans
- 9. Lifecycle Policies
- 10. Refined Benefits



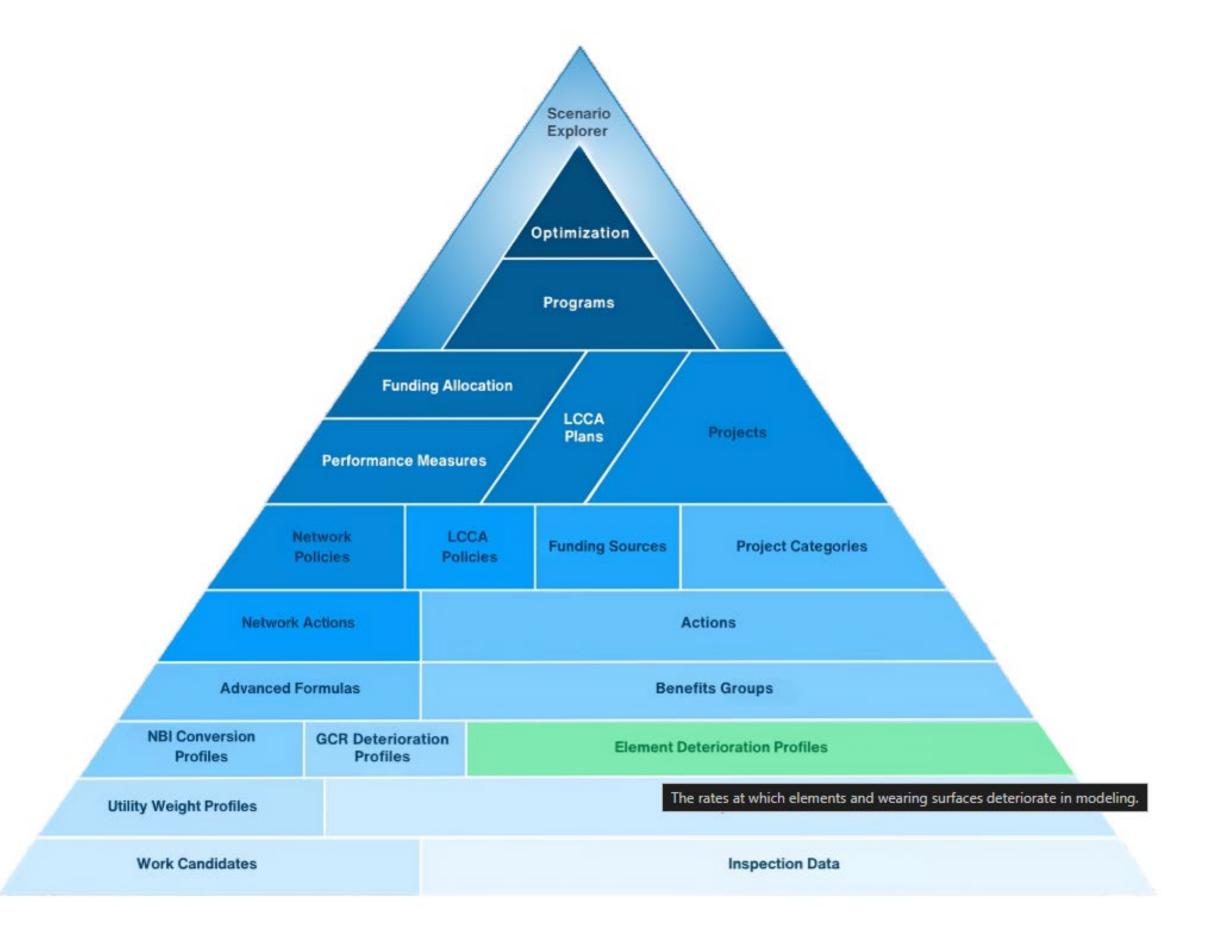
Deterioration

2 Types of Deterioration used in BrM

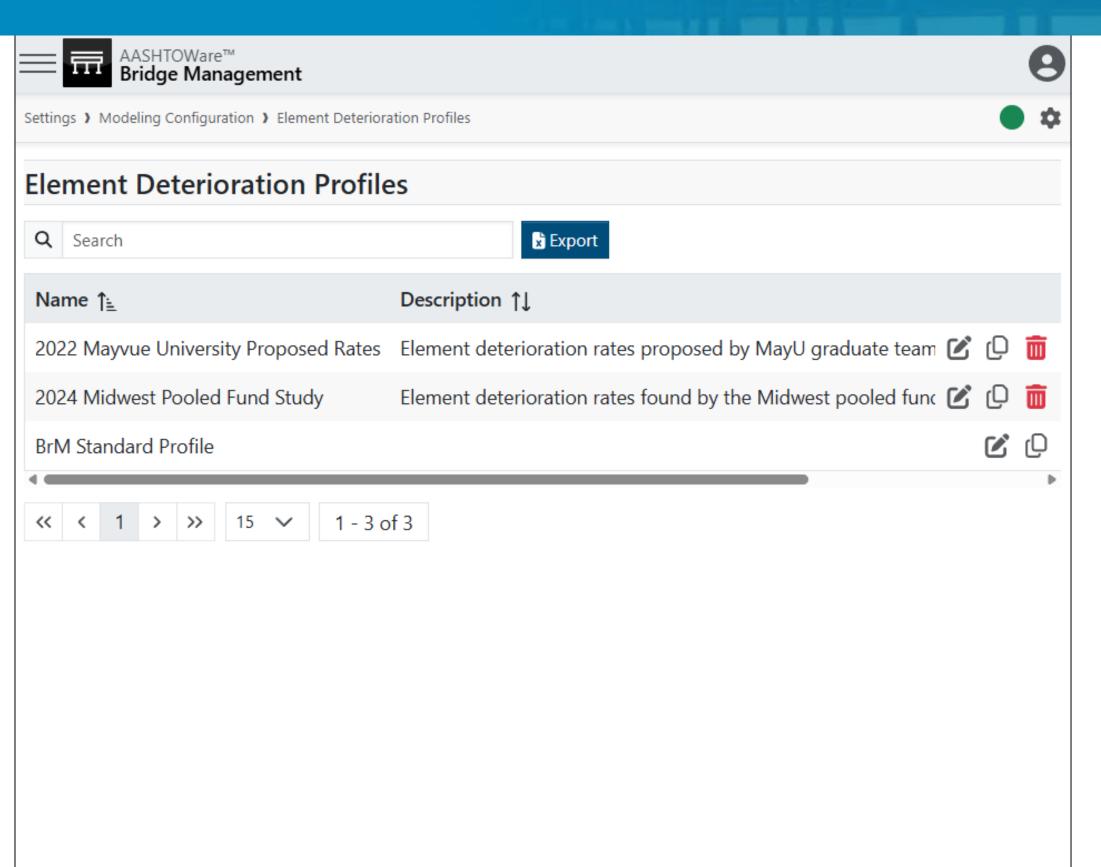
- 1. Element Deterioration
- 2. GCR Deterioration



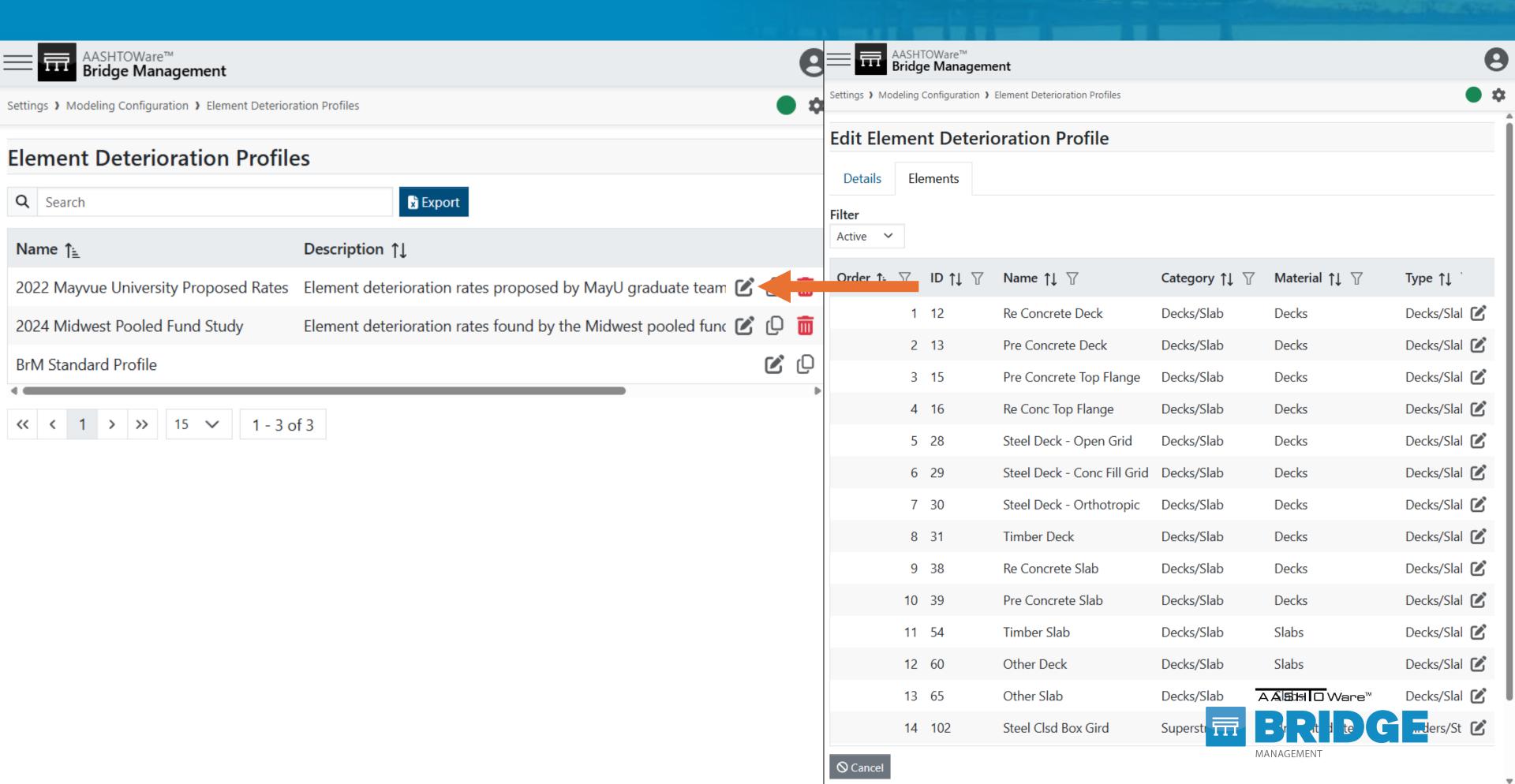
Element Deterioration Profiles

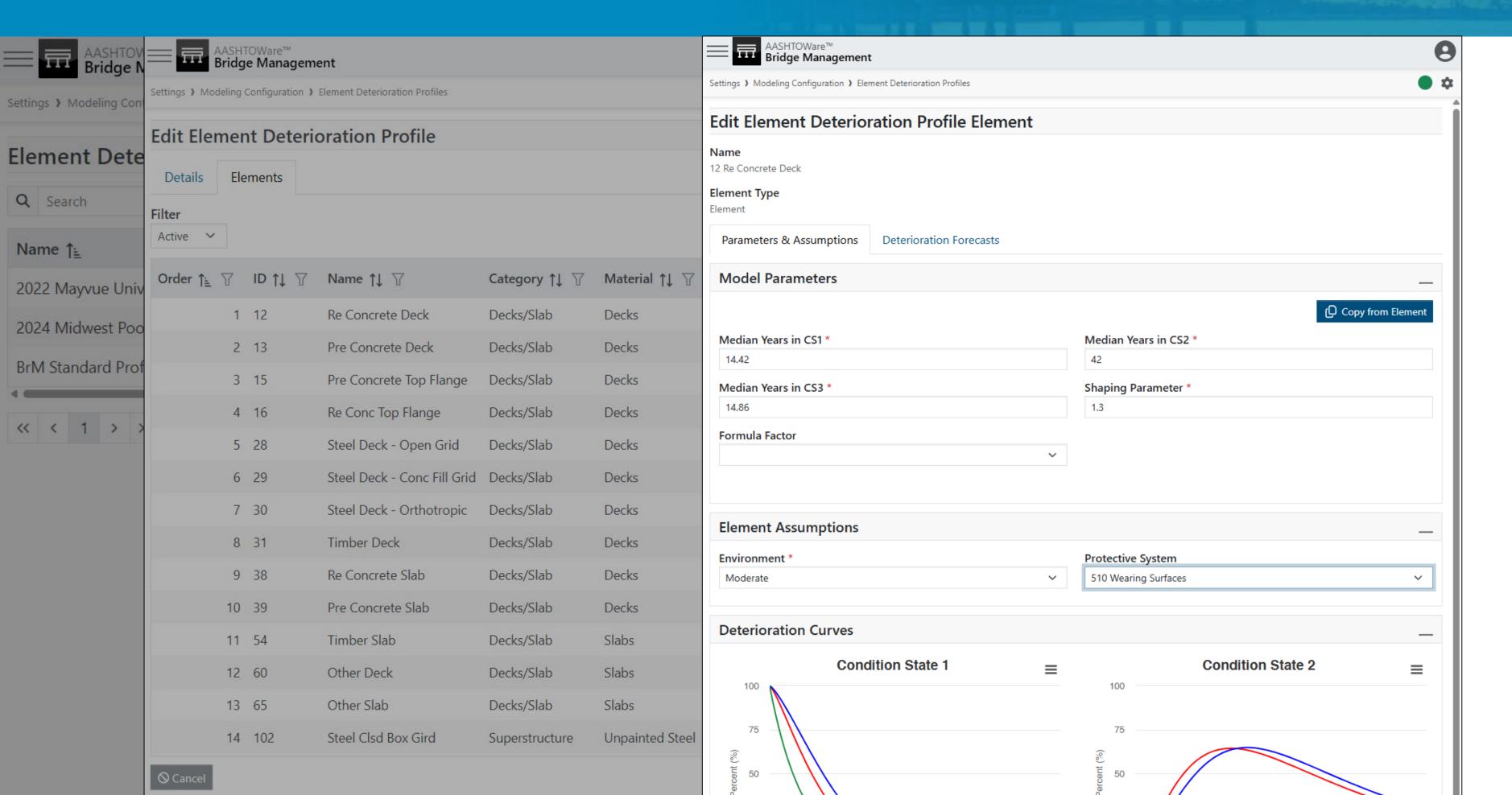


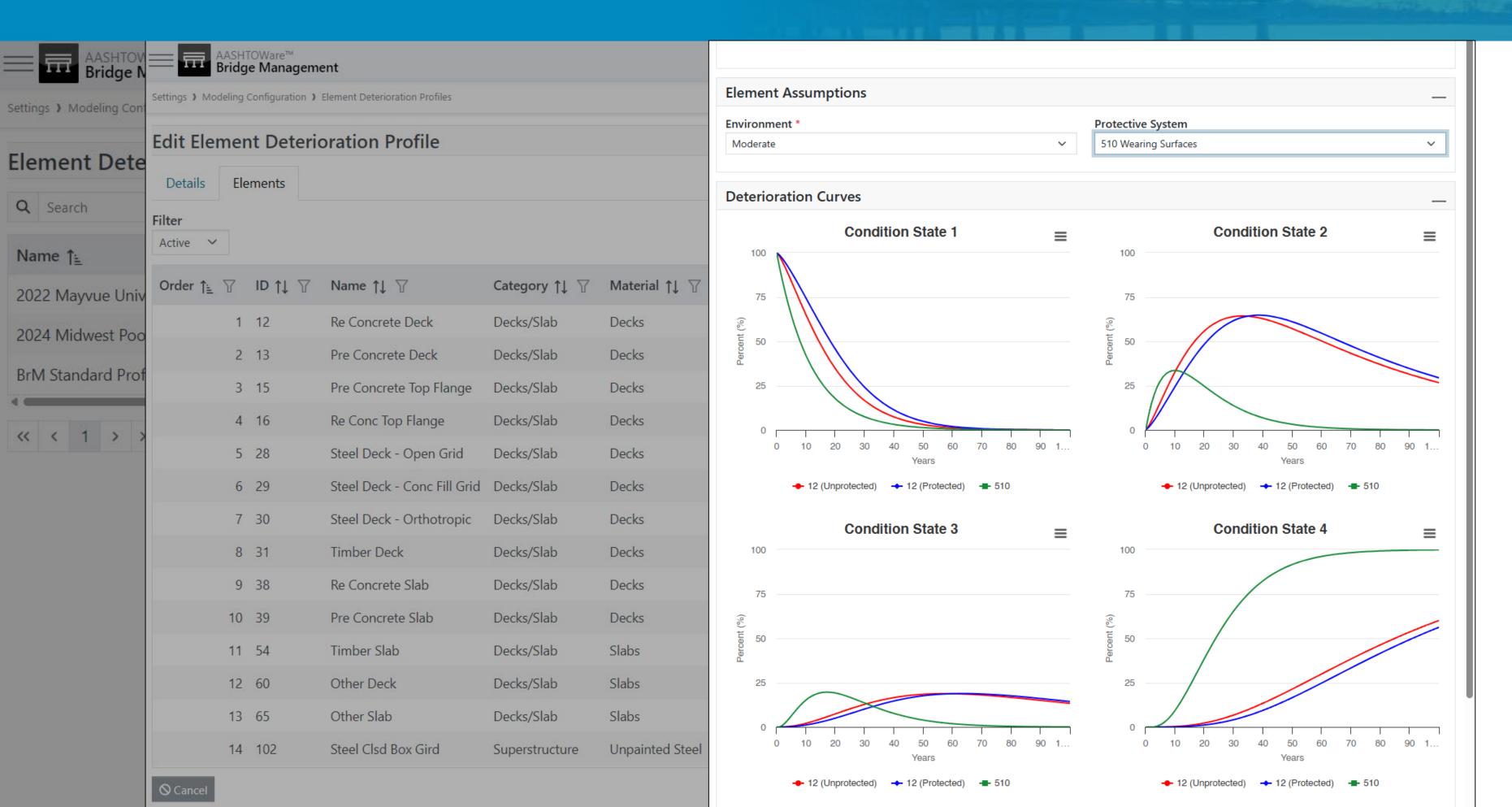


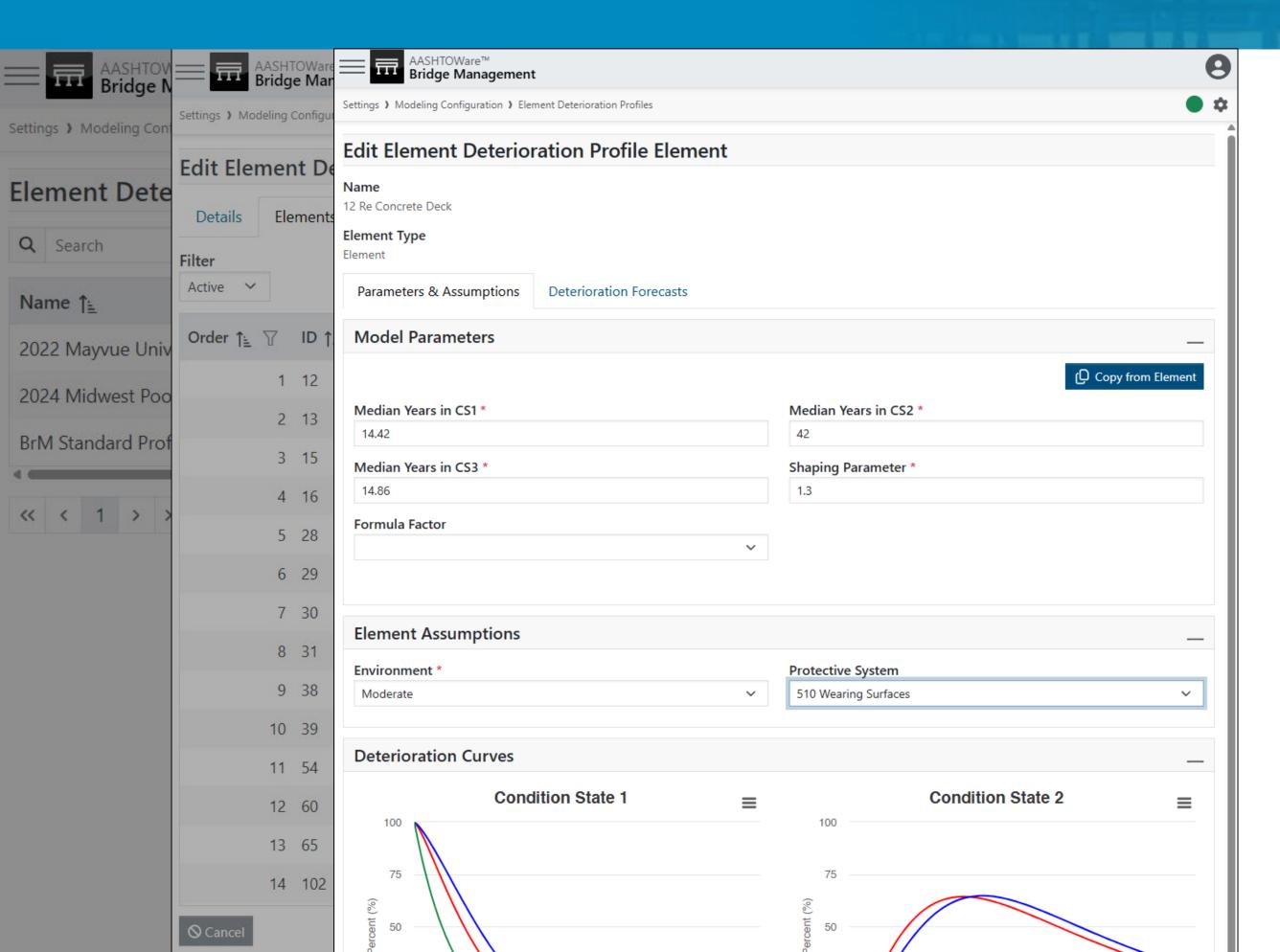




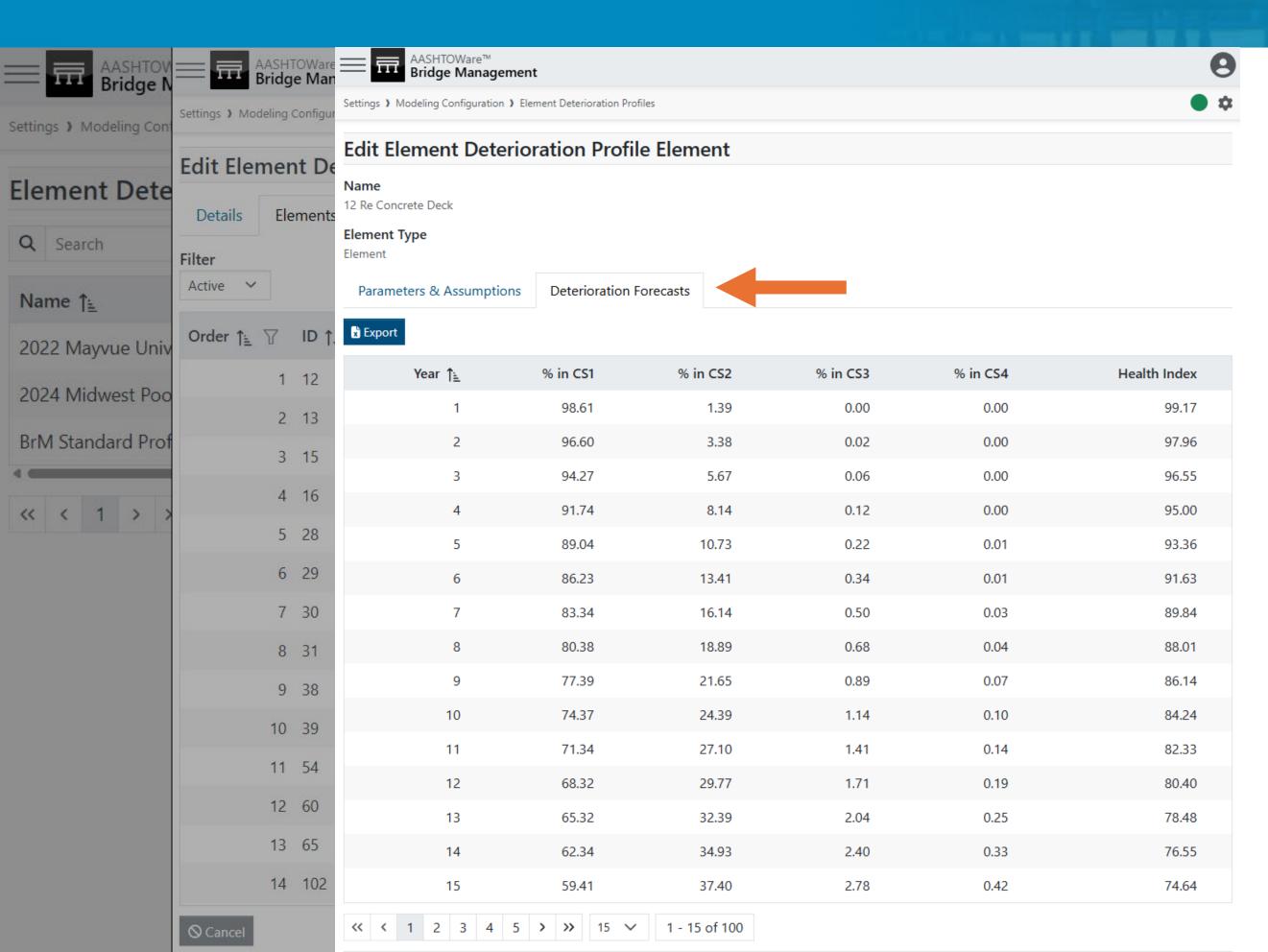


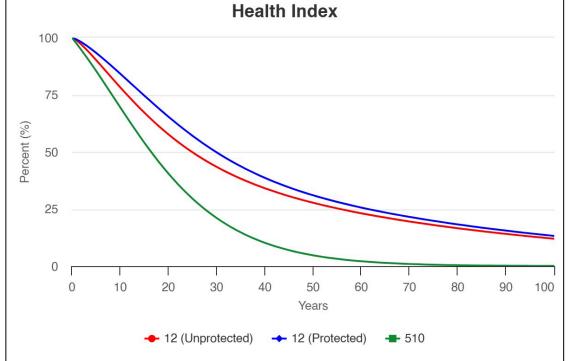




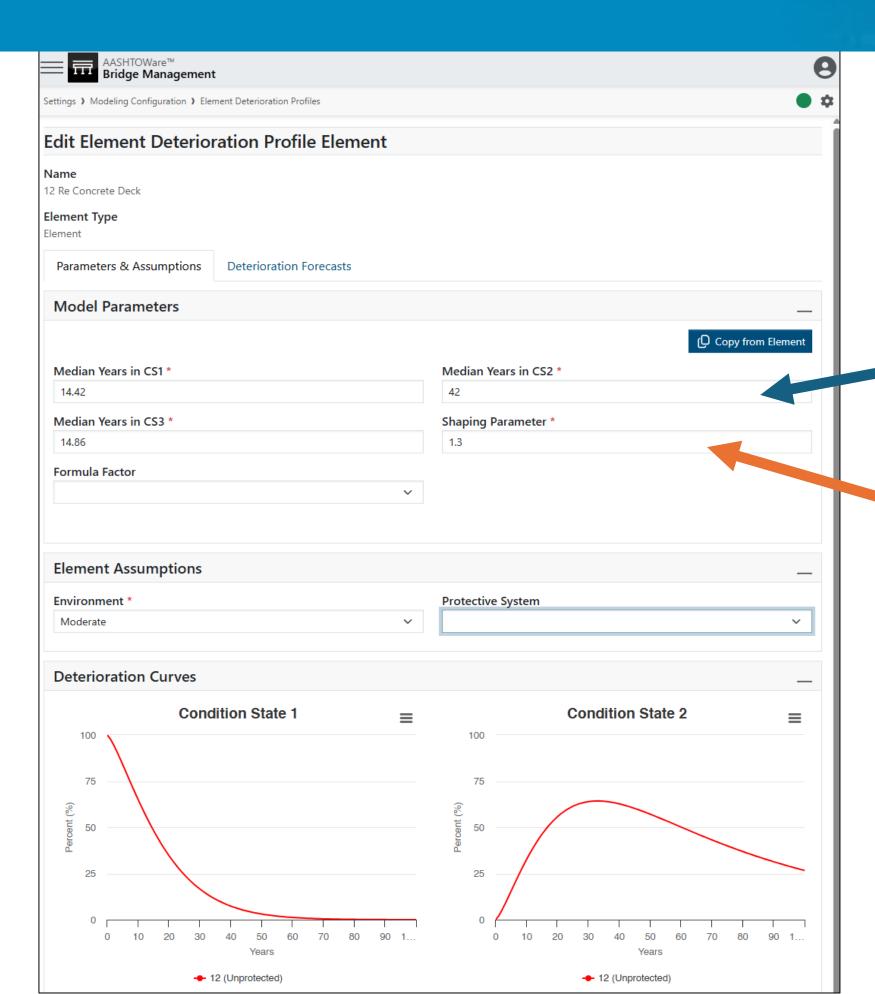










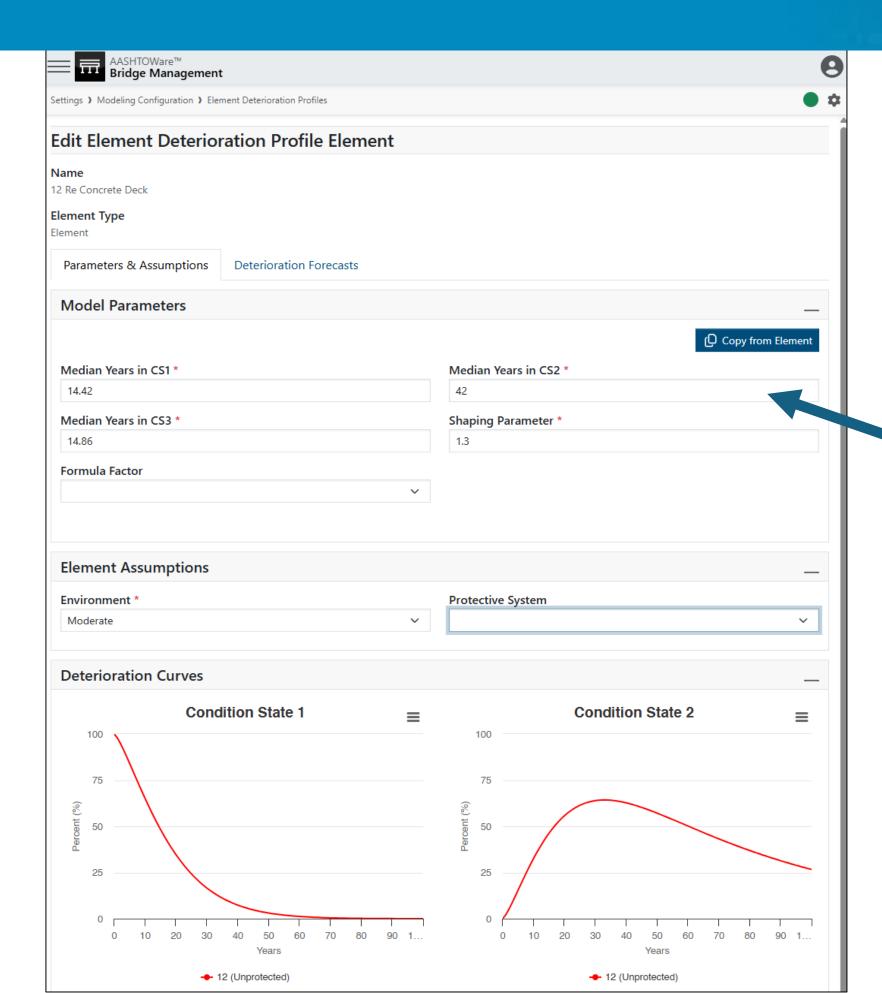


Configuring Element Deterioration

"Median years" Markovian Deterioration

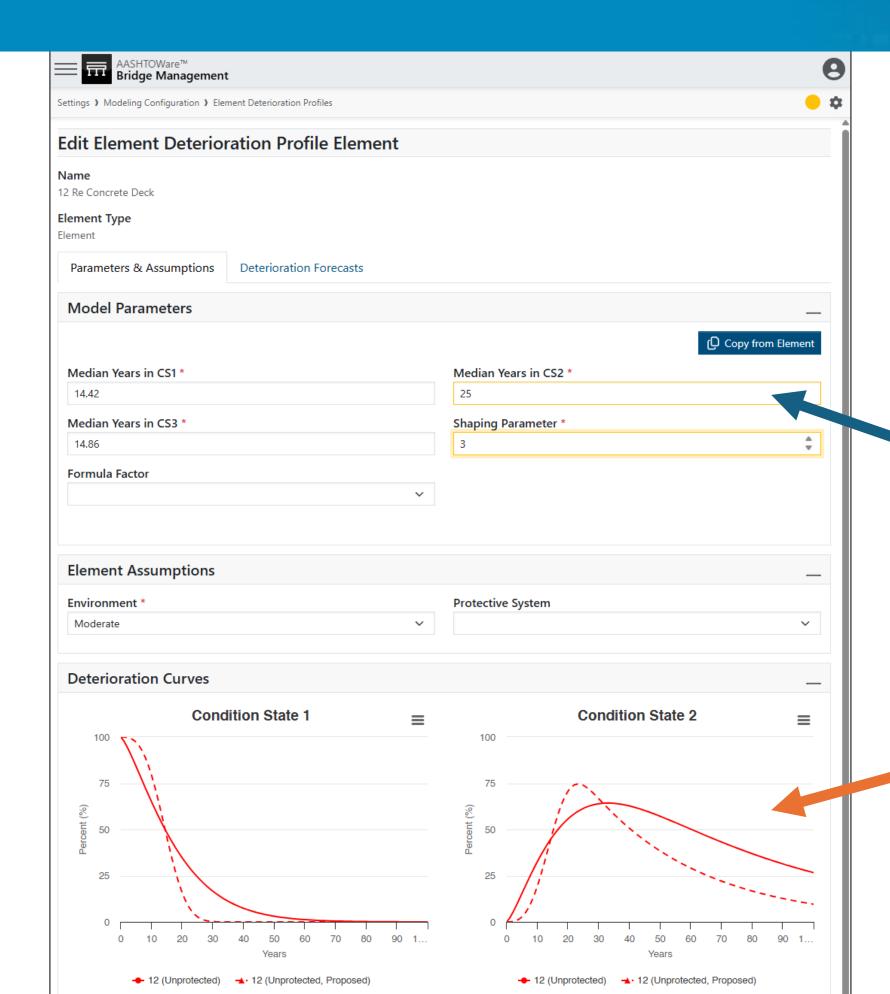
Shaping Parameter Weibull Deterioration





You don't need to have intuition about the half-life of CS2





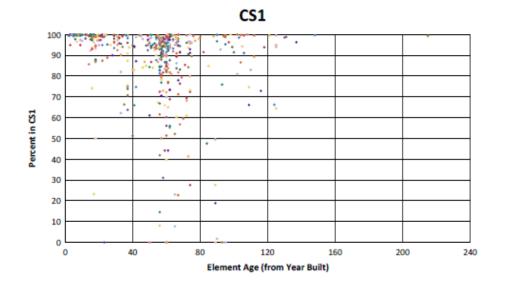
You don't need to have intuition about the half-life of CS2

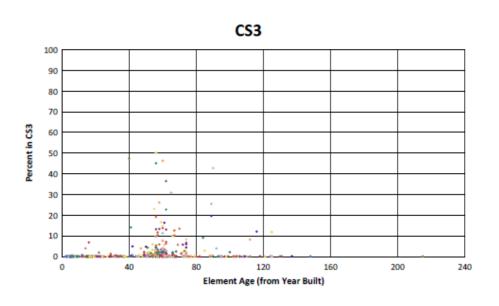
You can test what the resulting curve would look like.

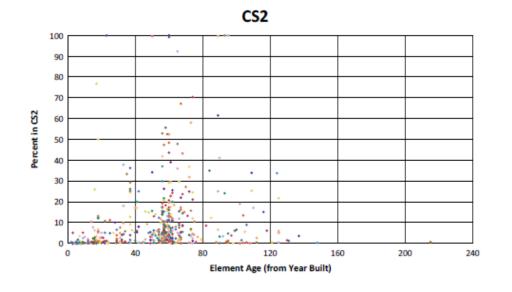


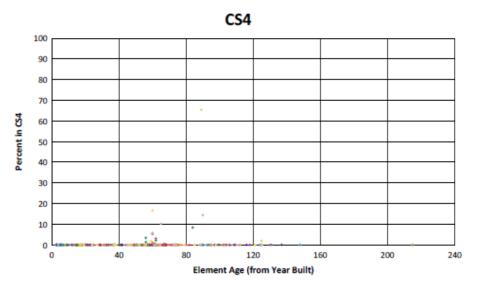
Configuring Element Deterioration for the first time:

- Focus on the most common elements
 - 12 Reinforced Concrete Deck
 - 107 Steel Open Girder
 - 109 Precast Open Concrete Girder
 - 215 Reinforced Concrete Abutment
 - 241 Reinforced Concrete Culvert
- Generate the Element Report (Insp009 Network Element Summary)









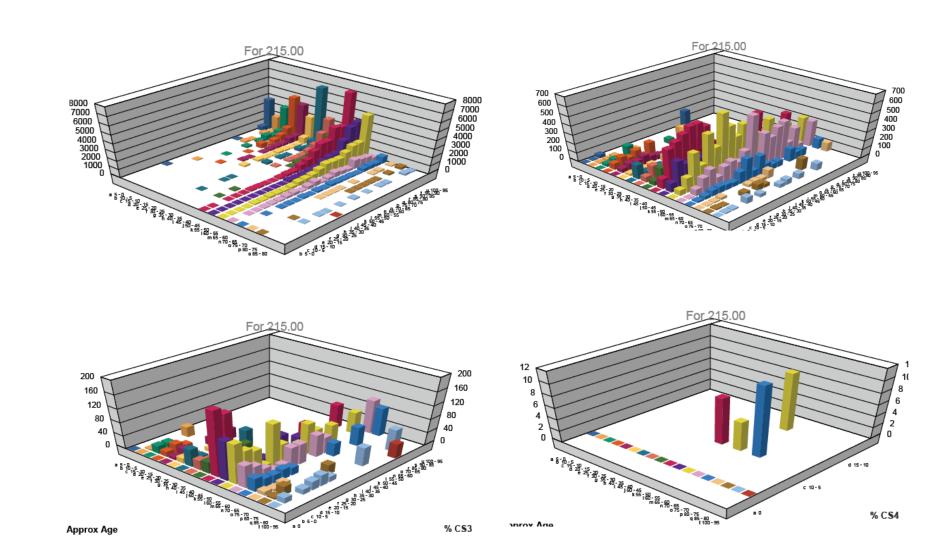


Configuring Element Deterioration for the first time:

- Focus on the most common elements
 - 12 Reinforced Concrete Deck
 - 107 Steel Open Girder
 - 109 Precast Open Concrete Girder
 - 215 Reinforced Concrete Abutment
 - 241 Reinforced Concrete Culvert
- Generate the Element Report (Insp009 Network Element Summary)
- Use other custom reports or ways to see data

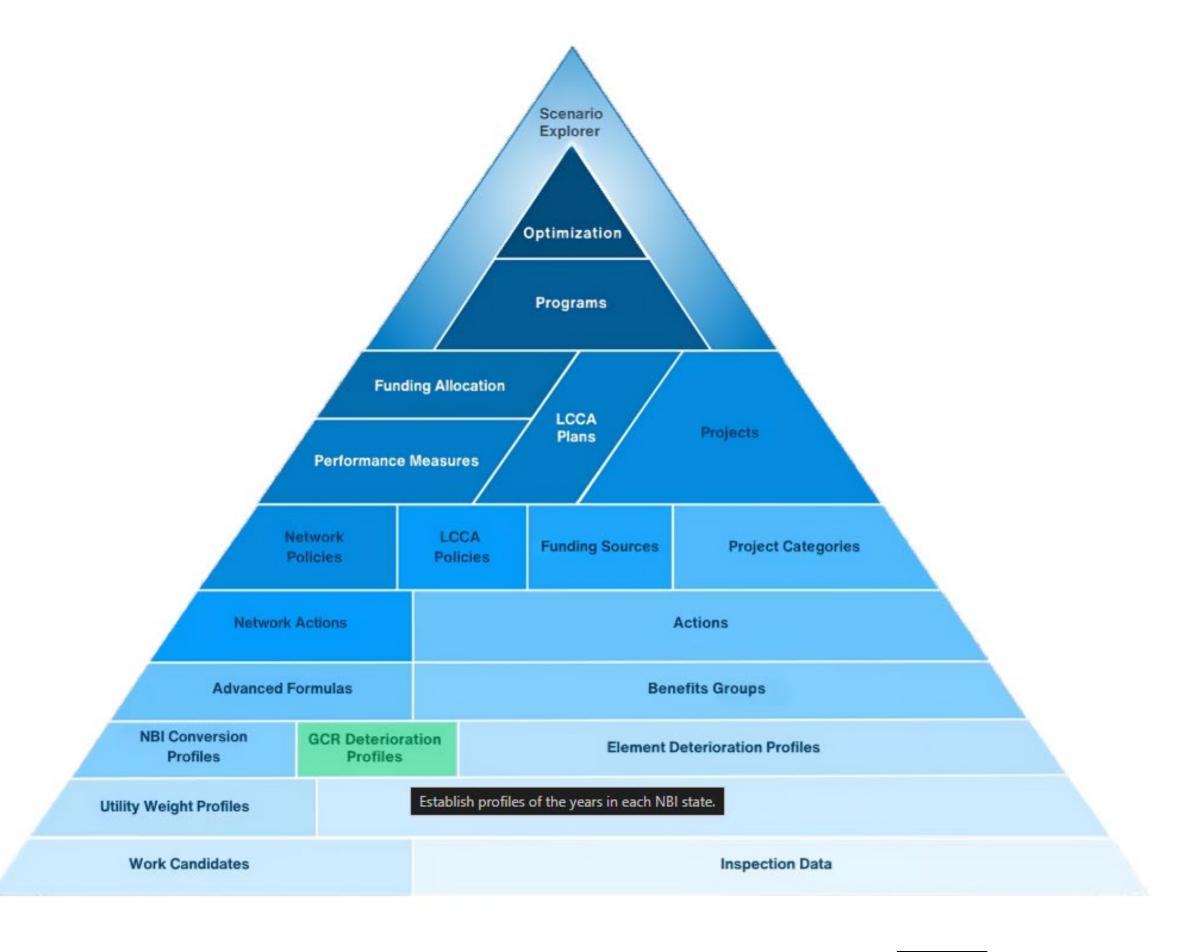
Easy mode:

• Leave deterioration rates until later. The defaults will work for your first passes.

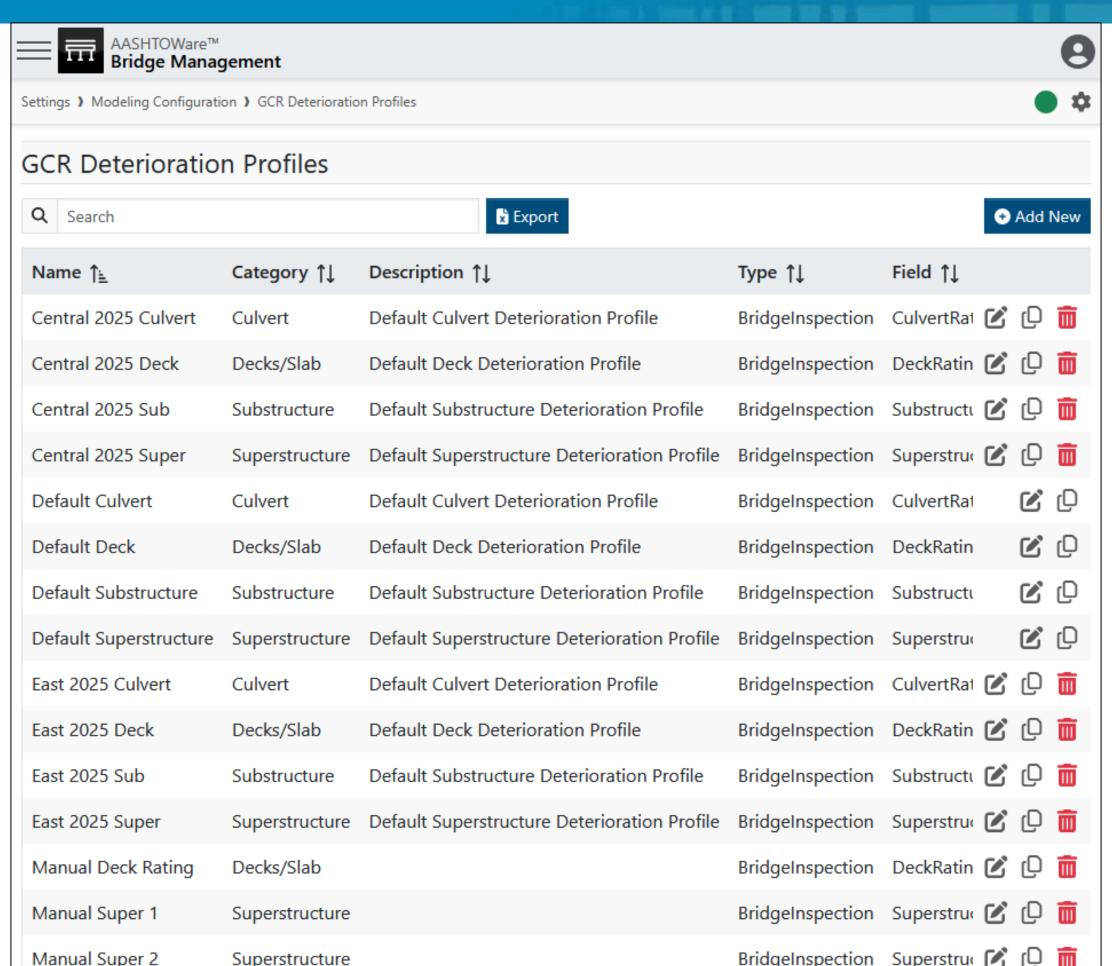




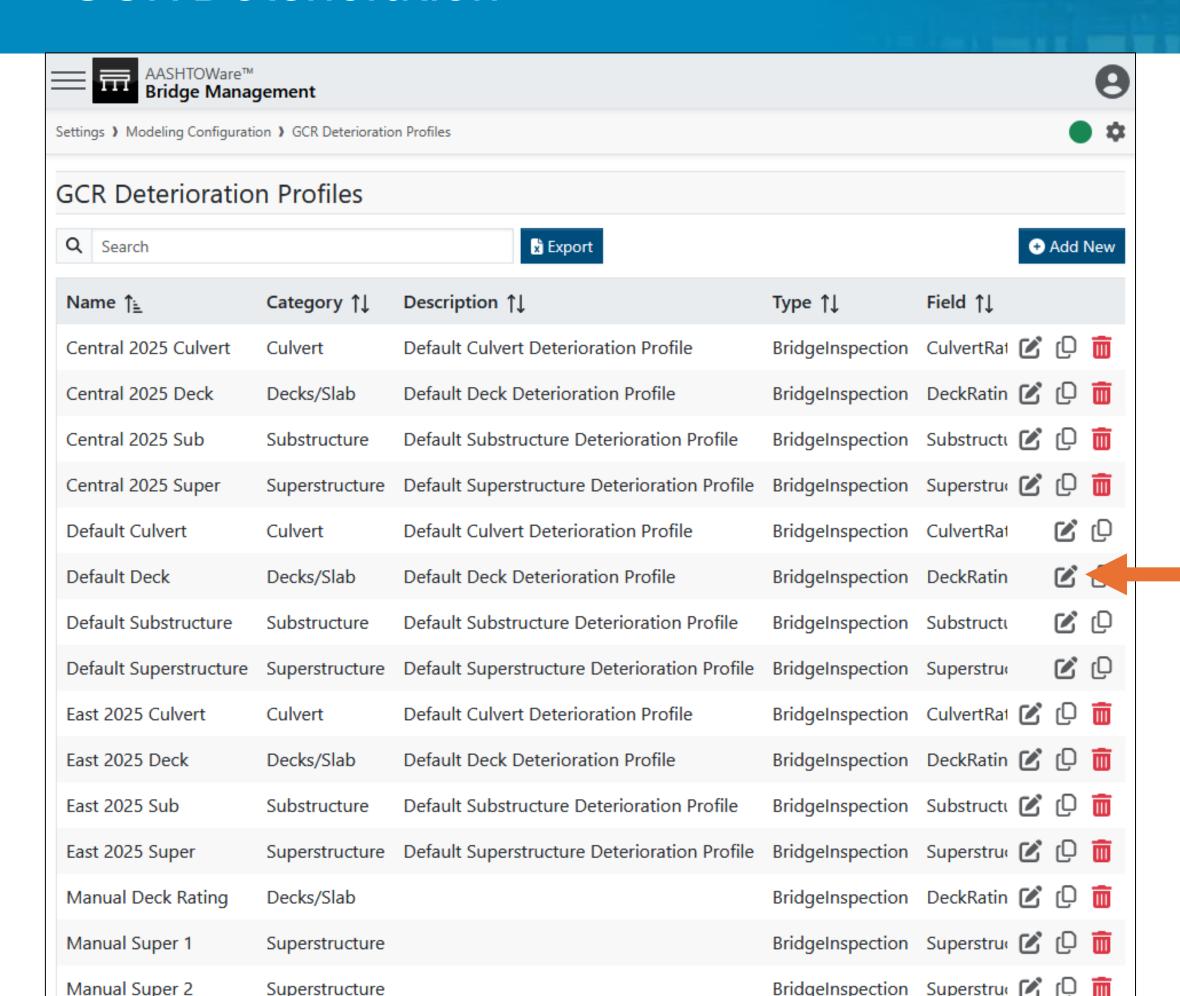
GCR Deterioration Profiles



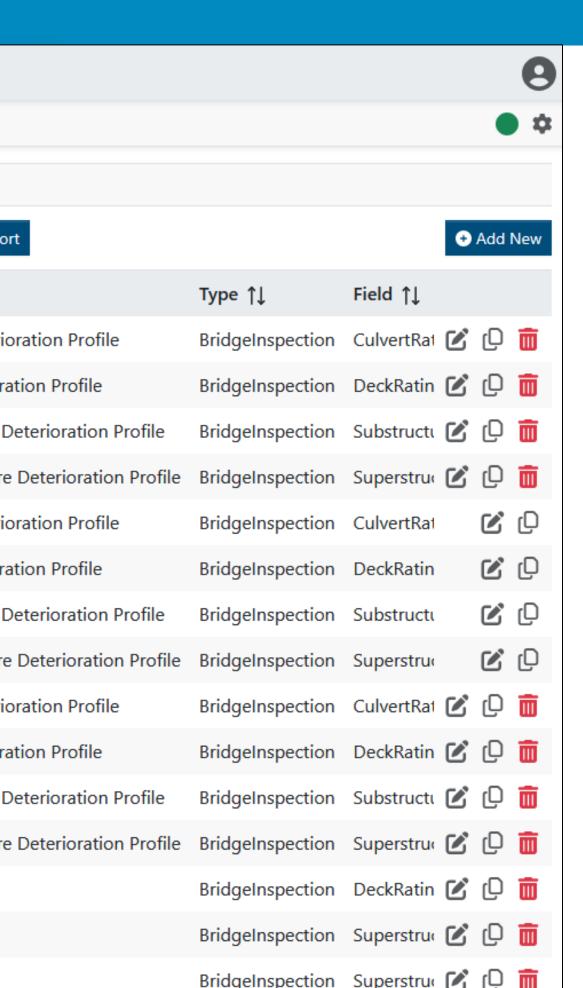


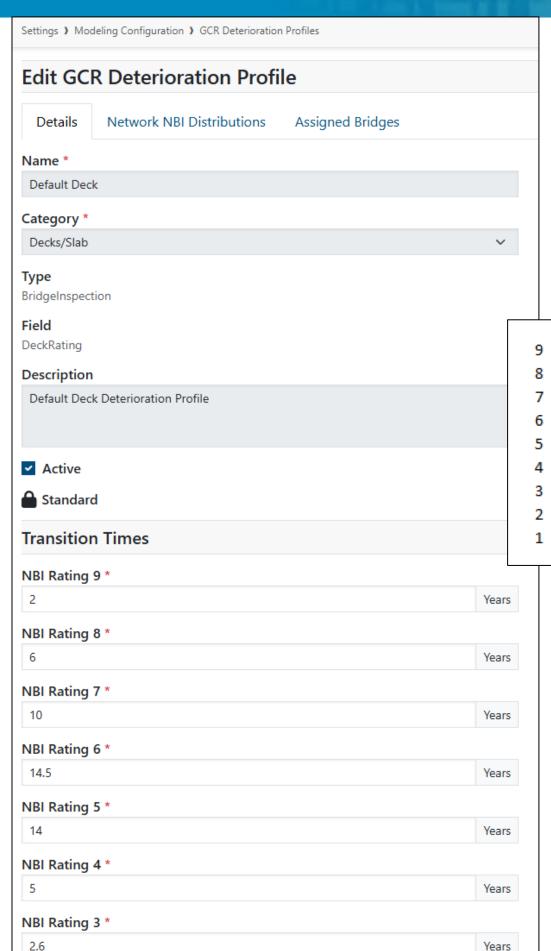


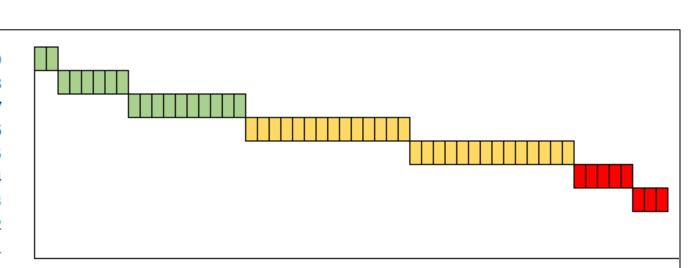




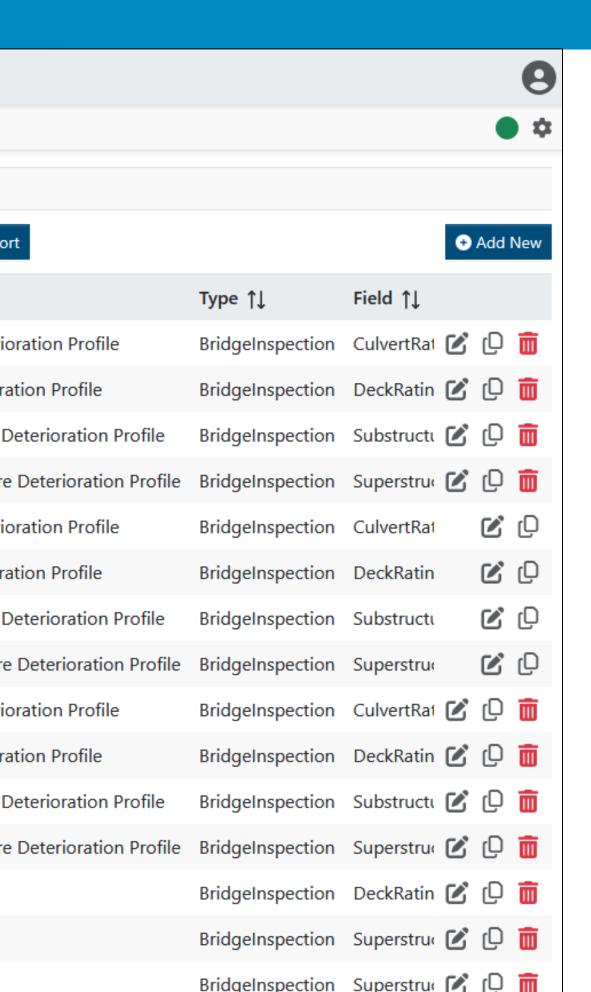
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L-1;+ C.C.	D D - t - u' - u - t' - u - Du - t'	1-	
East GC	R Deterioration Profi	ie	
Details	Network NBI Distributions	Assigned Bridges	
Name *			
Default Dec	:k		
Category *			
Decks/Slab			~
Type Bridgelnspec	tion		
Field DeckRating			
Description	1		
Default Dec	k Deterioration Profile		4
Active			
Standar	d		
Transitio	n Times		
NBI Rating	9 *		
2			Years
NBI Rating	8 *		
6			Years
NBI Rating	7 *		
10			Years
NBI Rating	6*		
14.5			Years
NBI Rating	E *		
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NBI Rating	3 *		V
2.6			Years



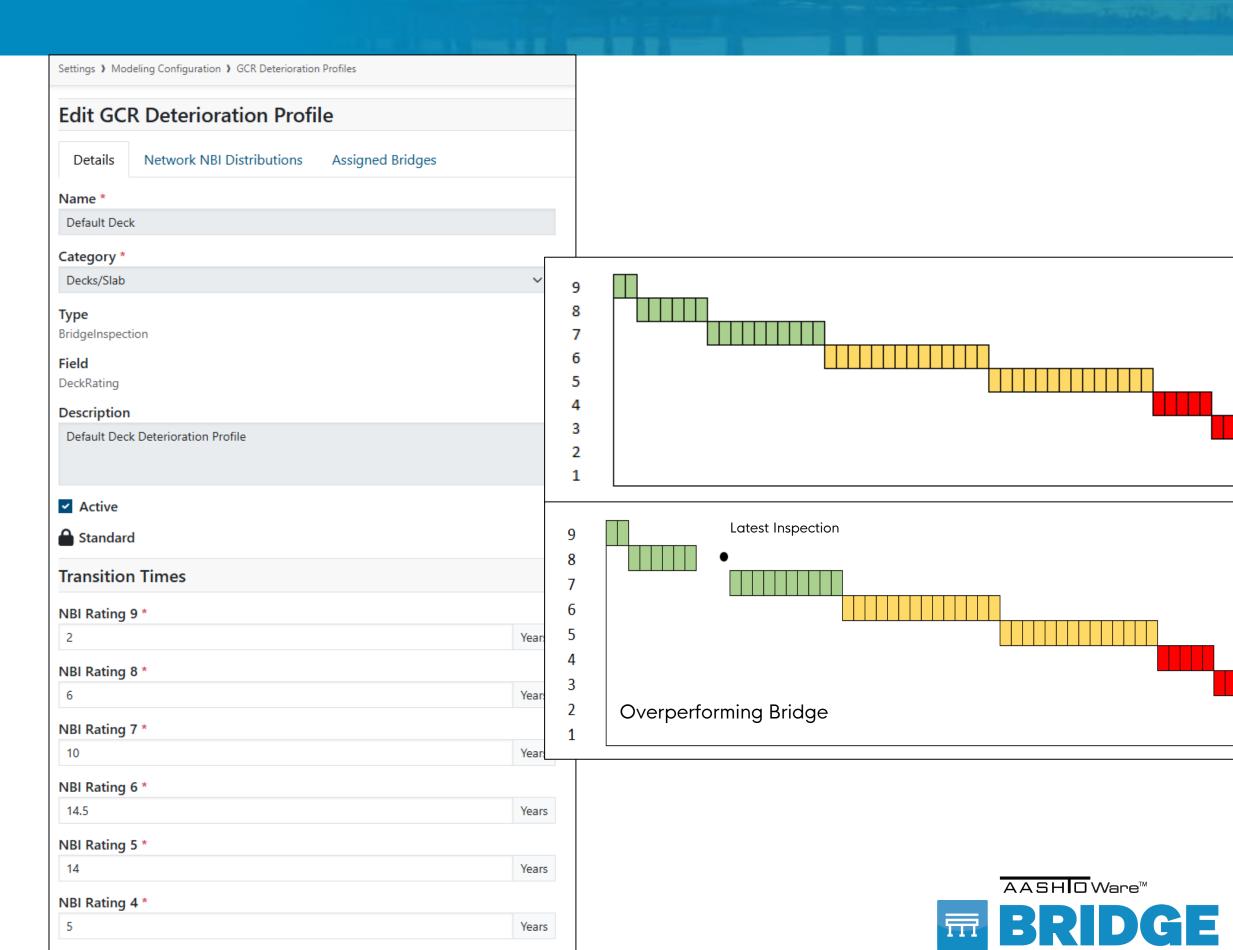




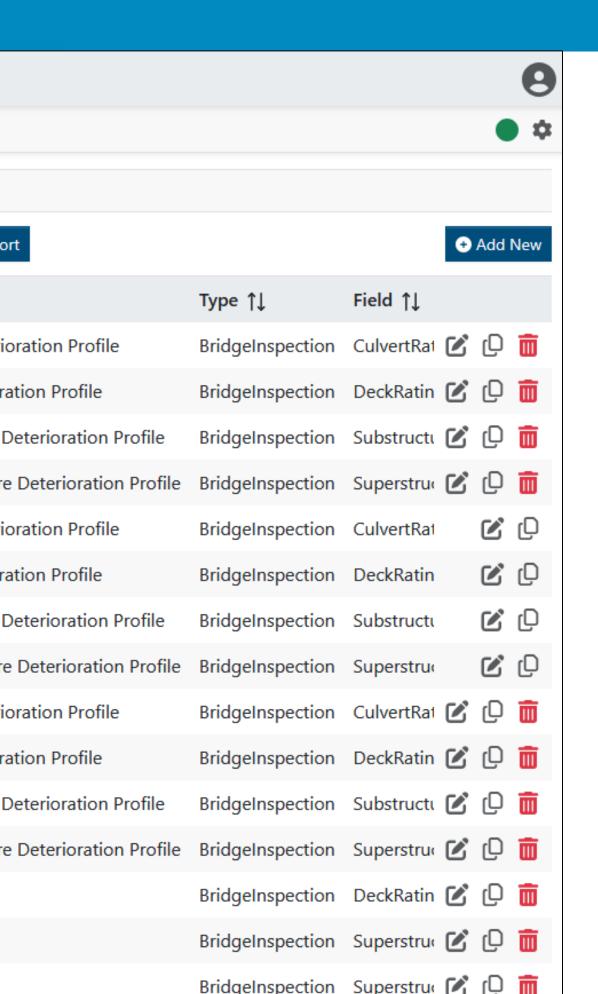


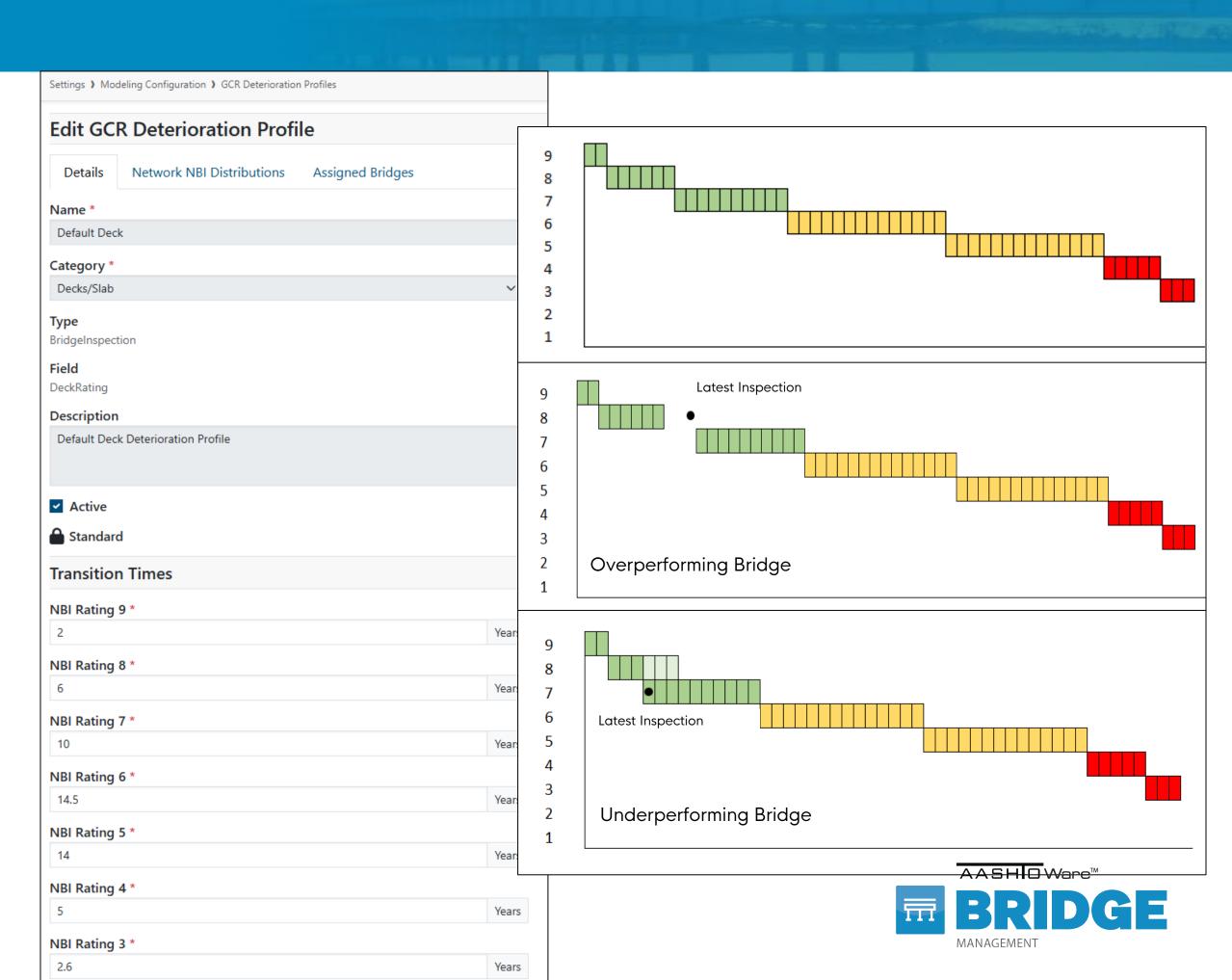


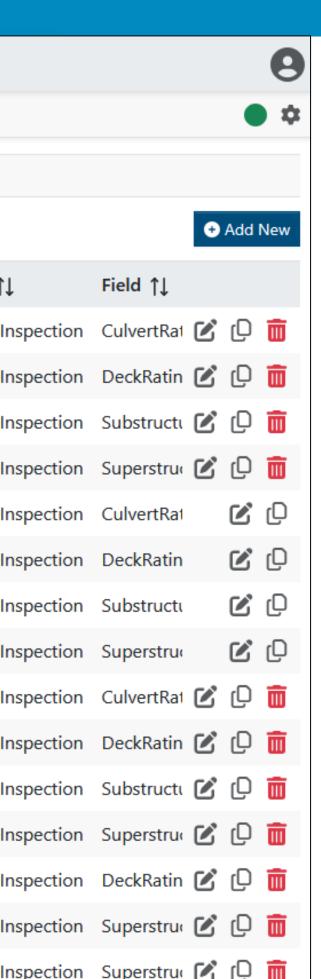
NBI Rating 3 *

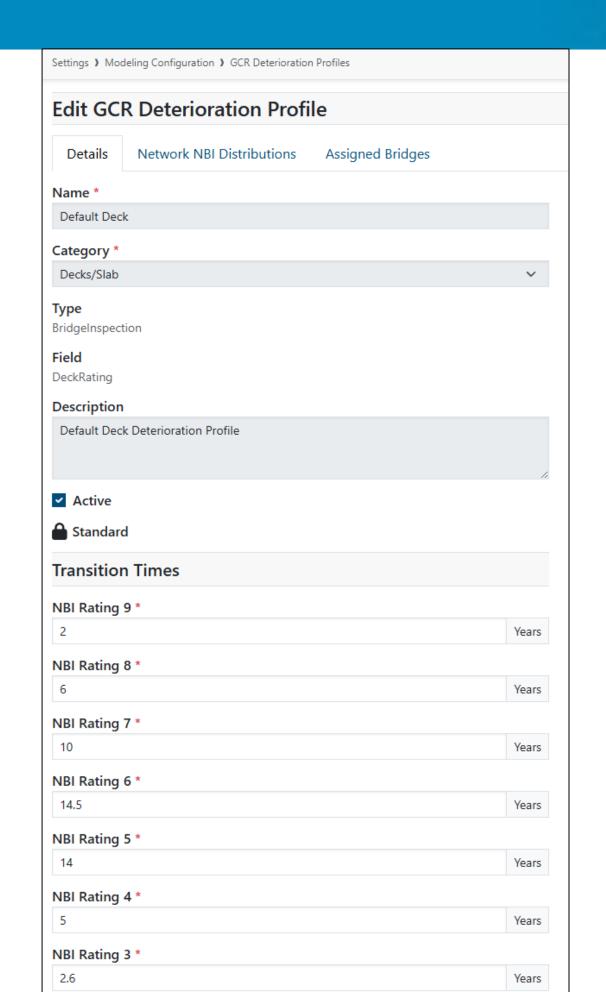


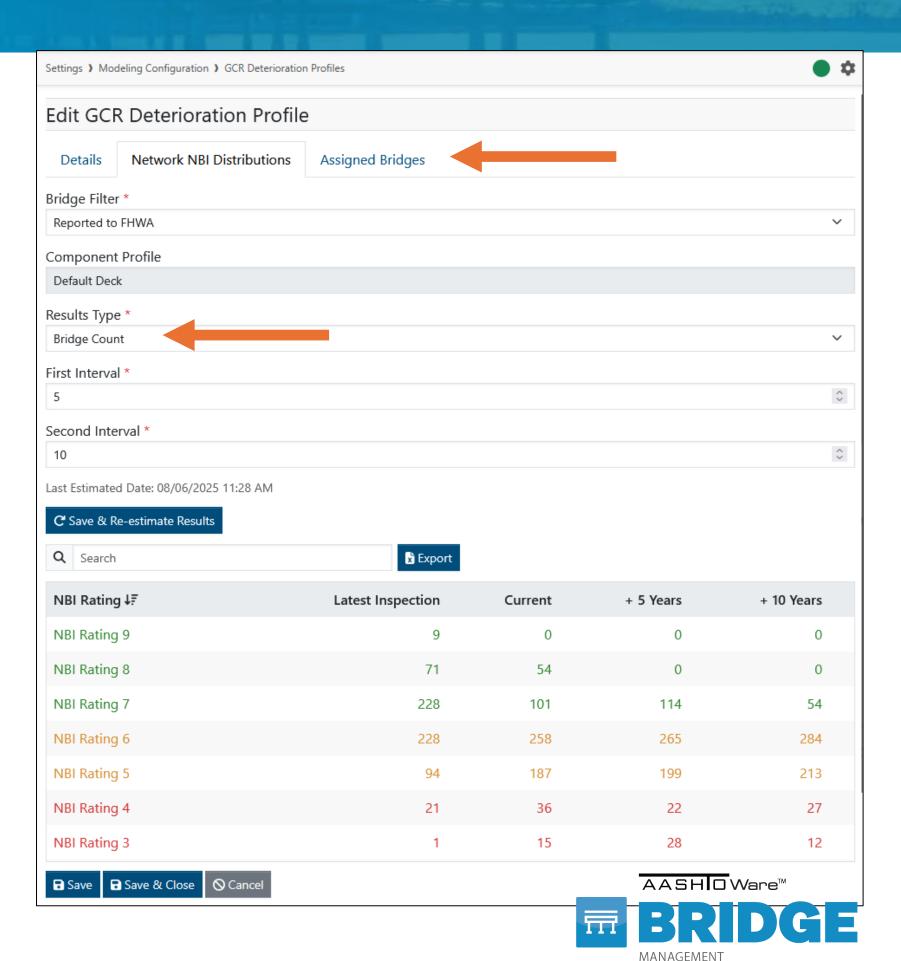
Years

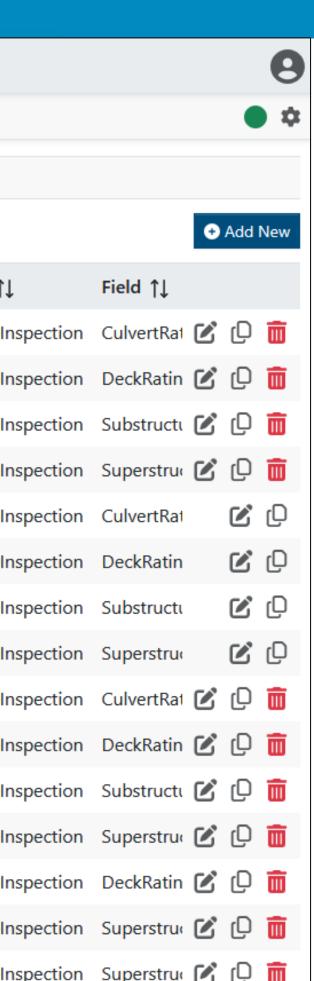


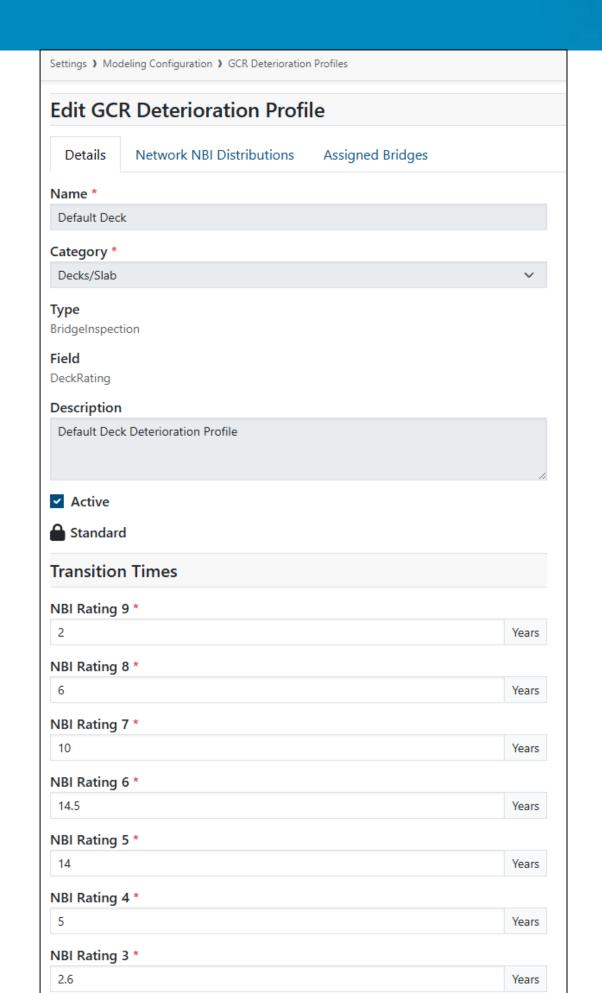


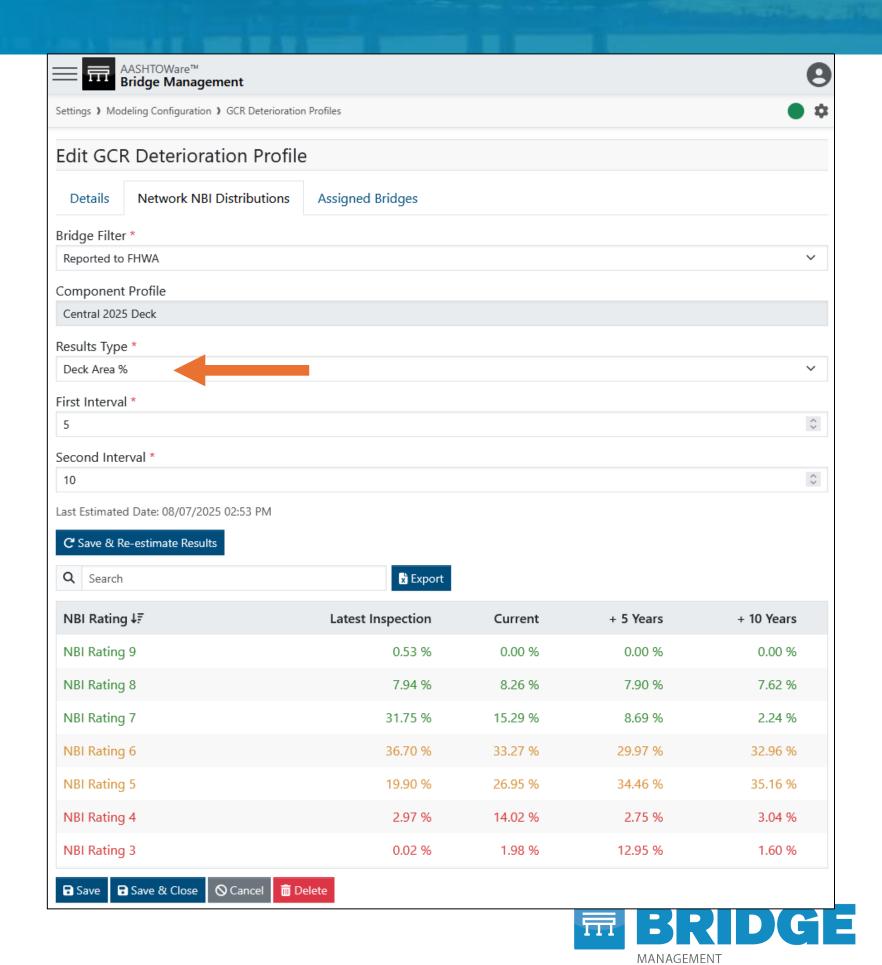


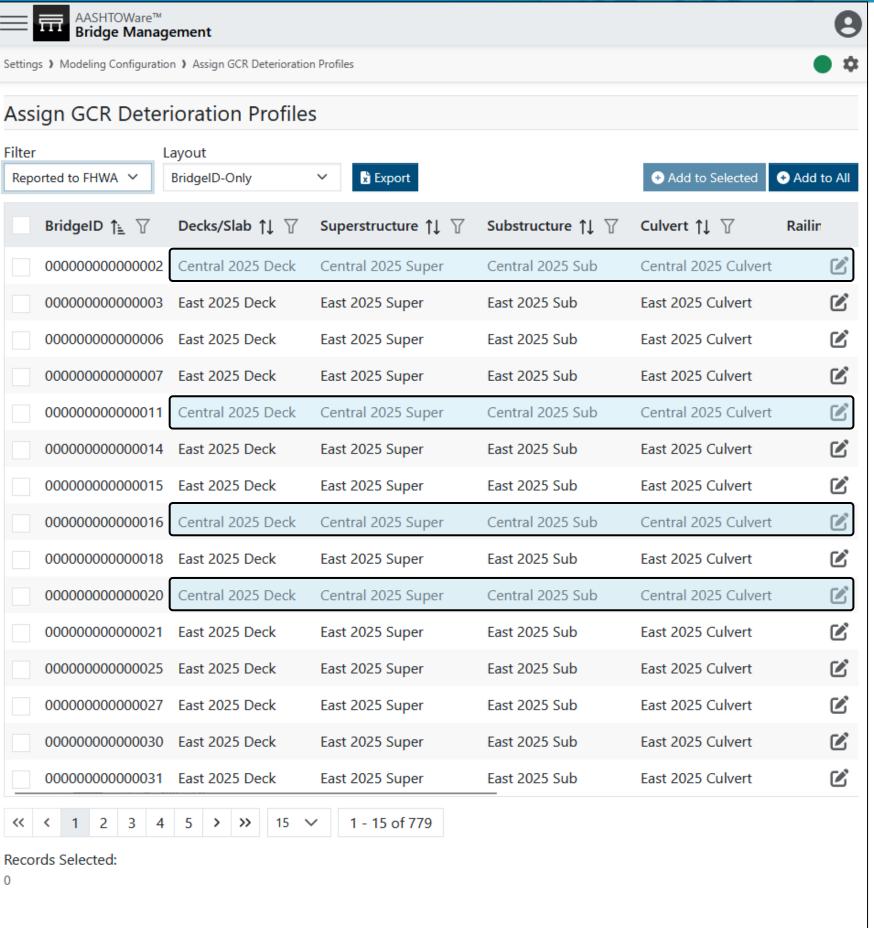














Different GCR Deterioration Profiles can be assigned to different structures.

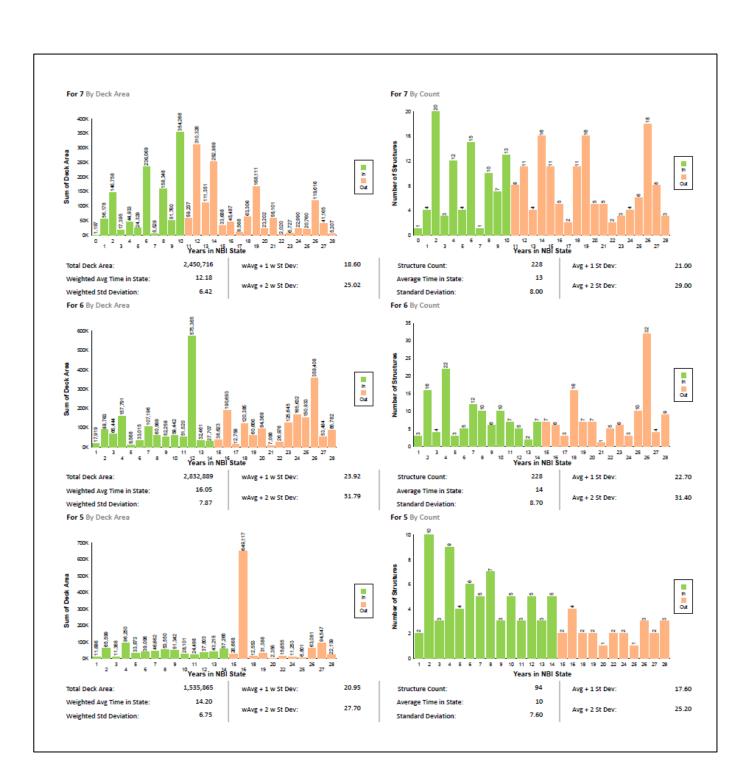


Configuring GCR Deterioration for the first time:

- You will want as much inspection history as possible.
- Run the Time in State report in BrM

Easy mode:

 Use the Time in State Report's Weighted Average + 2 Standard Deviations for your transition times.



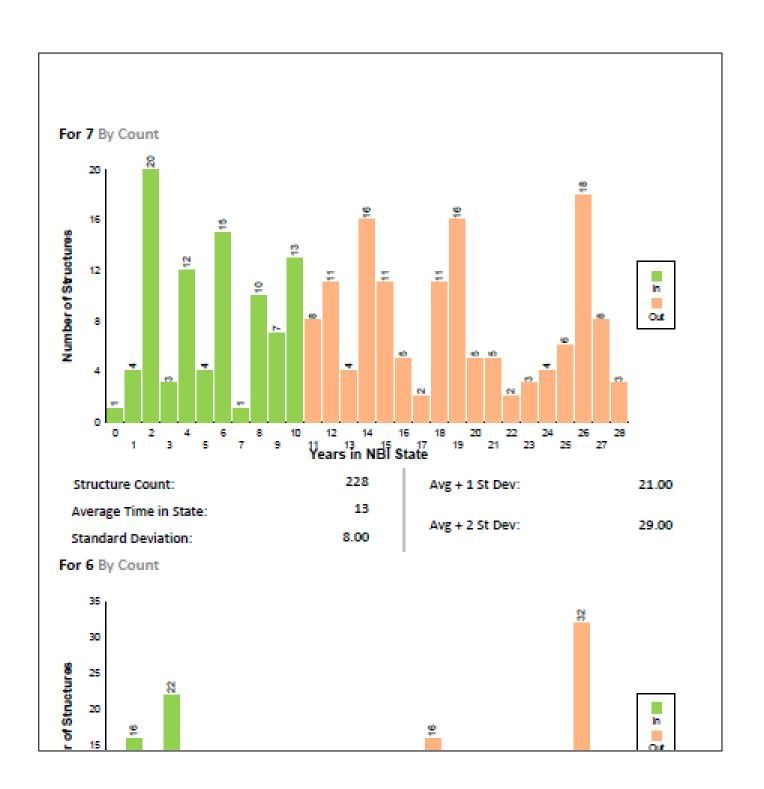


Configuring GCR Deterioration for the first time:

- You will want as much inspection history as possible.
- Run the Time in State report in BrM

Easy mode:

 Use the Time in State Report's Weighted Average + 2 Standard Deviations for your transition times.





Configuring GCR Deterioration for the first time:

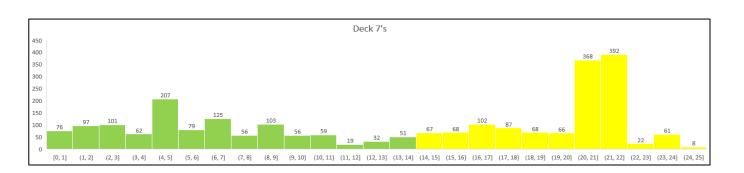
• The "First Year Problem" aka the "cliff"

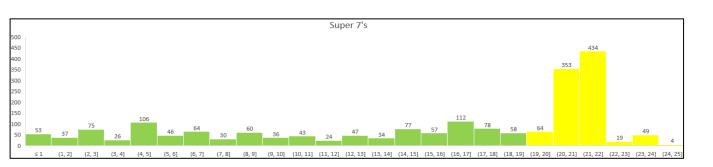
Easy mode:

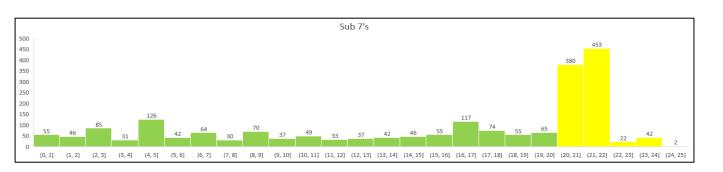
 Use the Time in State Report's Weighted Average + 2 Standard Deviations for your transition times.

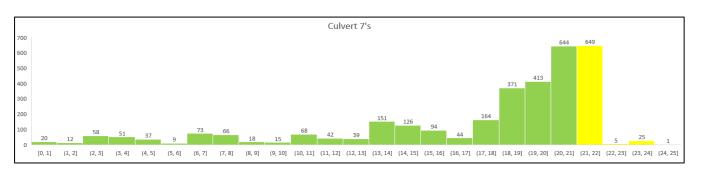
Advanced mode:

Many curves to break up deterioration groups.

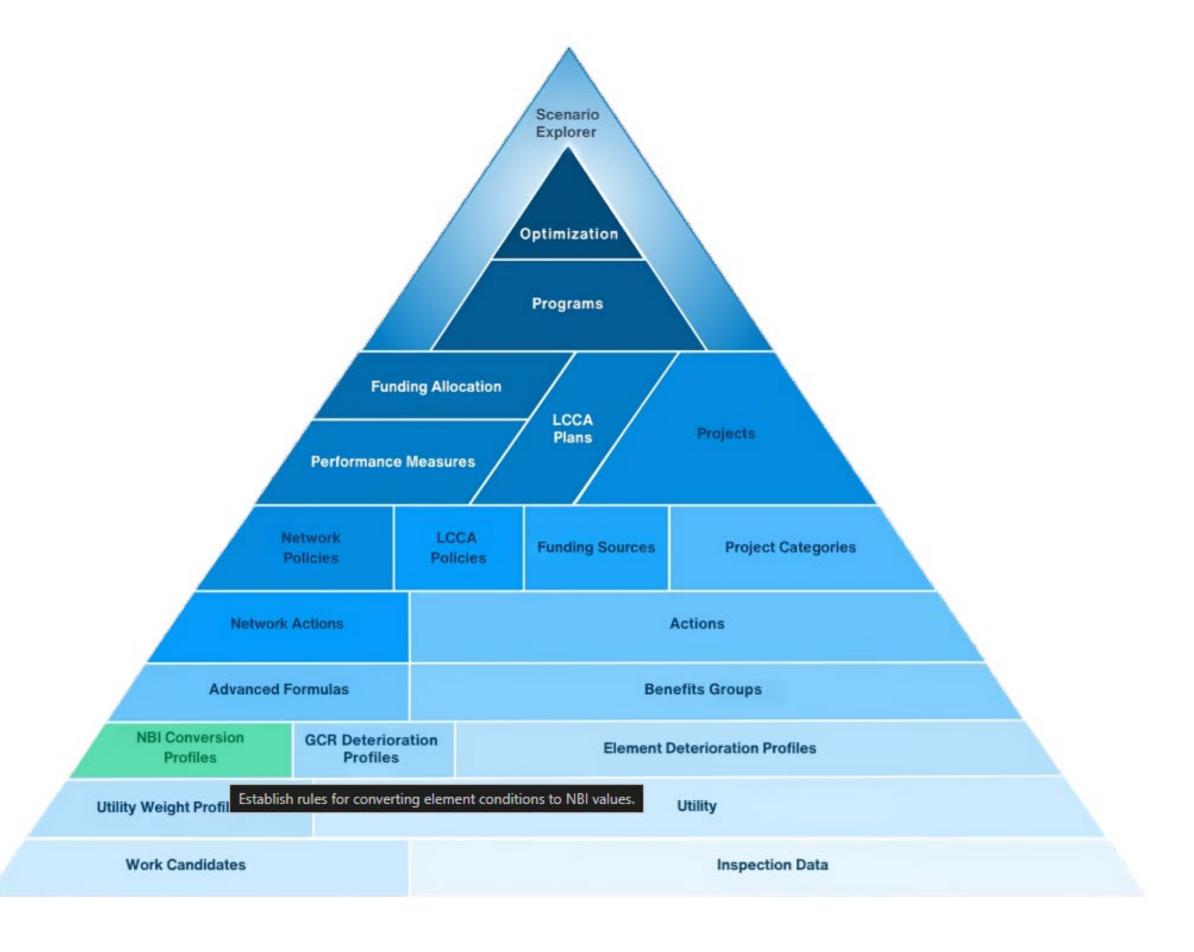




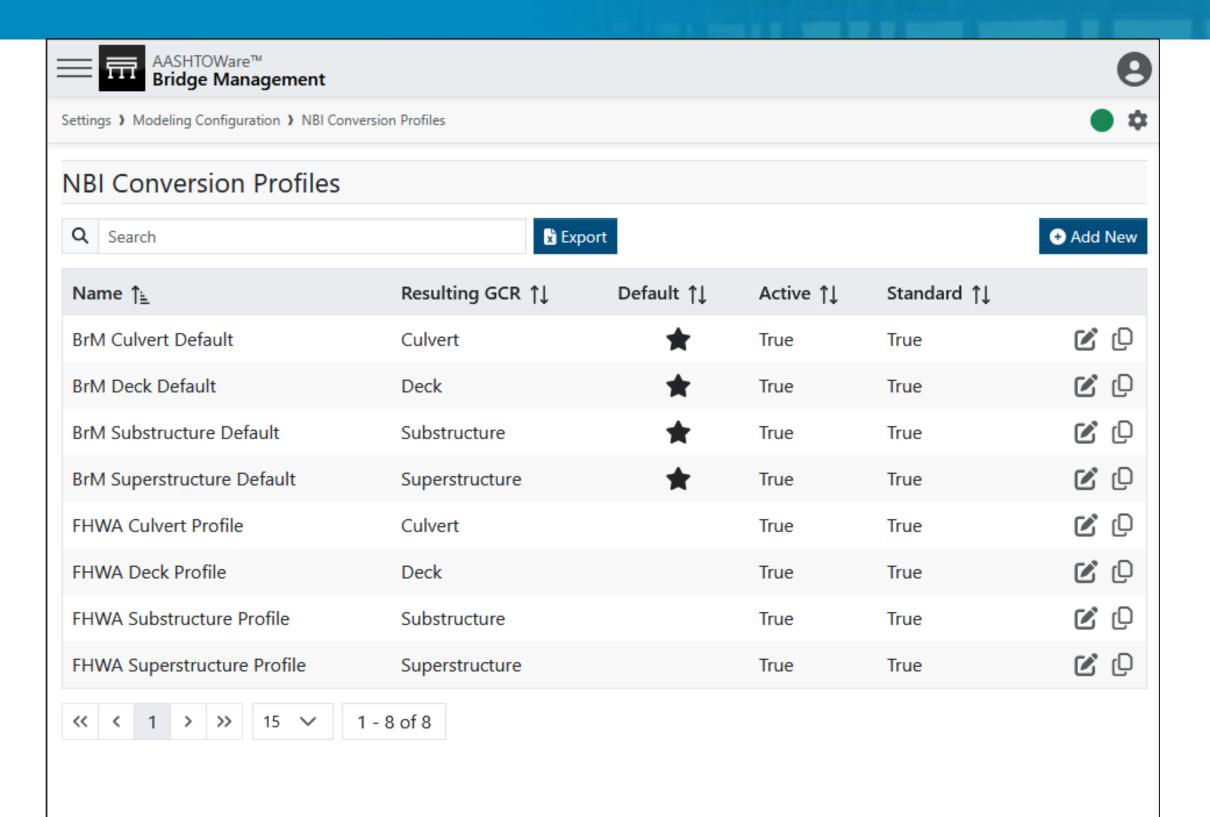




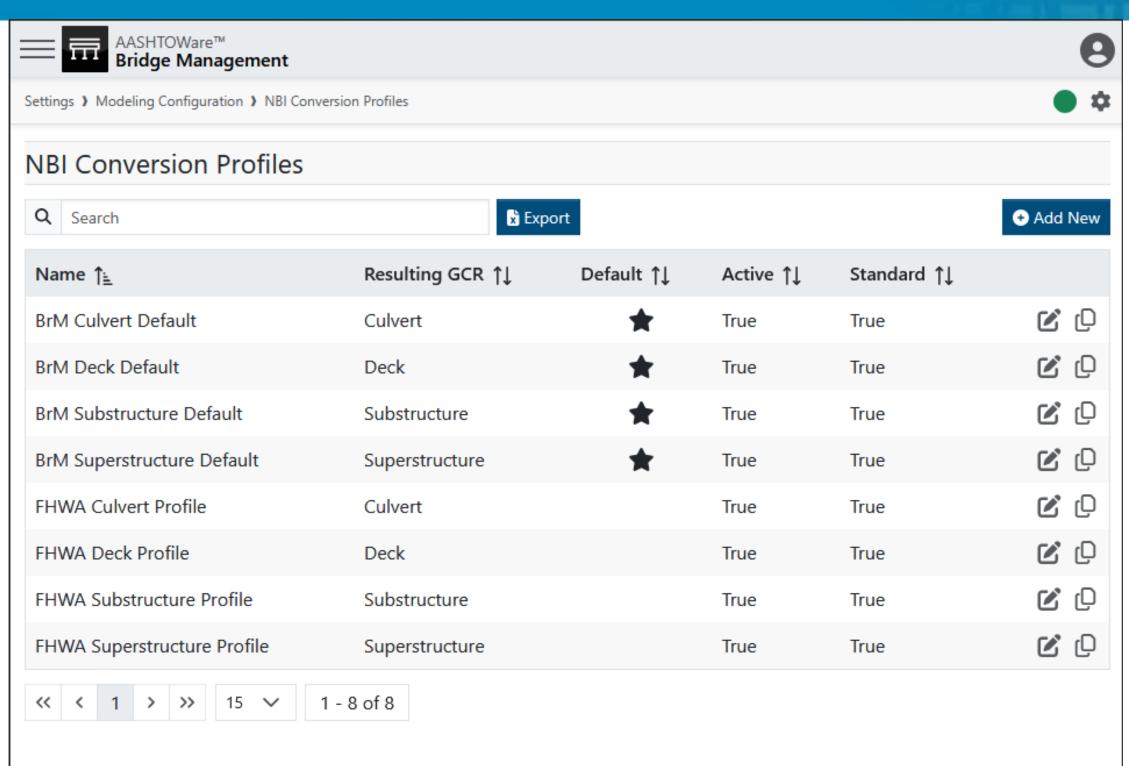


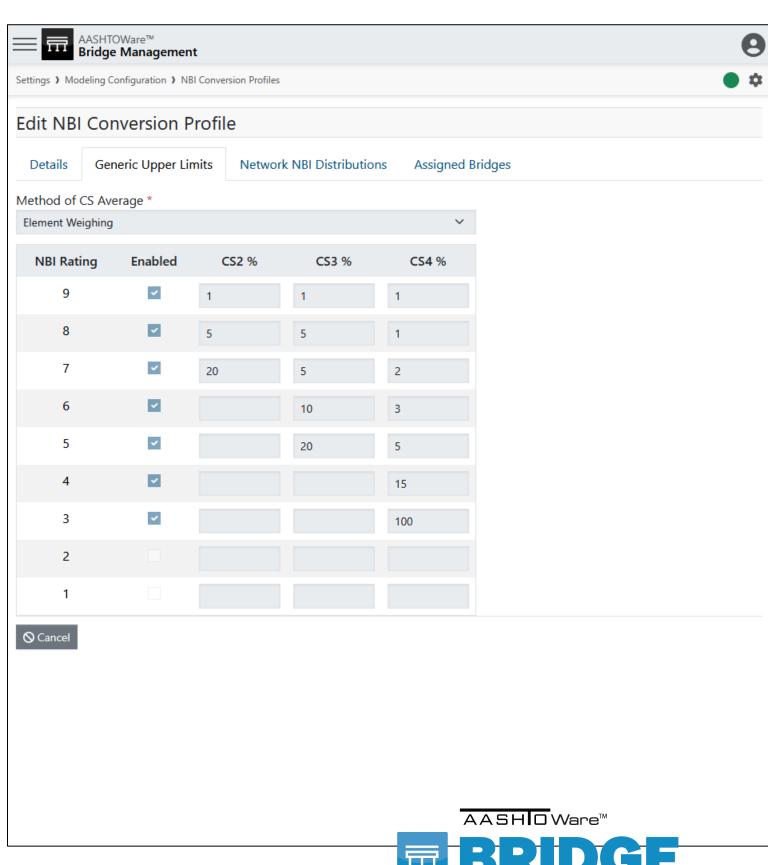


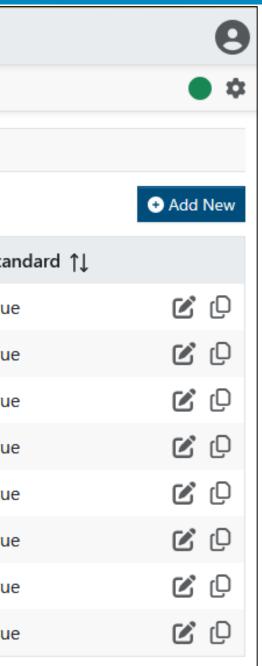


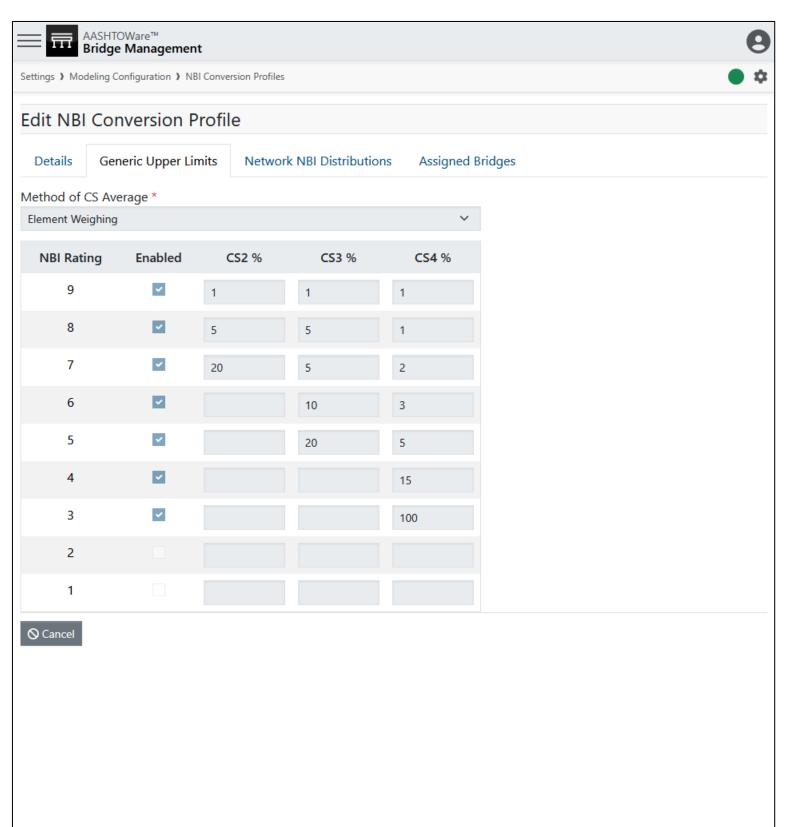


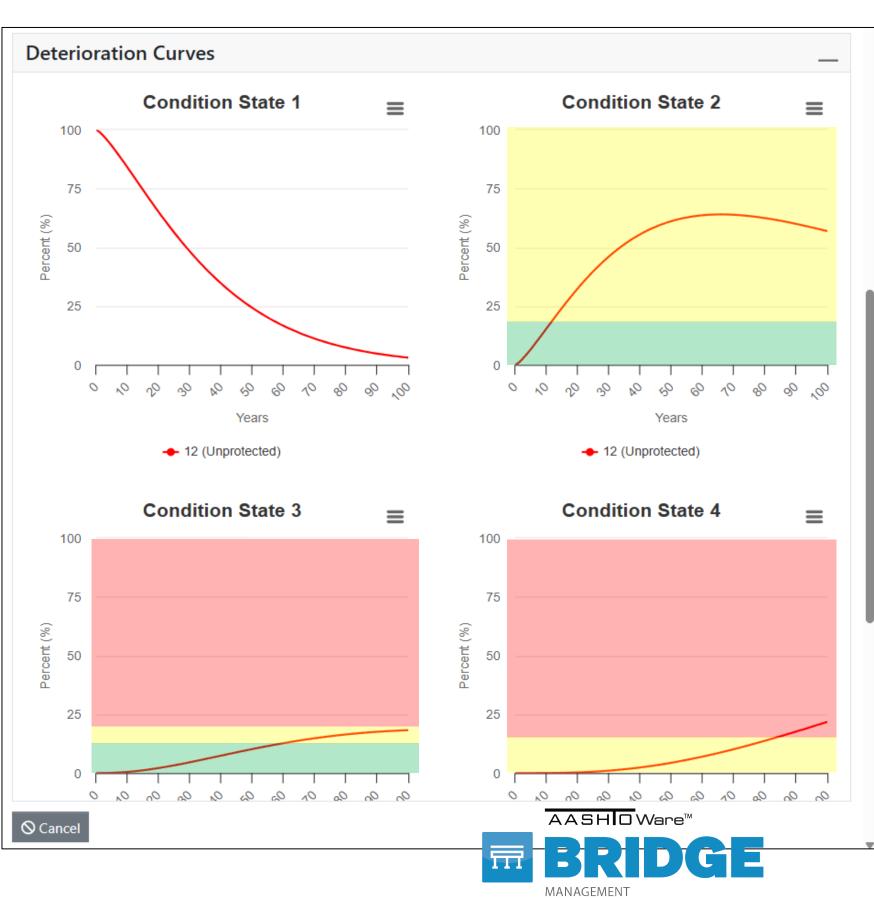


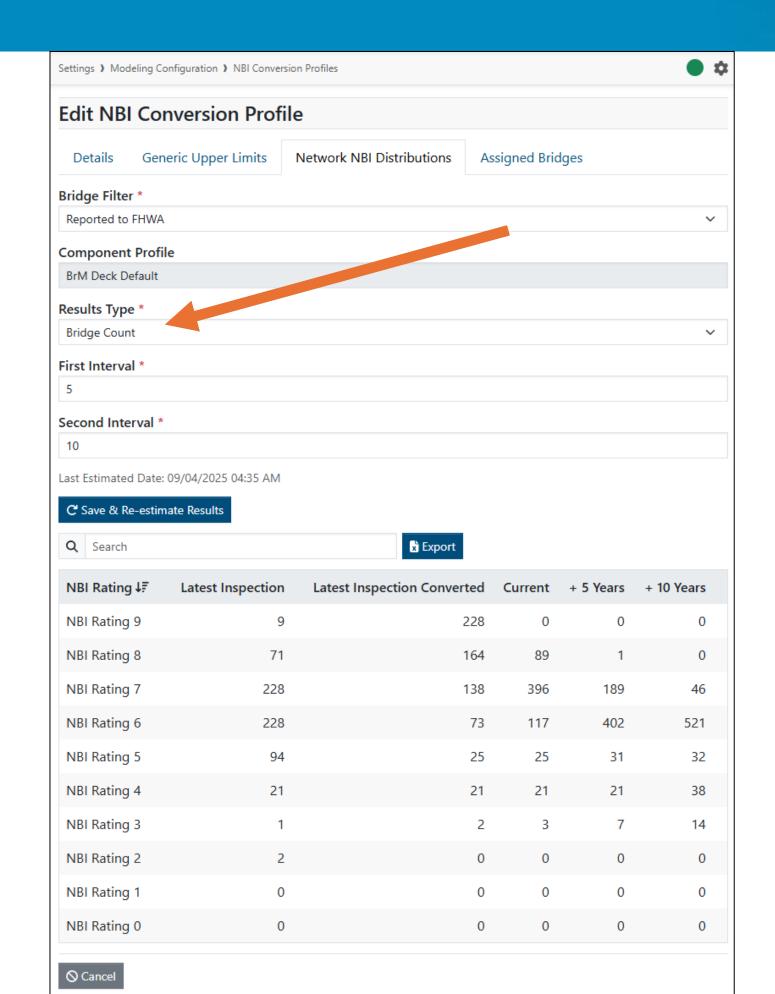


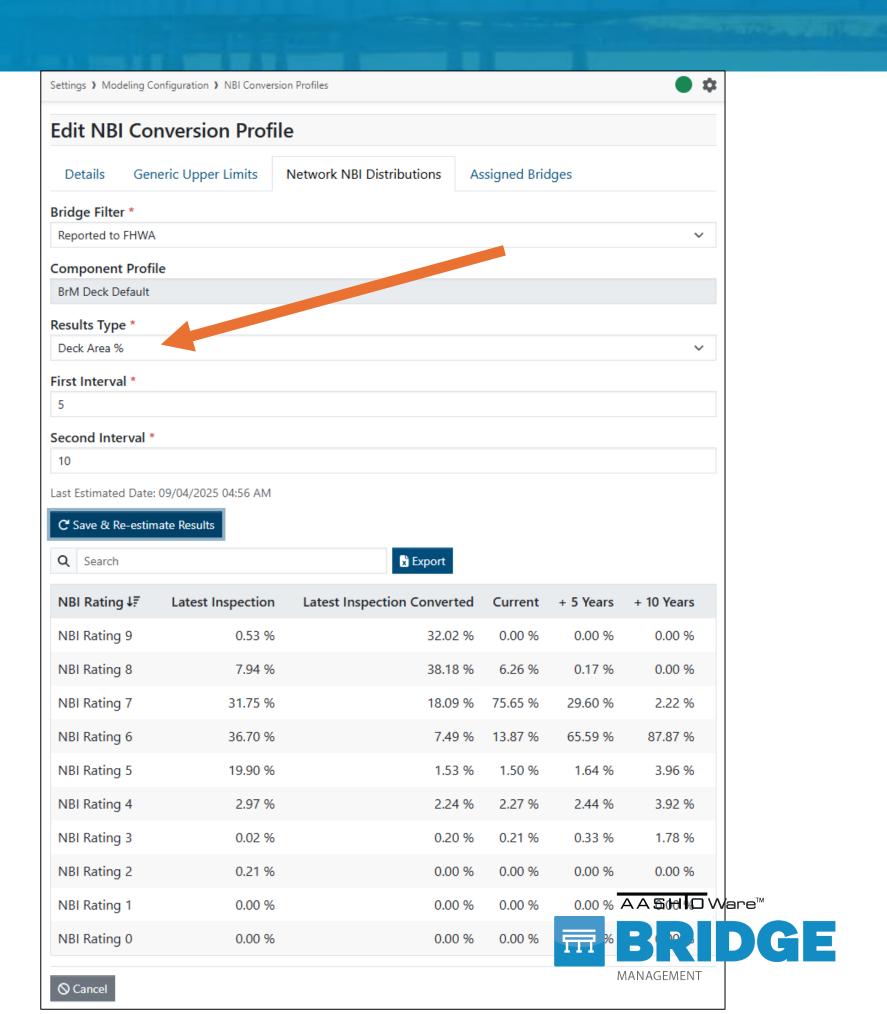












Configuring NBI Conversion Profiles for the first time:

- Run the NBI Element Conversion report (included with BrM) and watch where the main drop-offs are.
- Use the Network NBI Distributions profile estimation tool.

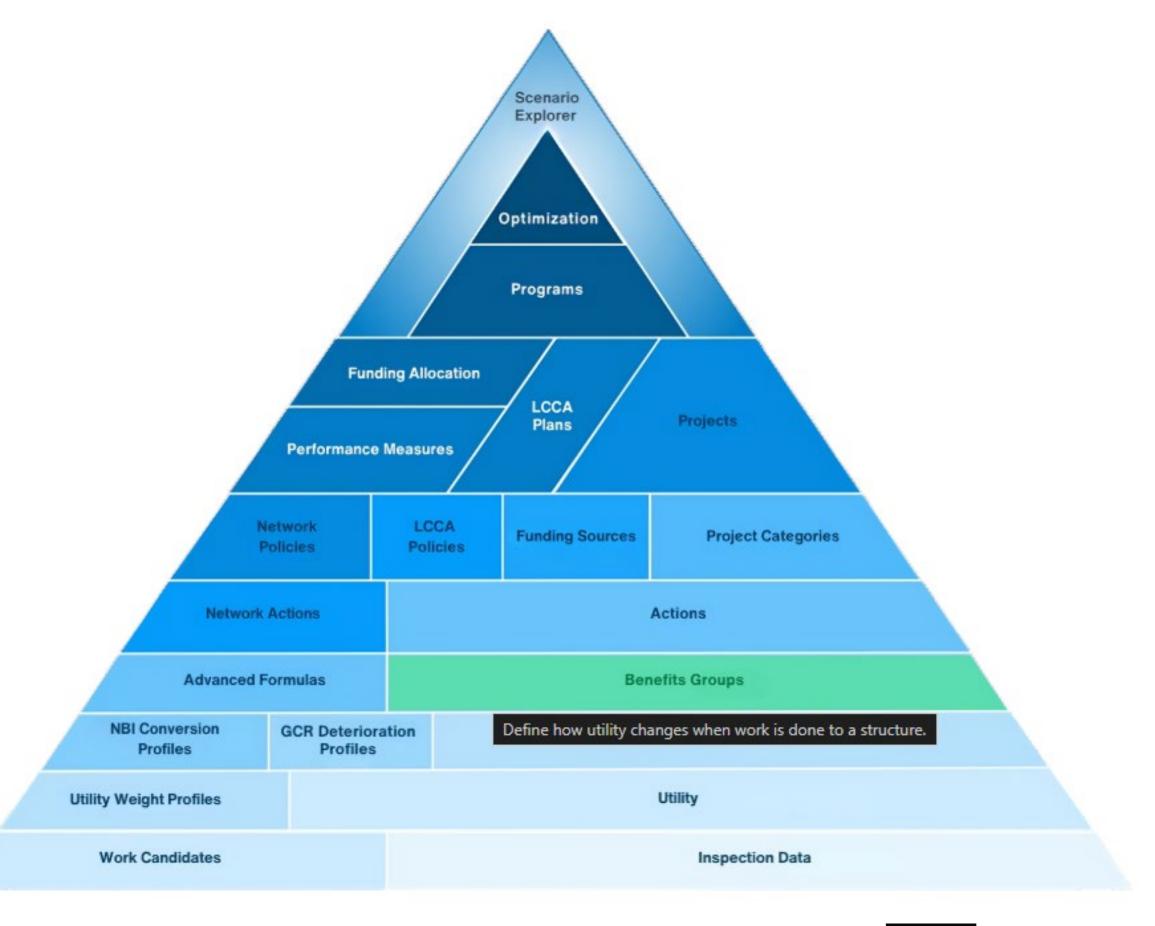
Easy mode:

• Aim to get within ±2% for the first pass.







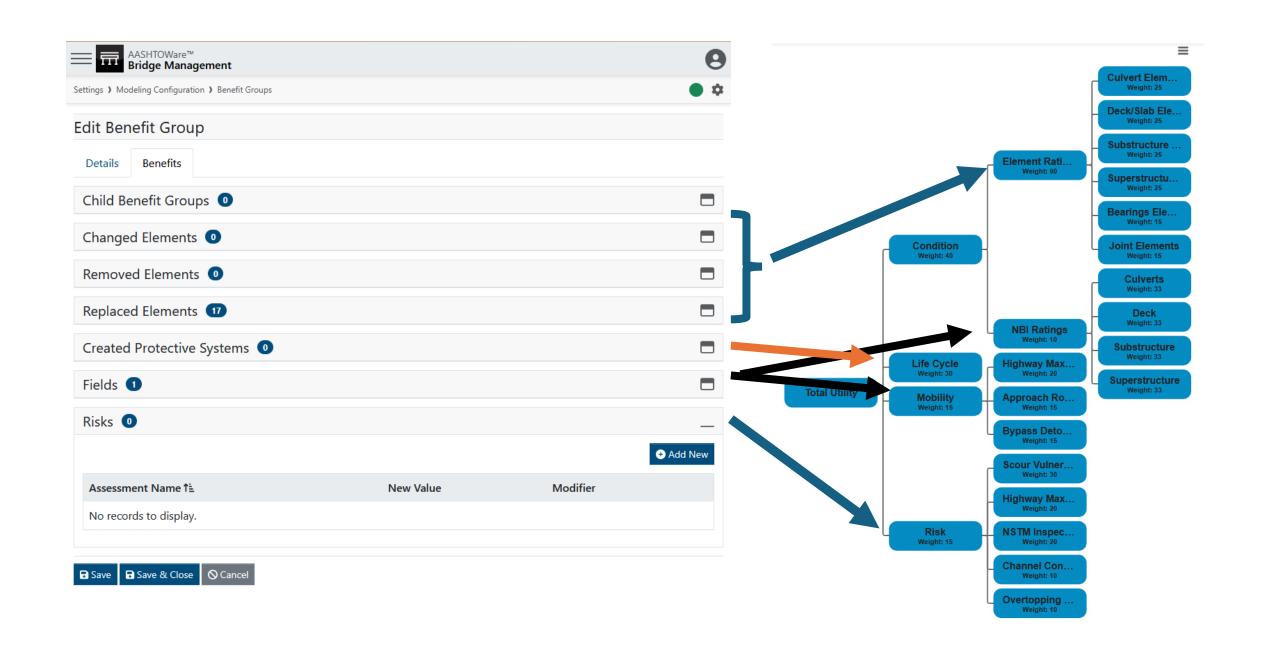




$$Benefit = \Delta Utility$$

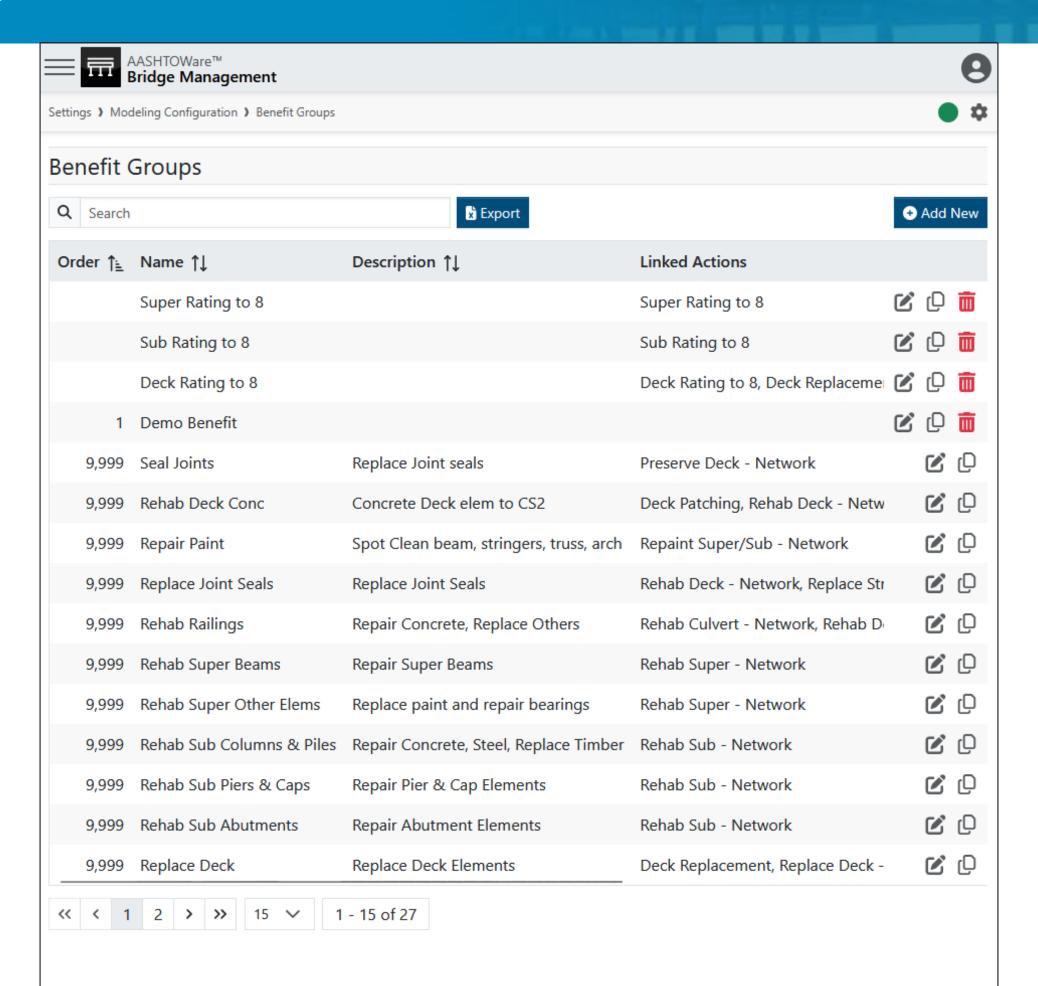
= $U_{After} - U_{Before}$



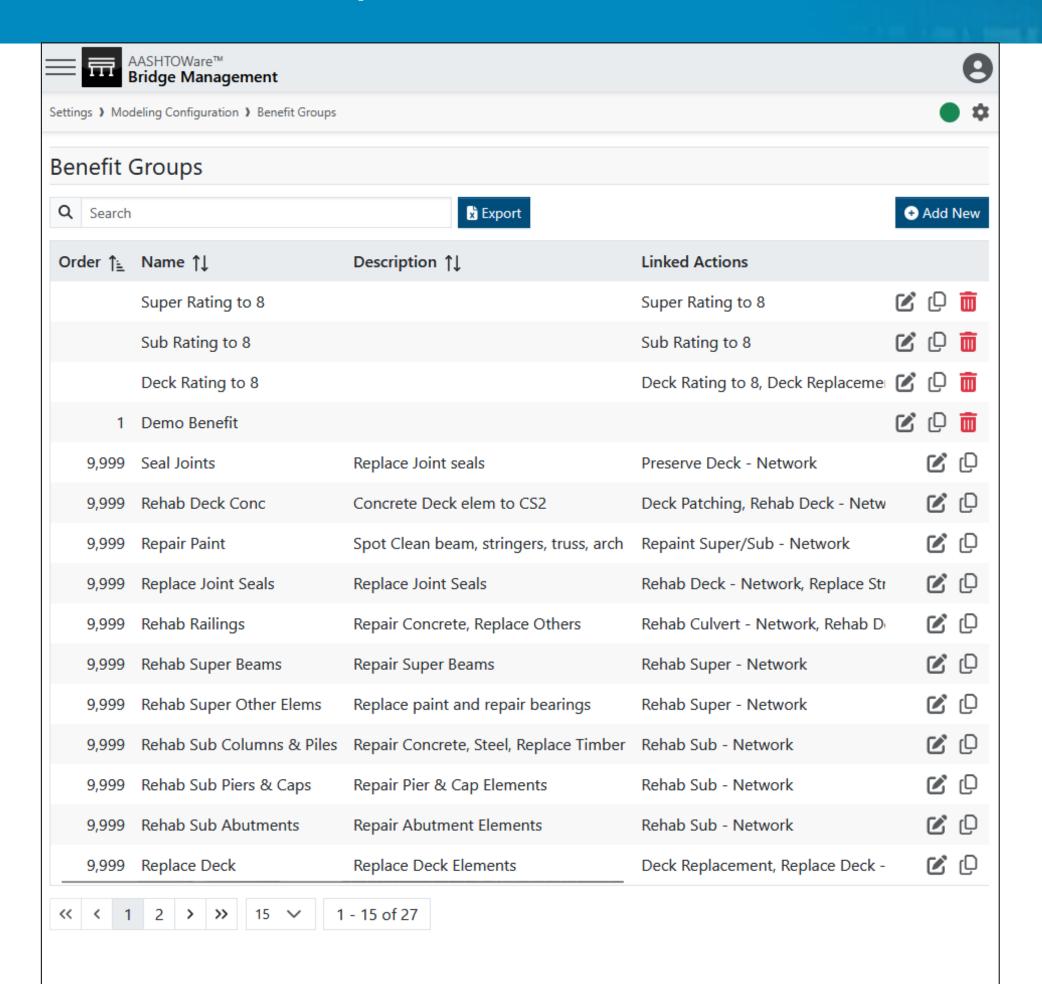


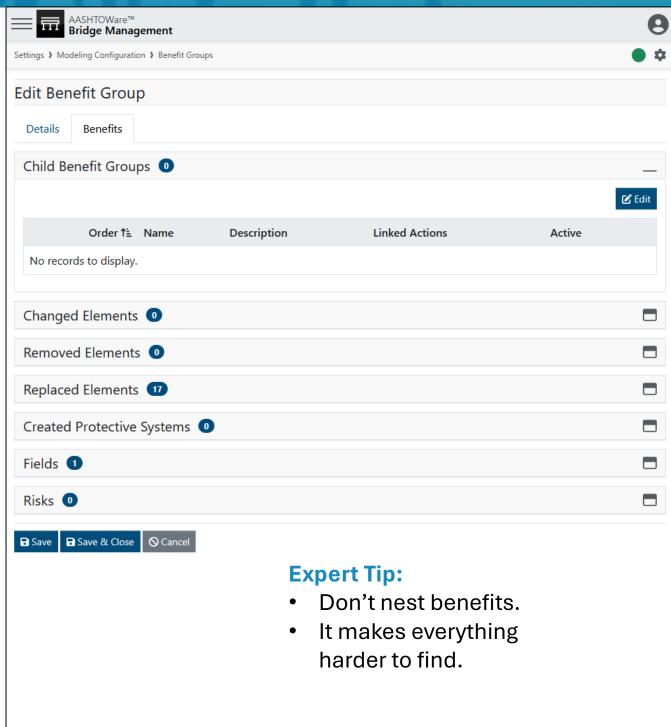
$$Benefit = \Delta Utility = U_{After} - U_{Before}$$







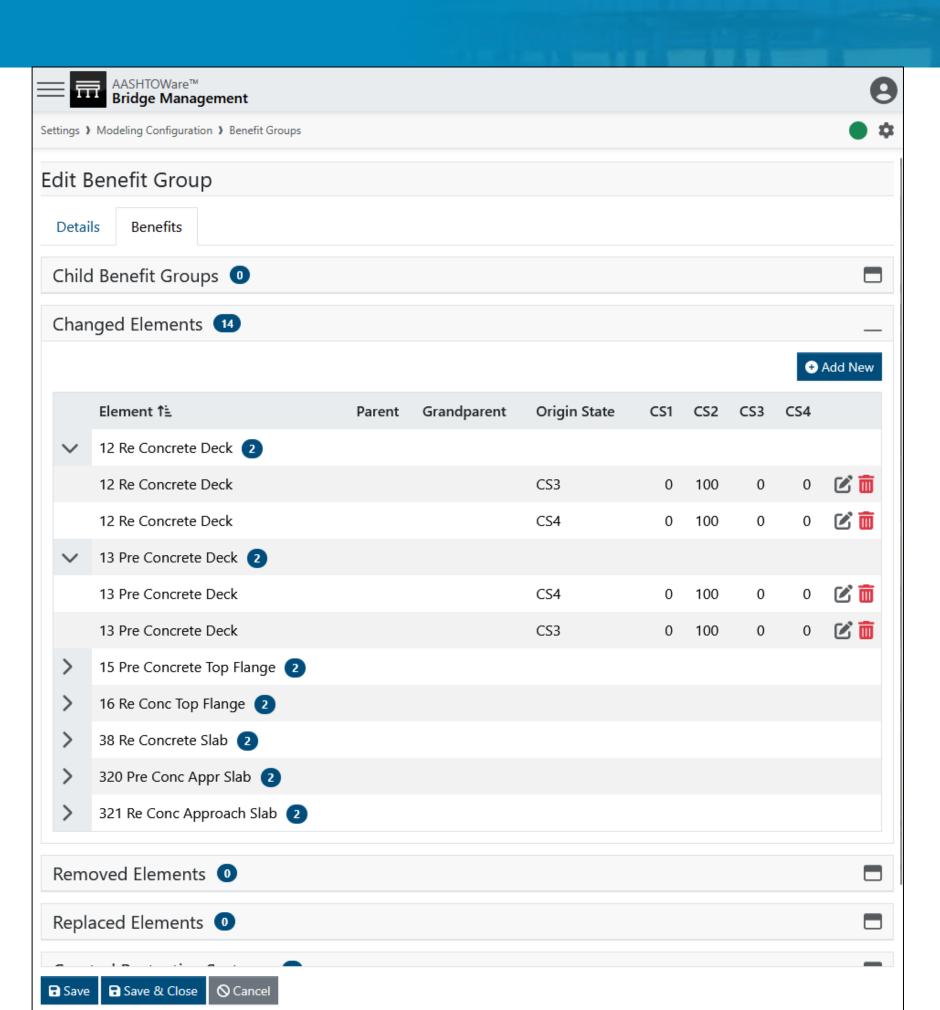






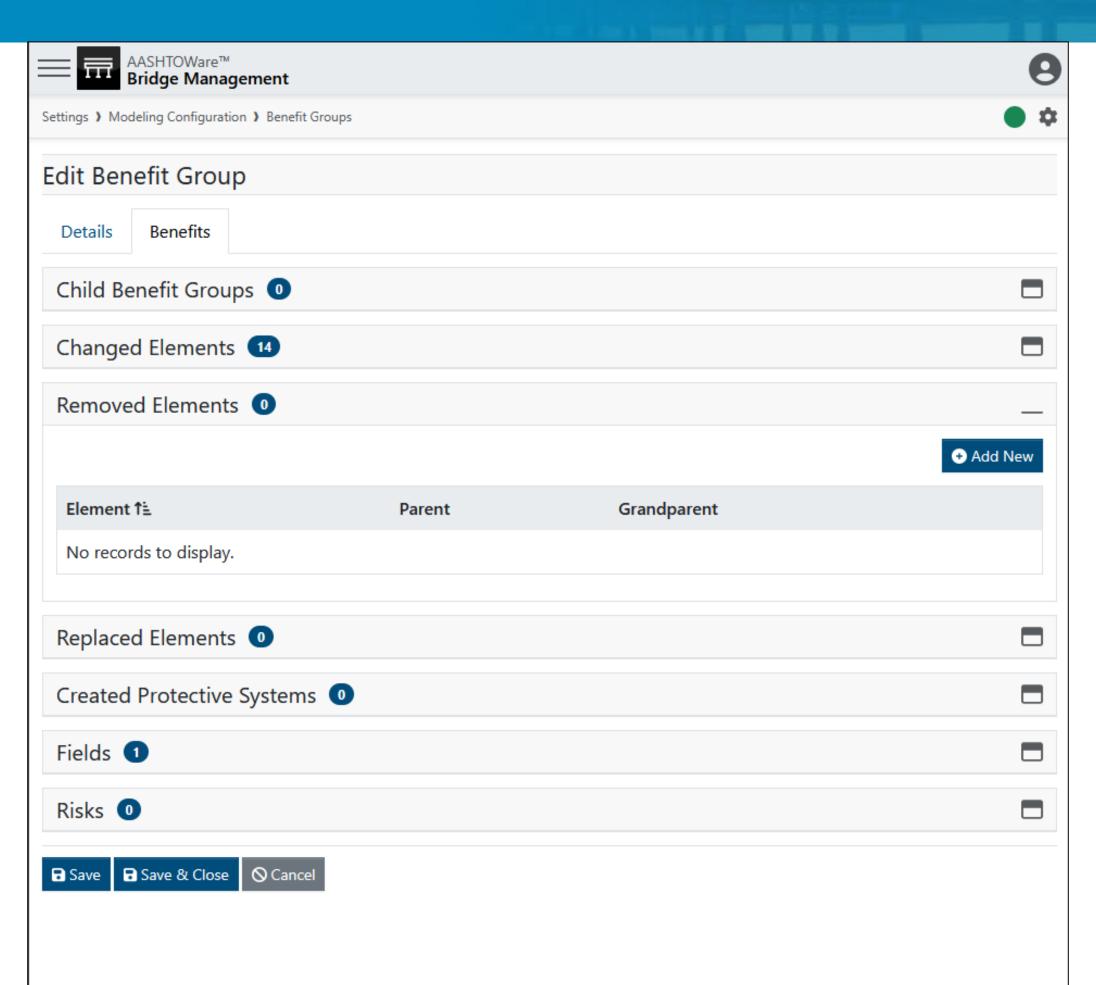
Examples:

- Pothole patching.
- Spot painting.



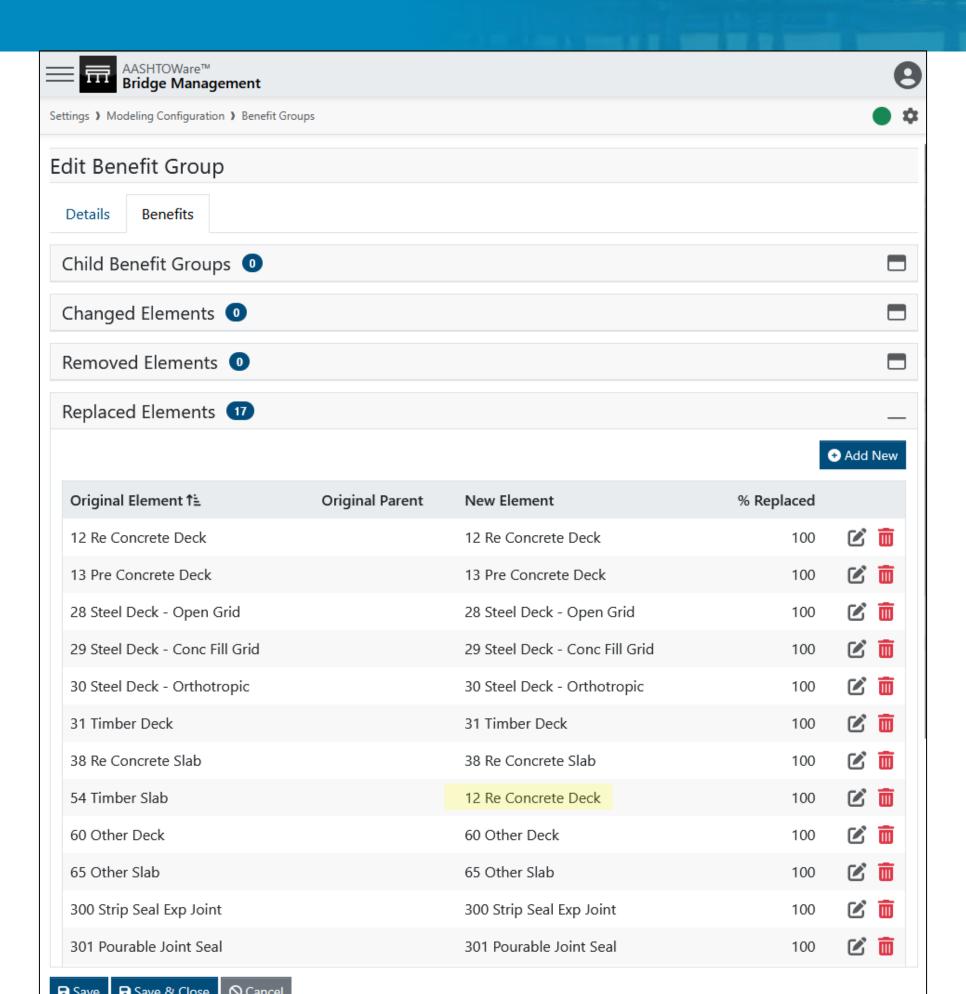


- Shoring
- Pin & Hangers



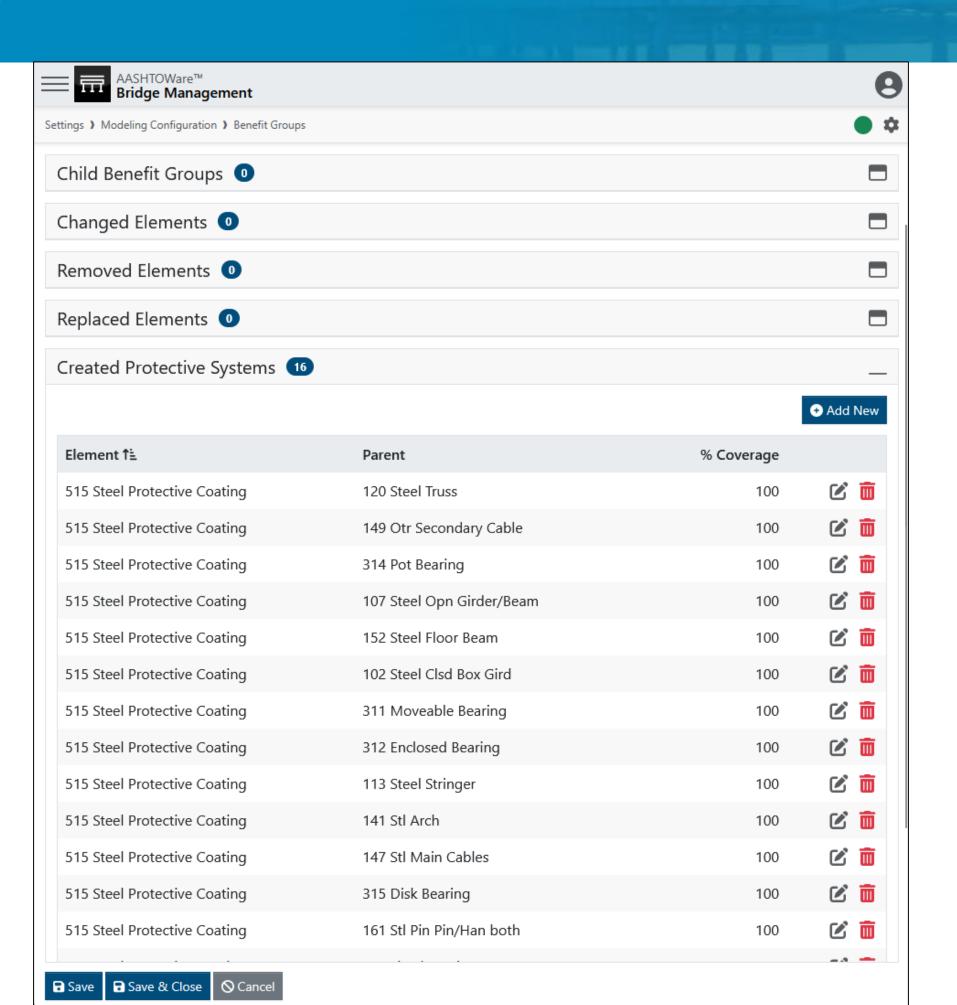


- Deck Replacements
- Bridge Replacements



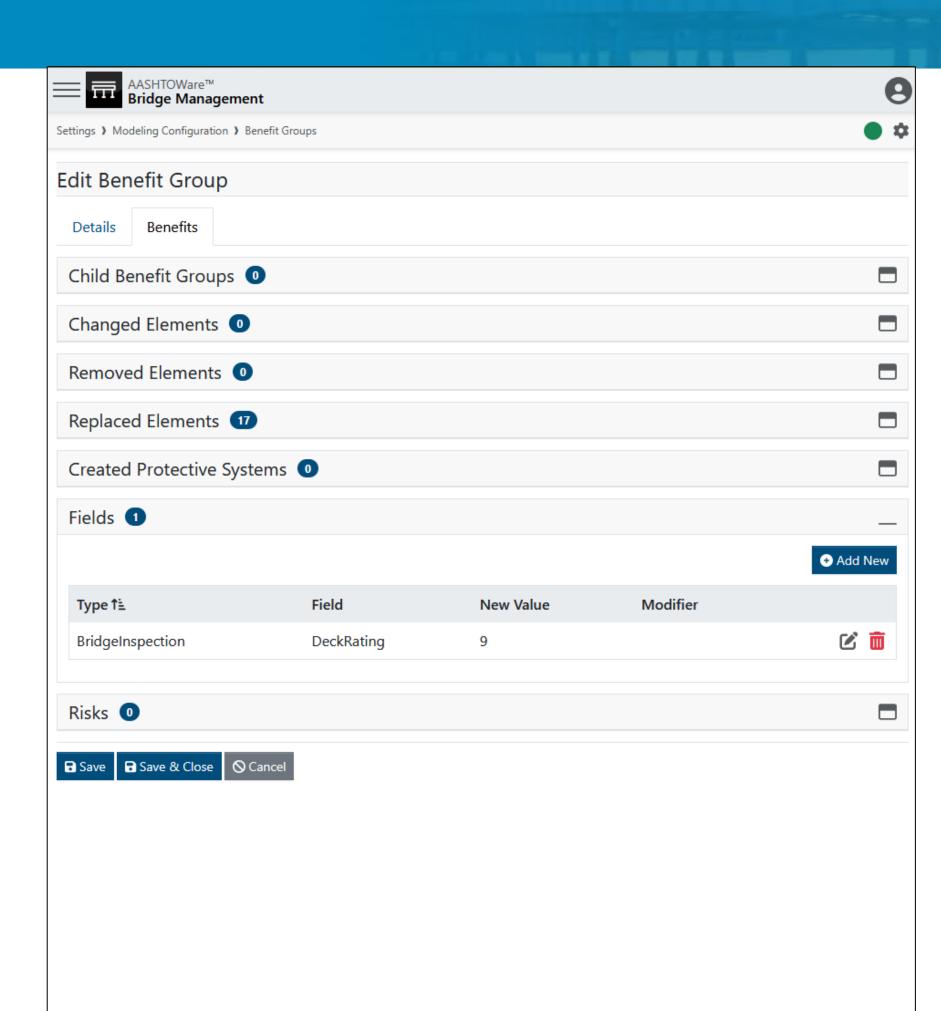


- Wearing Surfaces
- Paint
- Bearing Grease





- NBI Ratings
- Scour Countermeasures





When configuring Benefits for the first time:

- Start by listing actions.
- Then look at Utility nodes and find out which nodes would change for each type of work.
- Name benefits for what they do, not the action they go with (will save time later).

Easy mode:

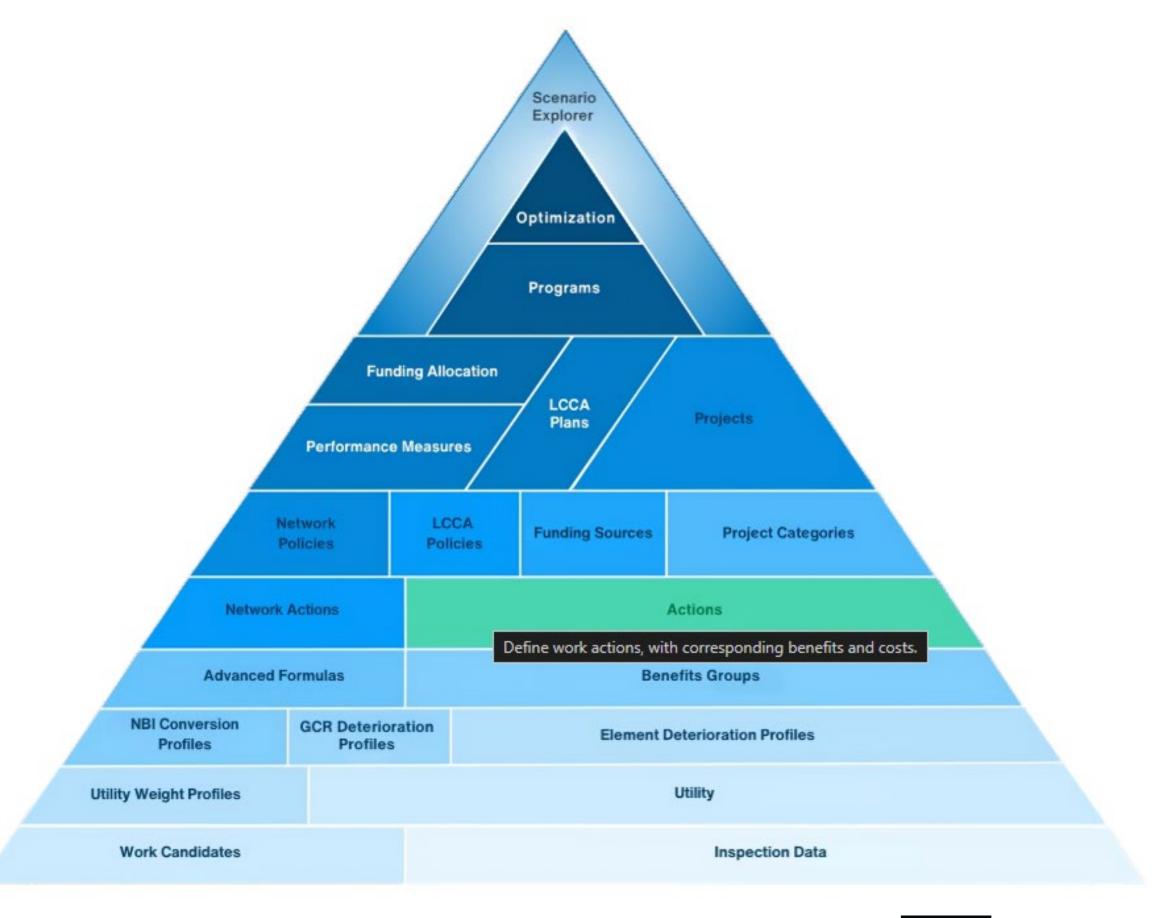
• Use the default benefits to begin with.

Advanced mode:

• Create multiple reusable benefits that can be assigned to each action

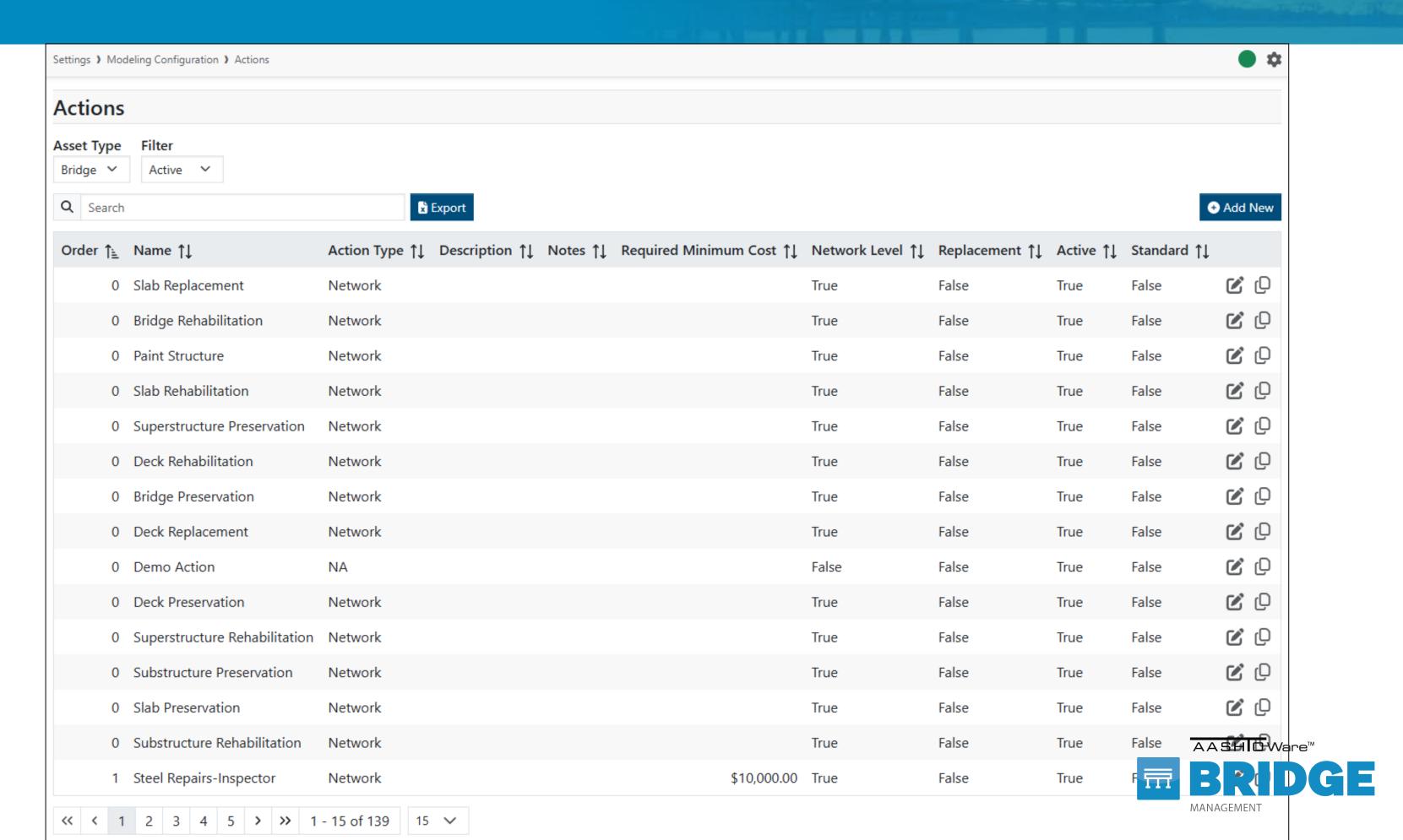


Actions

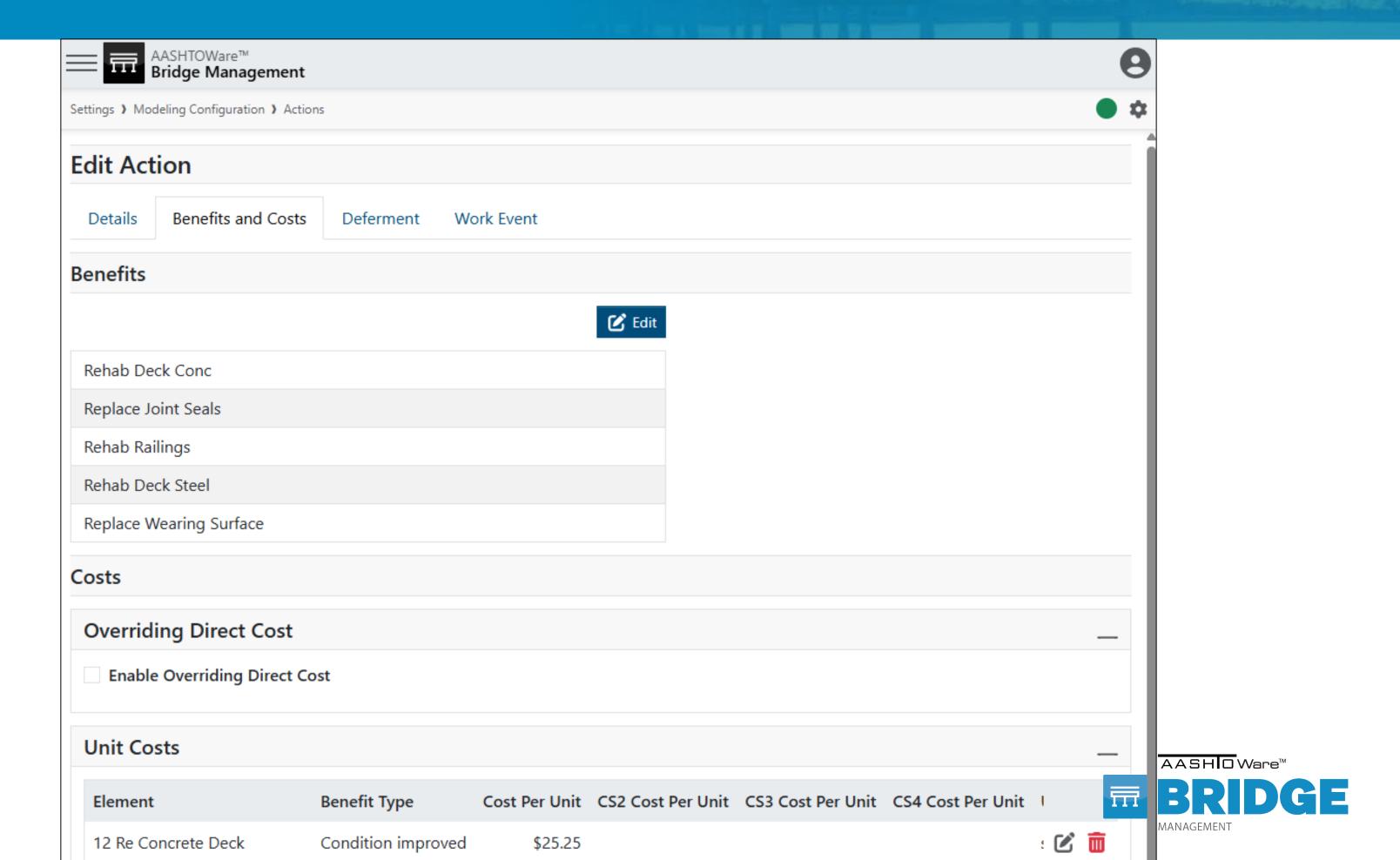




Actions



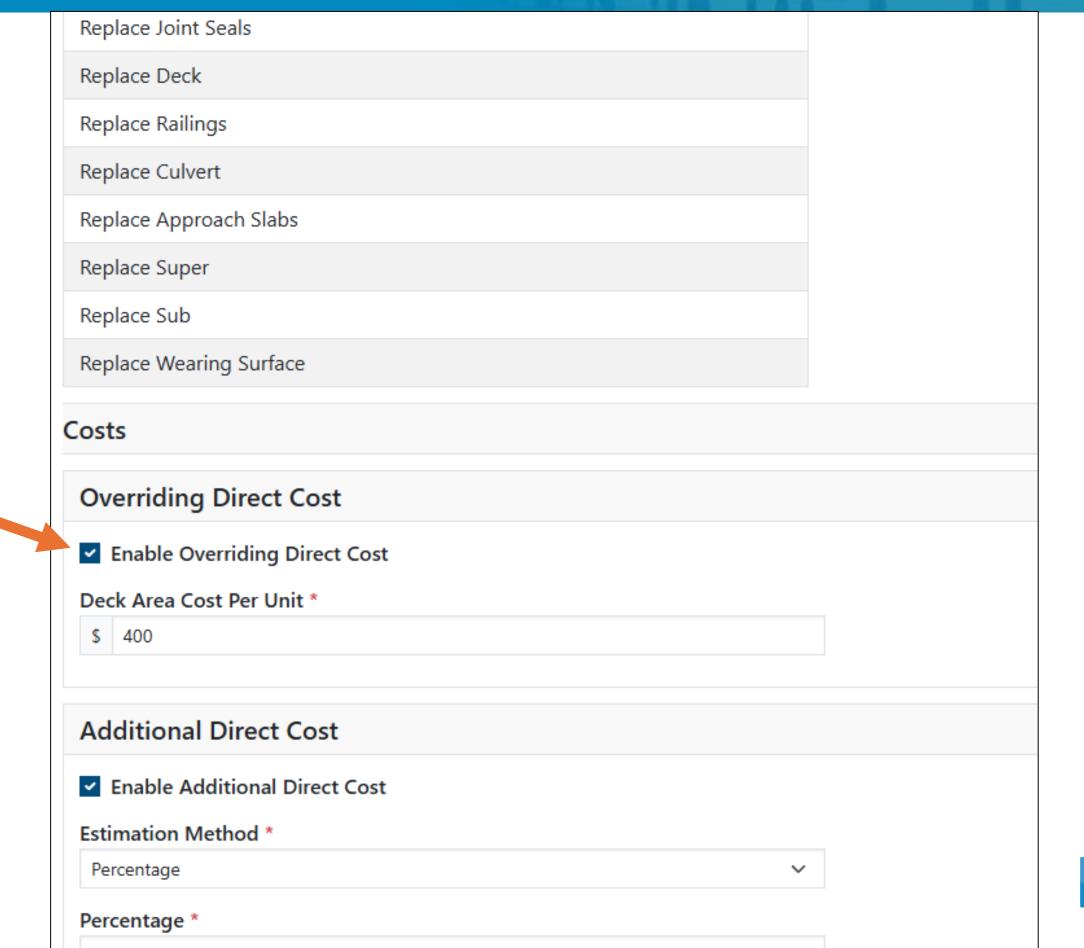
Actions



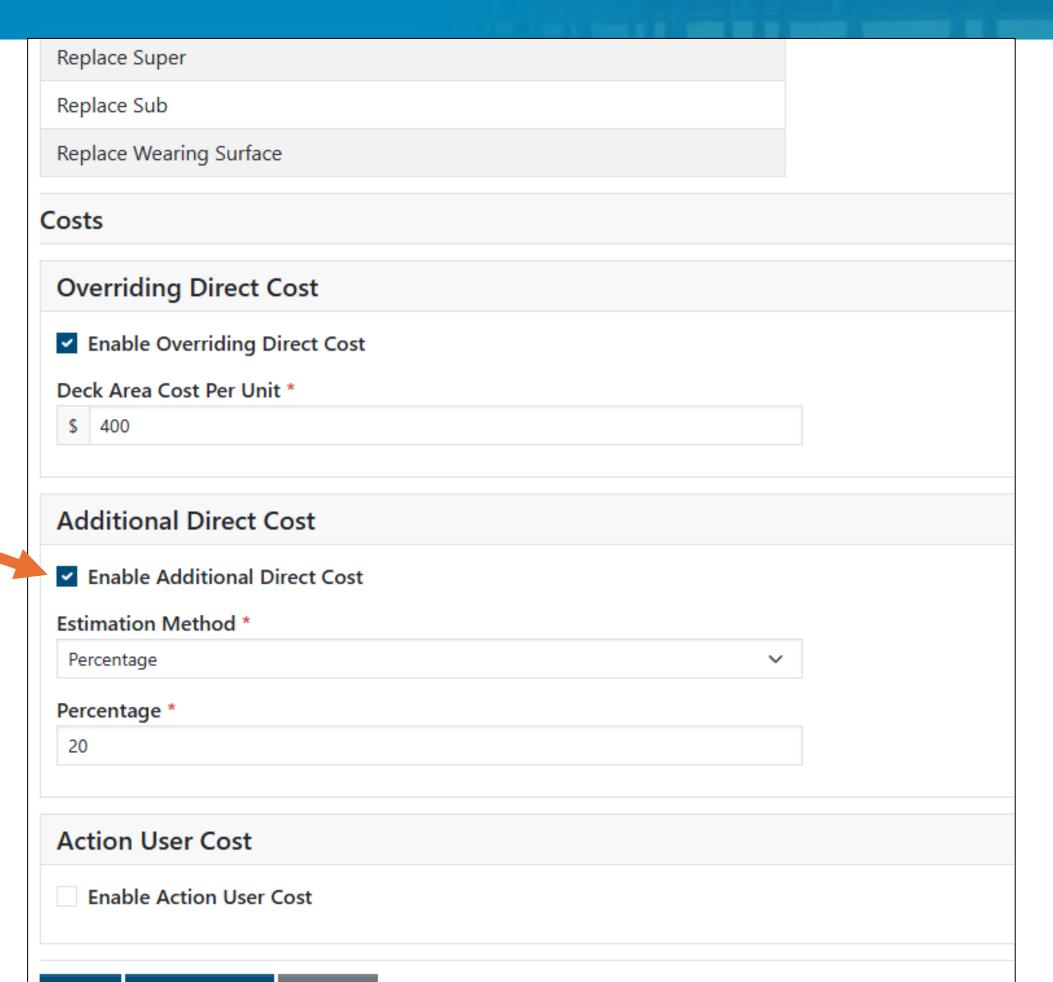
38 Re Concrete Slab	Condition improved	\$25.00	: (i	Z i
54 Timber Slab	Condition improved	\$100.00	<u> </u>	Z i
300 Strip Seal Exp Joint	Replaced	\$65.00	1 (Z i
301 Pourable Joint Seal	Replaced	\$15.00	† (Z i
302 Compressn Joint Seal	Replaced	\$65.00	† (Z i
303 Assem Jnt With Seal	Replaced	\$1,250.00	1 (Z i
304 Open Expansion Joint	Replaced	\$25.00	1 (Z i
305 Assem Jnt Wthut Seal	Replaced	\$1,250.00	1 (Z i
306 Other Joint	Replaced	\$1,250.00	1 (Z i
320 Pre Conc Appr Slab	Condition improved	\$25.00	£ (Z i
321 Re Conc Approach Slab	Condition improved	\$25.00	£ (Z i
330 Metal Bridge Railing	Condition improved	\$100.00	1 (Z i
331 Re Conc Bridge Railing	Condition improved	\$70.00	+ (Z i
332 Timb Bridge Railing	Condition improved	\$100.00	† (Z (
333 Other Bridge Railing	Condition improved	\$100.00	† (Z i
334 Masry Bdge Rling	Condition improved	\$70.00	† (Z i
510 Wearing Surfaces	Replaced	\$27.00	£ (Z 1



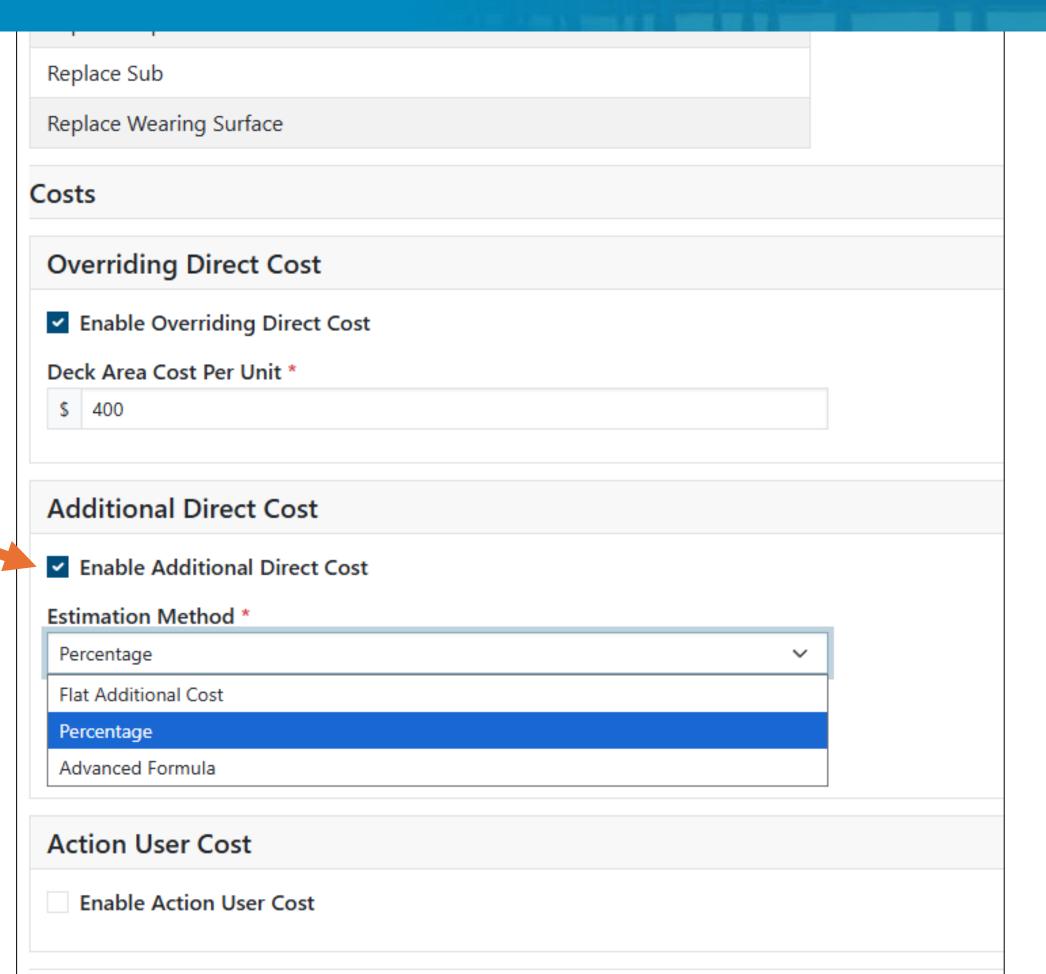
			AASHIO Ware ^M BRIDG
510 Wearing Surfaces	Replaced	\$27.00	s 🕜 🛅
334 Masry Bdge Rling	Condition improved	\$70.00	1 🗷 🛅
333 Other Bridge Railing	Condition improved	\$100.00	1 🗷 🛅
332 Timb Bridge Railing	Condition improved	\$100.00	1 🗷 🛅
331 Re Conc Bridge Railing	Condition improved	\$70.00	Ok Ok & Next O Cancel
330 Metal Bridge Railing	Condition improved	\$100.00	
321 Re Conc Approach Slab	Condition improved	\$25.00	CS4 Cost per Unit
320 Pre Conc Appr Slab	Condition improved	\$25.00	CS3 Cost per Unit
306 Other Joint	Replaced	\$1,250.00	s .
305 Assem Jnt Wthut Seal	Replaced	\$1,250.00	☑ Separate Cost per Unit by Condition State CS2 Cost per Unit
304 Open Expansion Joint	Replaced	\$25.00	Benefit Type Condition improved
303 Assem Jnt With Seal	Replaced	\$1,250.00	104 Pre Clsd Box Girder
302 Compressn Joint Seal	Replaced	\$65.00	Edit Unit Cost Element
301 Pourable Joint Seal	Replaced	\$15.00	
300 Strip Seal Exp Joint	Replaced	\$65.00	1 (2)
54 Timber Slab	Condition improved	\$100.00	
38 Re Concrete Slab	Condition improved	\$25.00	



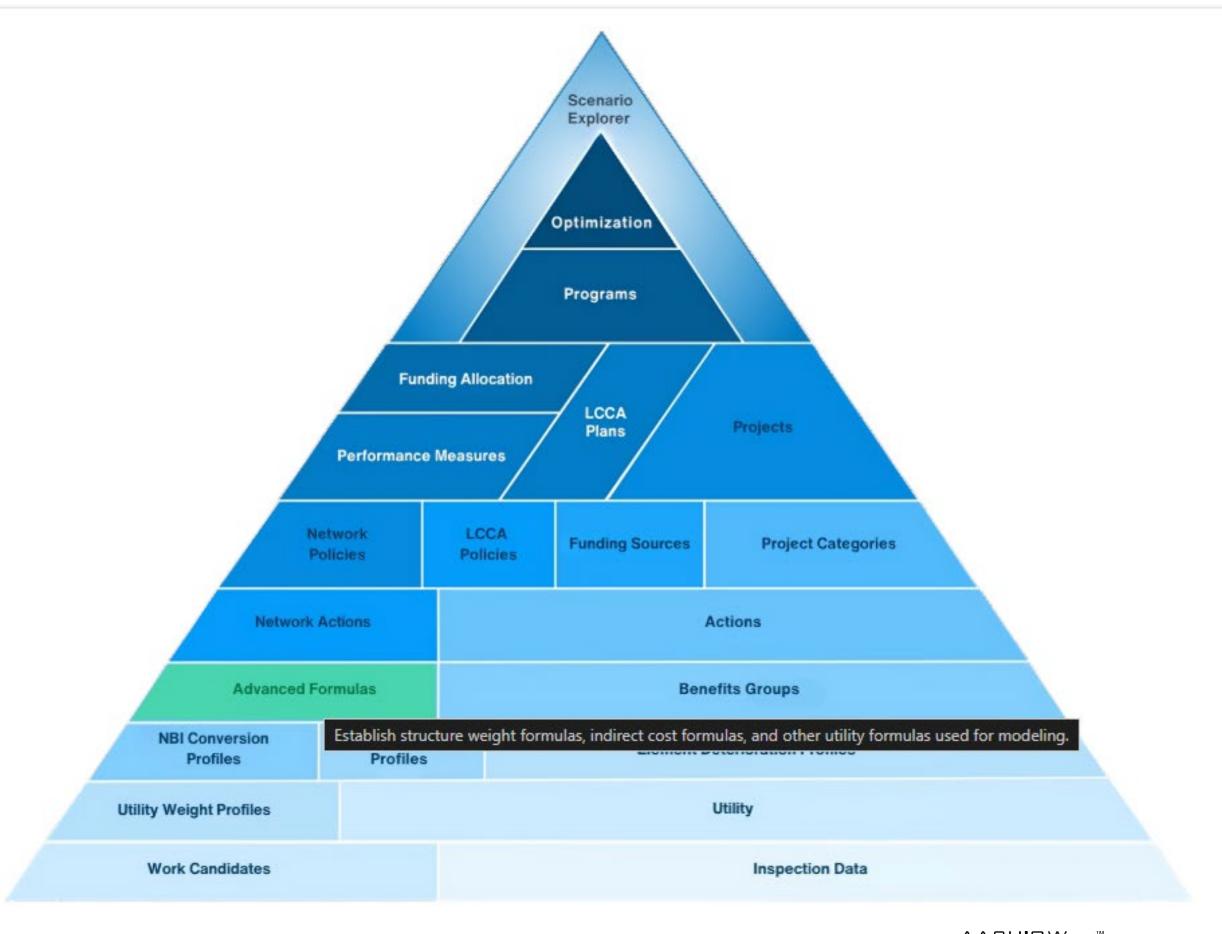




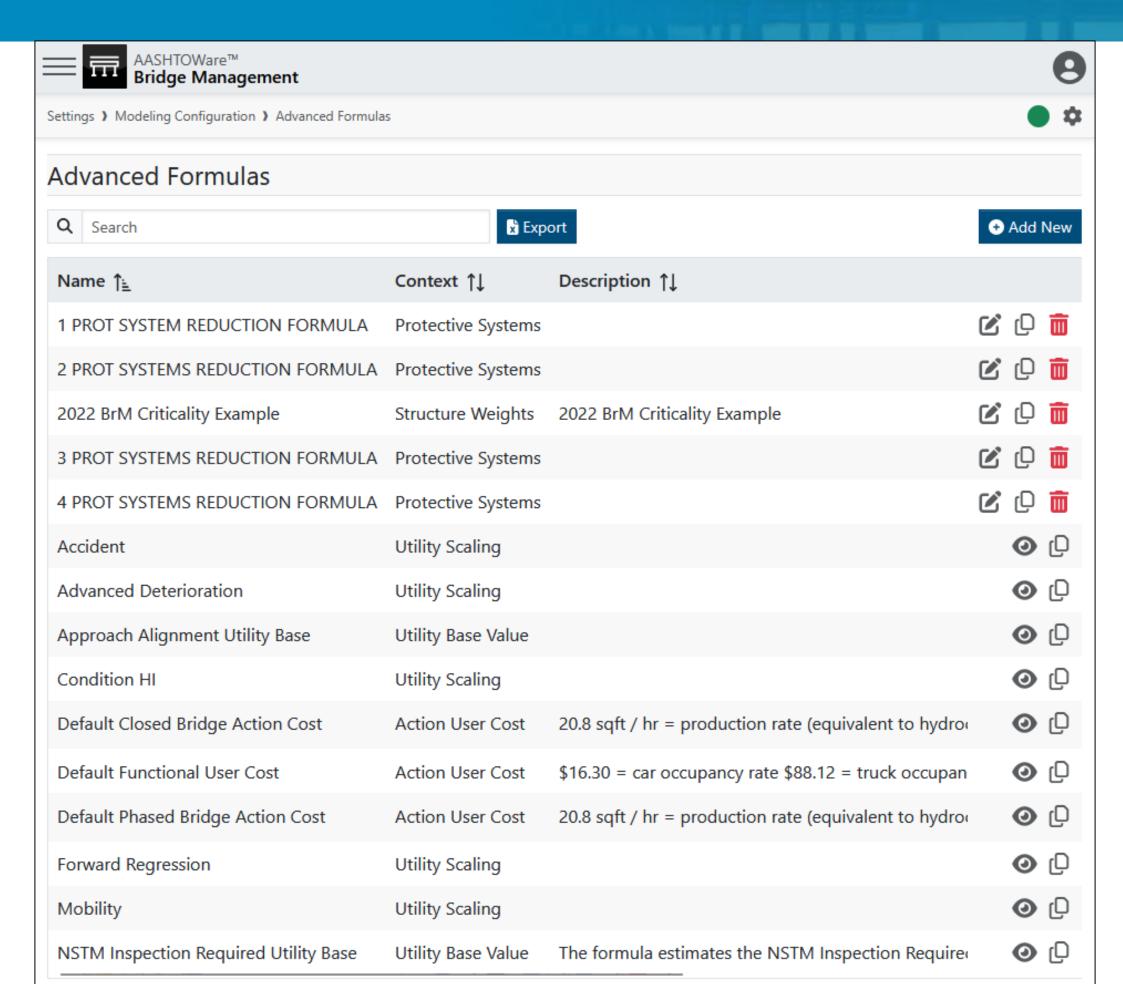






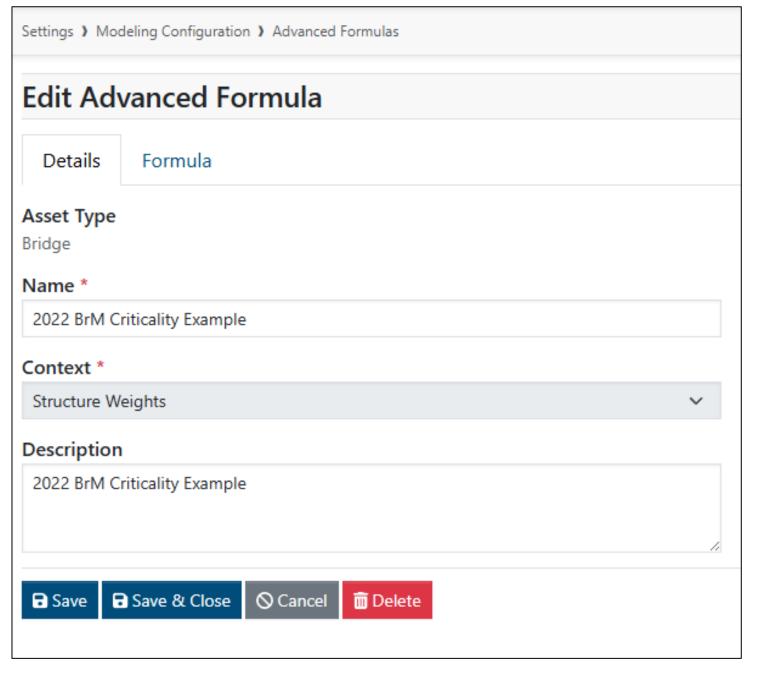




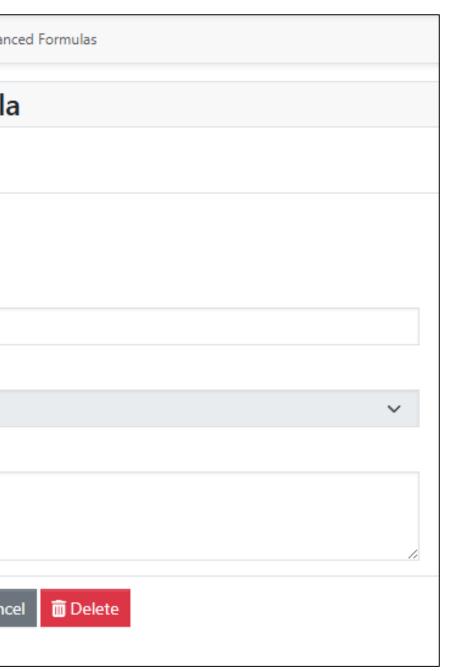


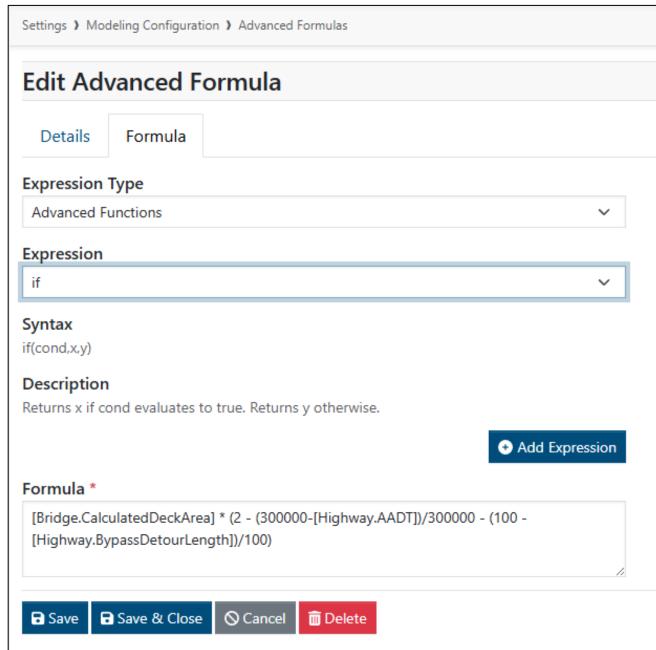


NEW and IMPROVED



Settings > Modeling Configuration > Advanced Formulas						
Edit Advanced Form	mula					
Details Formula						
Expression Type						
Advanced Functions	~					
Expression						
if	~					
Syntax if(cond,x,y)	Syntax	: NCalc2				
Description Returns x if cond evaluates to tru	ue. Returns y otherwise. • Add Expression					
Formula *	Trad Expression					
[Bridge.CalculatedDeckArea] * ([Highway.BypassDetourLength]	(2 - (300000-[Highway.AADT])/300000 - (100 -)/100)					
Save & Close	Cancel Delete					
	AA	.SH I O Ware™				

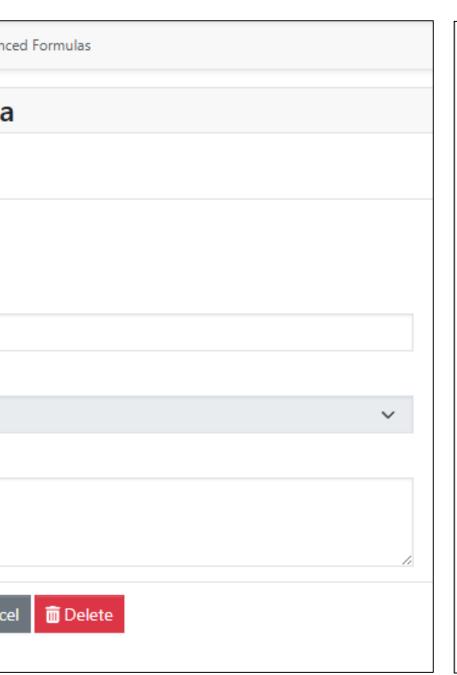


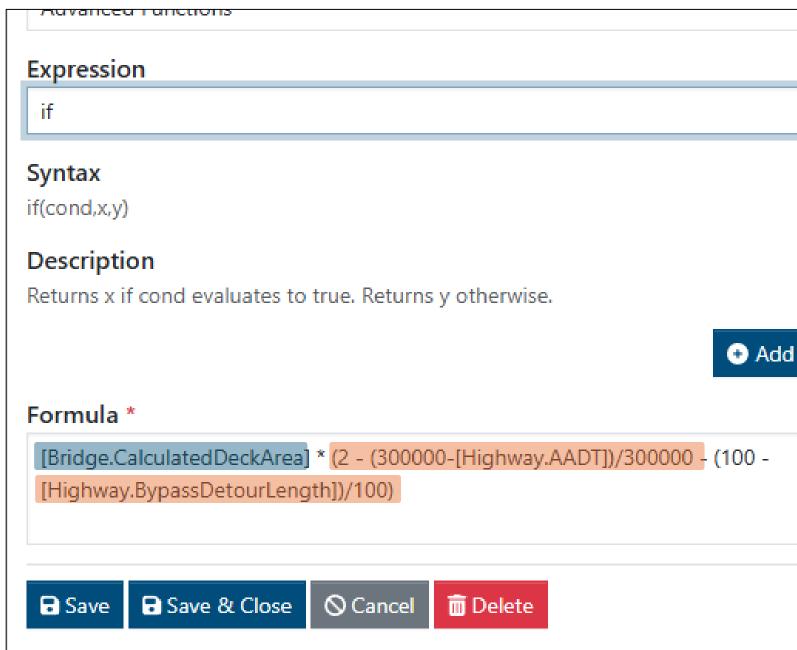


Default BrM Structure Weight Formula:

- NJ: Include Deck Area to counter cost scales
- ND: Scale ADT & Detour to control orders of magnitude
- NM: Put those two approaches together



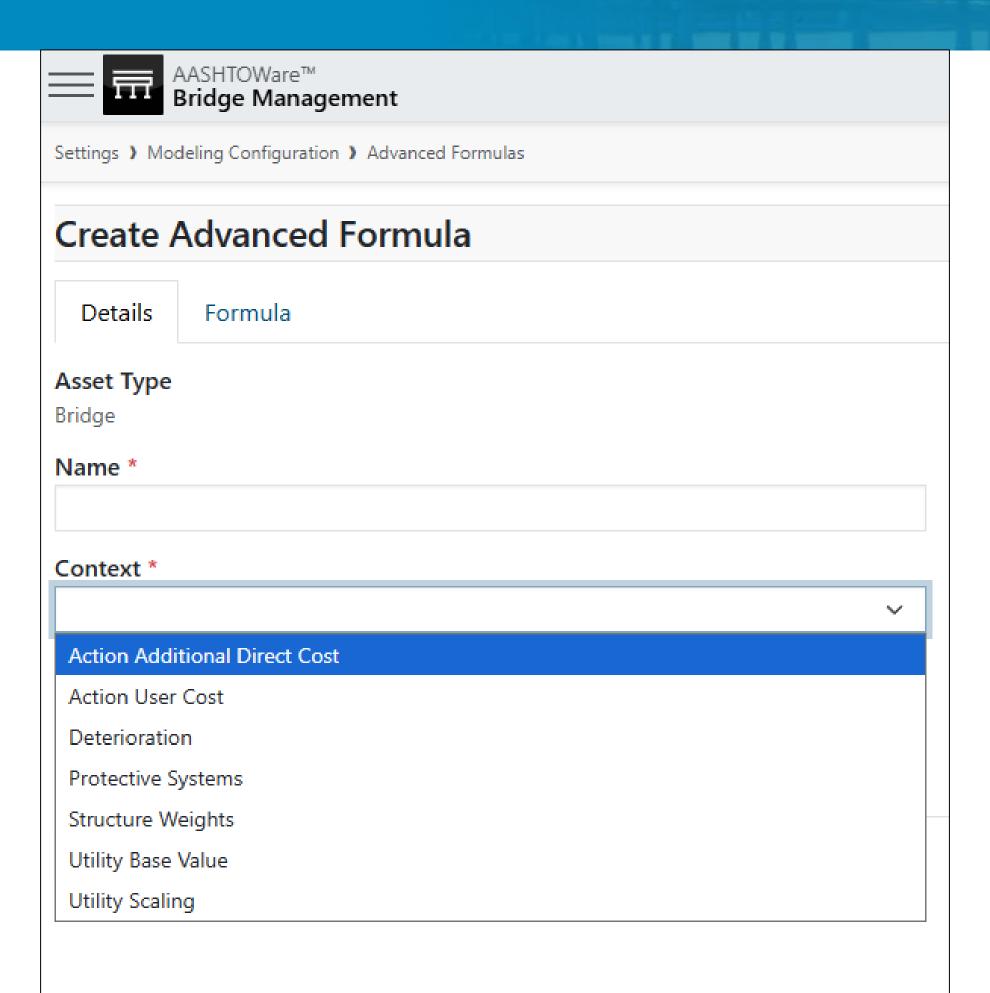




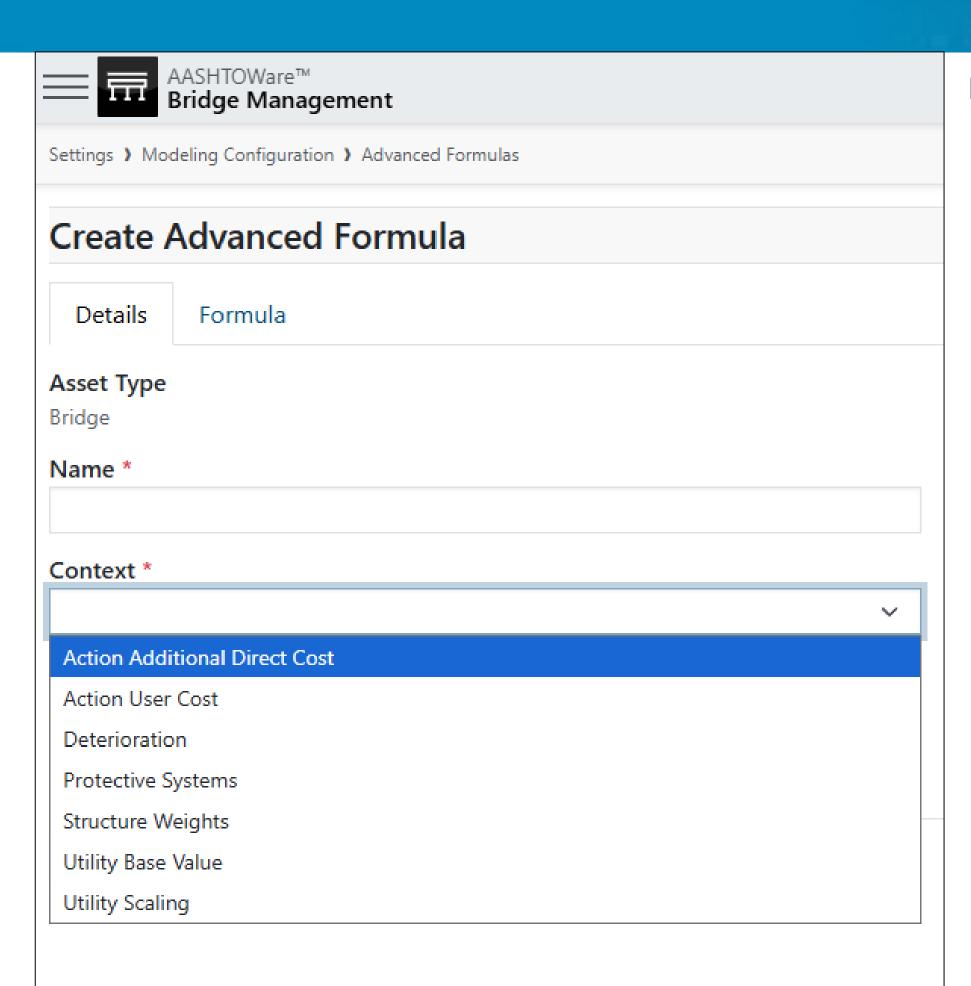
Default BrM Structure Weight Formula:

- NJ: Include Deck Area to counter cost scales
- ND: Scale ADT & Detour to control orders of magnitude
- NM: Put those two approaches together









Example Replacement Cost Formulas:

LaDOTD Replacement Cost (Unit cost as a function of bridge length, 30% increase for bridges over navigable waterways greater than 125ft and 5x the cost for moveable bridges):

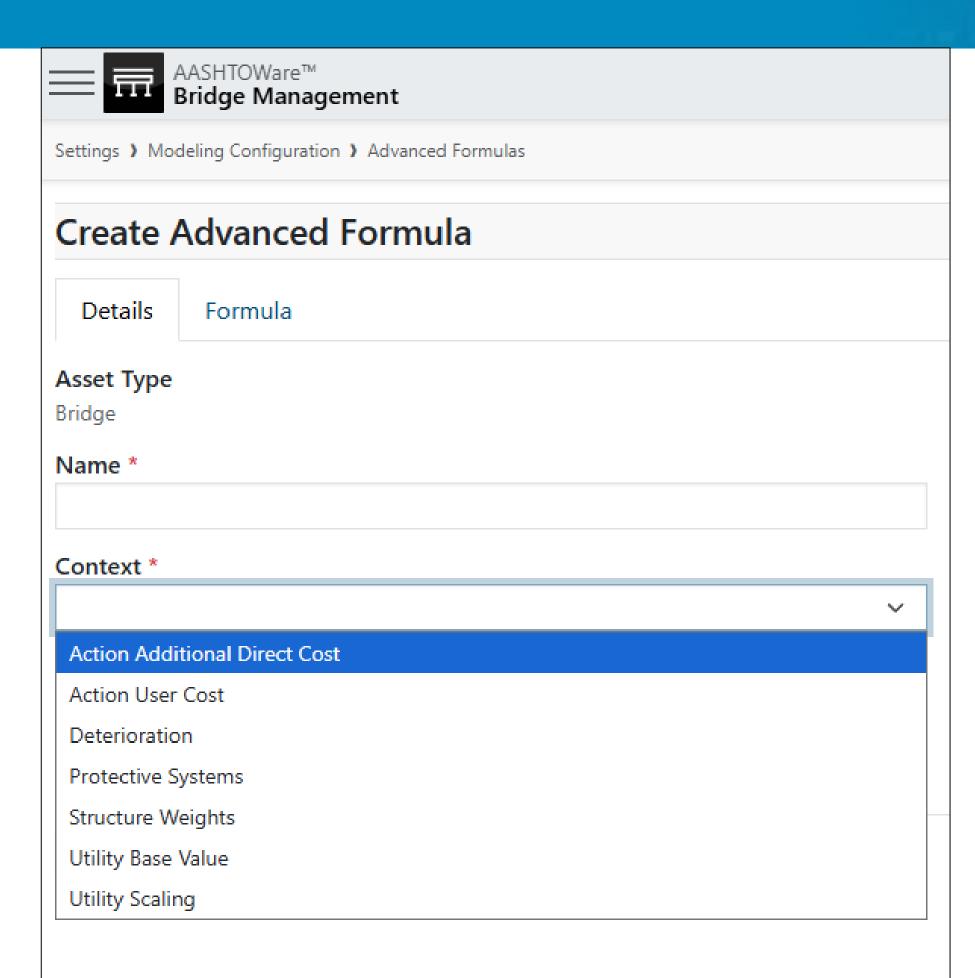
```
({bridge.deck_area} * ((less_equal[500]({bridge.length}) * 400) + (greater[500]({bridge.length}) * less[5000]({bridge.length}) * ((-1/45) * {bridge.length} + 411.11)) + (greater_equal[5000]({bridge.length}) * 300))) * (1+ (greater[125]({bridge.navhc}) * 0.3)) * (1+ (equal['Moveable']('{userbrdg.structure_category}') *4))
```

CTDOT Replacement Cost (They actually graphed replacement costs from past projects vs Deck Area and found a logarithmic best fit curve):

```
(1076-60* log[3]( {bridge.deck_area} )) * {bridge.deck_area}
```

NJDOT Replacement (Defined specific Deck area ranges and a factor times a unit cost):

```
({bridge.deck_area} * 2045 *
((3 * greater[300000]({bridge.deck_area})) +
(1.5 * (less_equal[300000]({bridge.deck_area}) * greater[100000]({bridge.deck_area}))) +
(1.25 * (less_equal[100000]({bridge.deck_area}) * greater[25000]({bridge.deck_area}))) +
(1.0 * (less_equal[25000]({bridge.deck_area}) * greater[2500]({bridge.deck_area}))) +
(0.95 * less[2500]({bridge.deck_area})) *
equal['Y']('{bridge.nbislen}'))) +
{bridge.deck_area} * 2045 *
(0.95 * equal['N']('{bridge.nbislen}'))
```



Example Replacement Cost Formulas:

HDOT Replacement (NBI improvement length formula, factors for districts, bypass/detour lengths greater than 5 miles, specific route and material, and coastal bridges with specific designmain value):

```
((less_equal[100]({bridge.length})*(1.894 - (({bridge.length}*0.3048) * 0.1919) + (0.00815*({bridge.length}*0.3048)^2) - (0.0001176*({bridge.length}*0.3048)^3)))* ({Cost.direct_cost}*1.8) + (greater[100]({bridge.length})*(0.436 - (({bridge.length}*0.3048) * 0.00623) + (0.0000351*({bridge.length}*0.3048)^2) - (0.00000071*({bridge.length}*0.3048) ^3)))* ({Cost.direct_cost}*1.2)
```

- + ({Cost.direct_cost}*1.4)*(equal[10]({bridge.district})*0.1 + equal[15]({bridge.district})*0.3 + equal[20]({bridge.district})*0.3 + equal[25]({bridge.district})*0)
- + (greater[5]({roadway.BYPASSLEN})*3*(less_equal[100]({bridge.length})*(2.894 (({bridge.length}*0.3048) * 0.1919) + (0.00815*({bridge.length}*0.3048)^2) (0.0001176*({bridge.length}*0.3048)^3)))* ({Cost.direct_cost}*1.1) + (greater[100]({bridge.length})*(1.436 (({bridge.length}*0.3048) * 0.00623) + (0.0000351*({bridge.length}*0.3048)^2) (0.000000071*({bridge.length}*0.3048)^3)))* ({Cost.direct_cost}*1.1))
- + (equal[00019]({roadway.ROUTENUM}) * equal[3]({bridge.materialmain}) * {Cost.direct_cost} *3))
- * (1- equal[1]({userbrdg.coastal_bridge})*0.33 (equal[01]({bridge.designmain})*equal[1]({userbrdg.coastal_bridge})*0.70))



Be sure to TEST your Replacement Cost formula:

- 1. Use a spreadsheet or perform hand calculations to determine what the expected costs should be for a sample set of bridges.
- 2. Run an optimization on those bridges and compare results.



QUESTIONS

