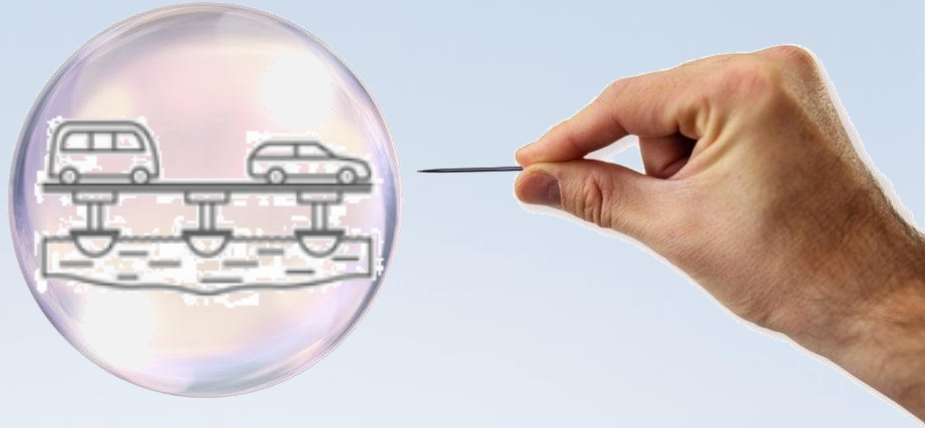


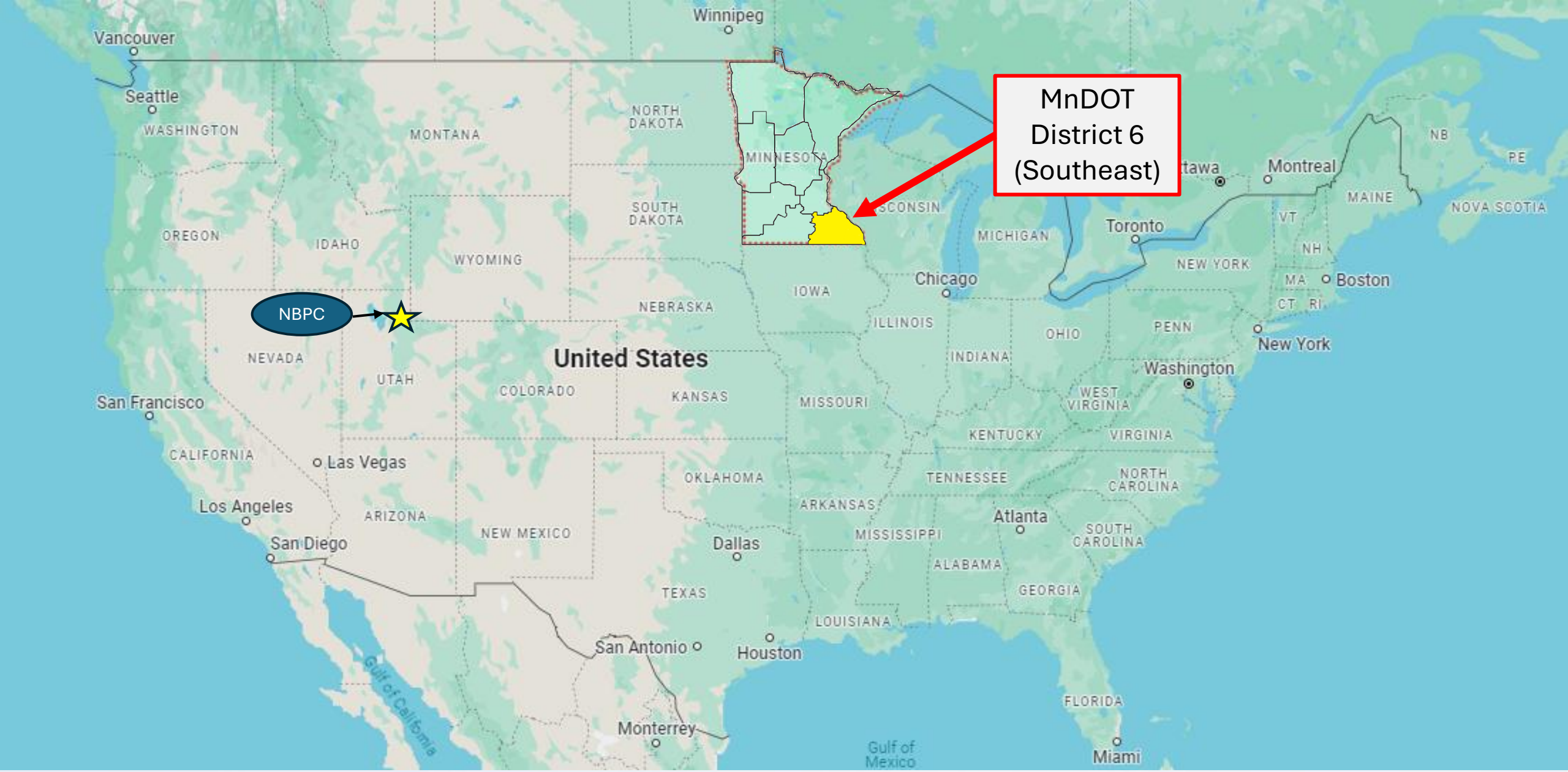
Don’t Pop The Bubble

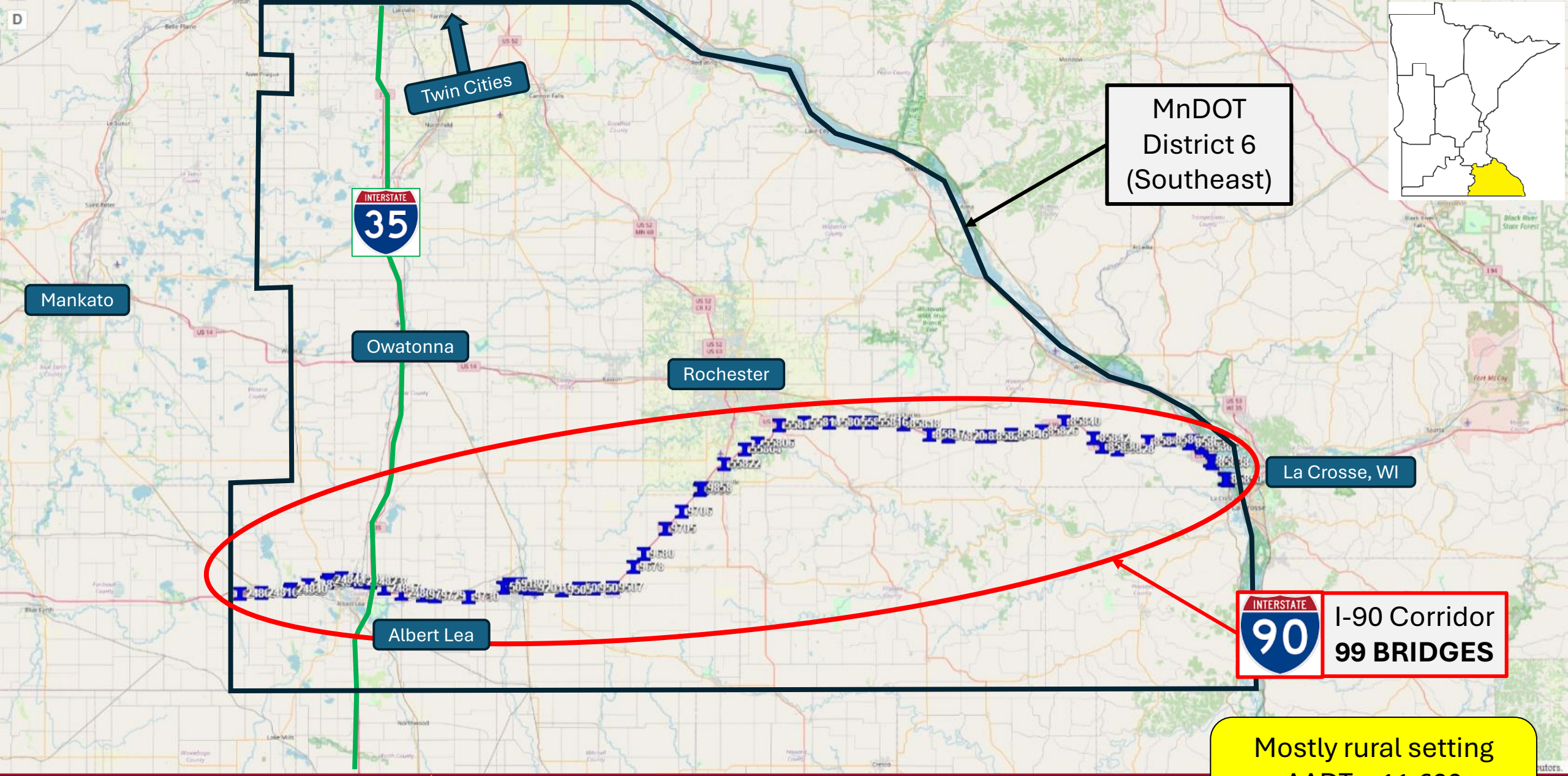
MnDOT D6 I-90 Corridor Management Plan

Nick Haltvick, P.E. (MN)

Minnesota Department of Transportation

nick.haltvick@state.mn.us


MnDOT
District 6
(Southeast)
NBPC
United States
Winnipeg
Vancouver
Seattle
WASHINGTON
MONTANA
NORTH DAKOTA
MINNESOTA
SOUTH DAKOTA
OREGON
IDAHO
WYOMING
NEBRASKA
IOWA
WISCONSIN
MICHIGAN
Chicago
Toronto
Montreal
NEW YORK
MAINE
NB
PE
NOVA SCOTIA
VT
NH
MA
CT
RI
Boston
New York
PENN
OHIO
INDIANA
ILLINOIS
Washington
WEST VIRGINIA
KENTUCKY
VIRGINIA
NORTH CAROLINA
SOUTH CAROLINA
TENNESSEE
Atlanta
NEVADA
UTAH
COLORADO
KANSAS
MISSOURI
San Francisco
CALIFORNIA
Las Vegas
Los Angeles
San Diego
ARIZONA
NEW MEXICO
OKLAHOMA
ARKANSAS
MISSISSIPPI
ALABAMA
GEORGIA
FLORIDA
Dallas
TEXAS
LOUISIANA
San Antonio
Houston
Monterrey
Gulf of California
Gulf of Mexico
Miami


Twin Cities
MnDOT
District 6
(Southeast)
INTERSTATE
35
Mankato
Owatonna
Rochester
La Crosse, WI
Albert Lea
INTERSTATE
90
I-90 Corridor
99 BRIDGES
Mostly rural setting
AADT ≈ 11,600
HCADT ≈ 2500

Why do we need a management plan?

or perhaps…

What bubble do we not want to pop?

- MnDOT District 6 owns 99 bridges that carry or span over I-90
- Majority are nearing 60 years old
- Typical design life is 50 years…

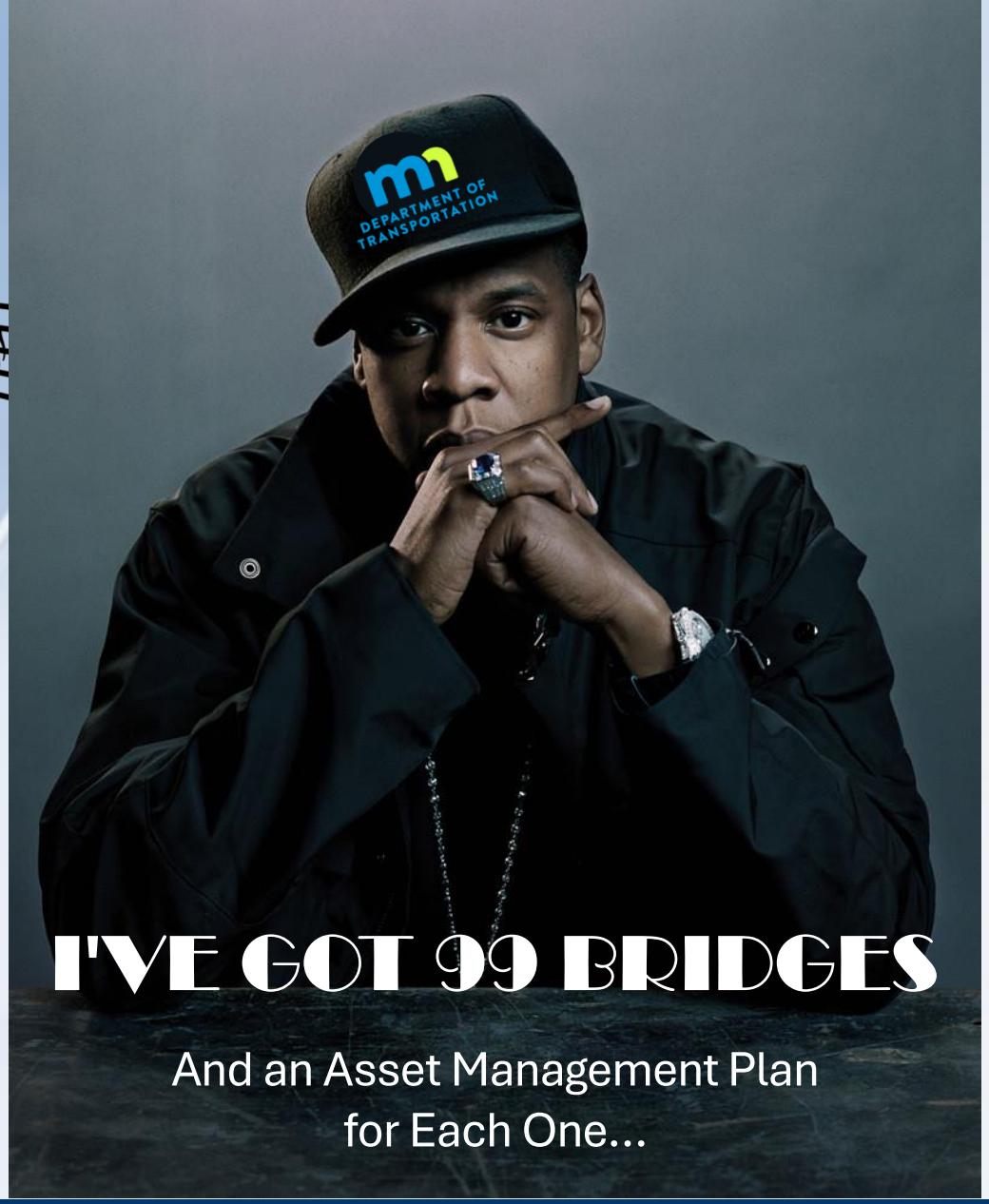
Why do we need a management plan?

- Replacement of all is not possible – or necessary!
- Manage based on condition and geometrics

NEED:

A systematic way to cost-effectively manage bridge assets

which leads us to…

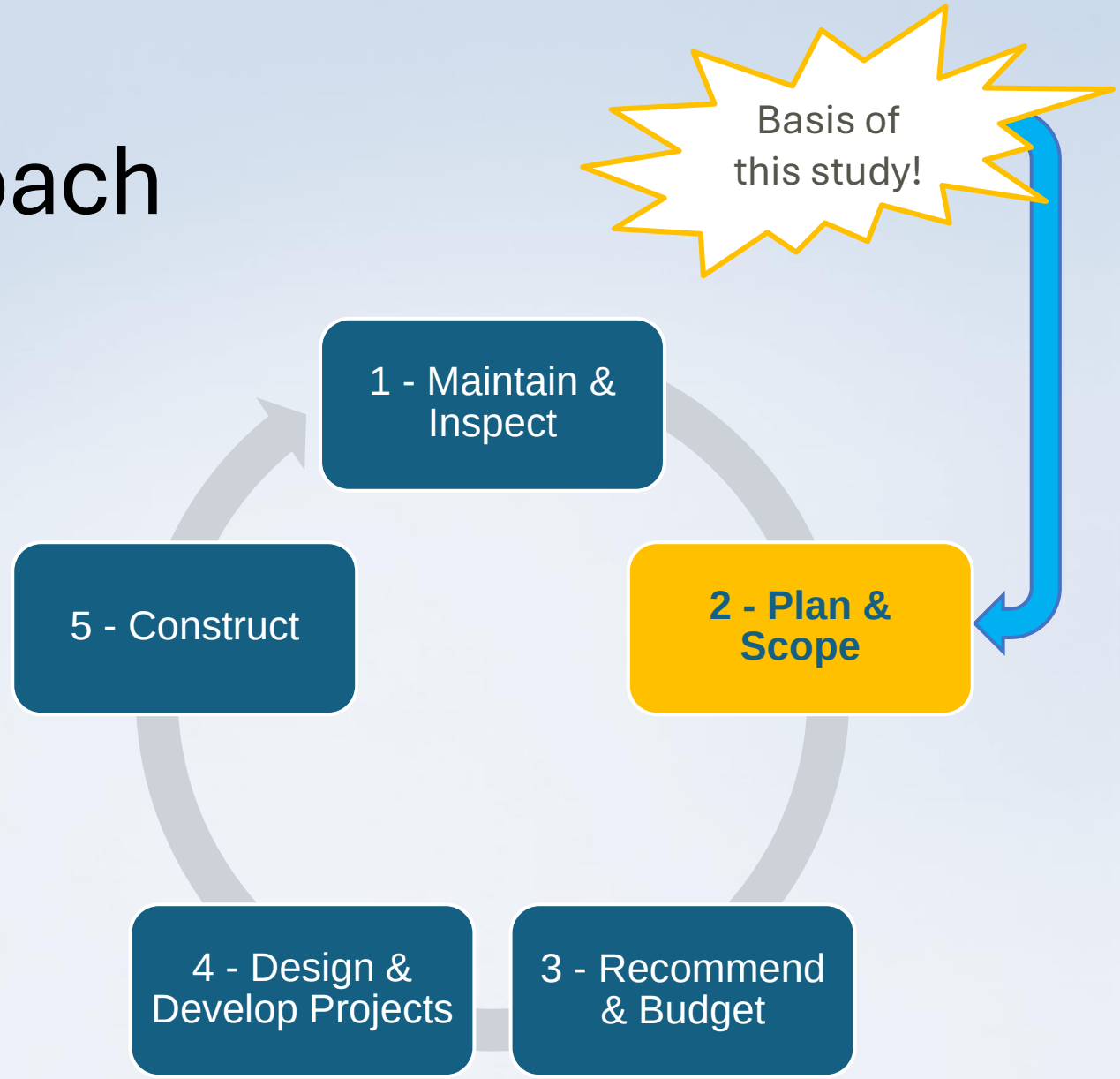


I'VE GOT 99 BRIDGES

And an Asset Management Plan
for Each One...

MnDOT's Typical Approach

1. Perform preventative maintenance and routinely inspect.
2. Plan projects based on condition and user needs. Scope projects for "best-fit".
3. Develop detailed recommendations and establish a budget.
4. Prepare plans and specifications to complete the recommended work
5. Construct



Statewide Risk-Based Planning

- Bridge Replacement and Improvement Management (BRIM)
- Tool used to:
  - Improve planning and programming by considering risk
  - Decision matrix to develop planning level costs
  - Communicate funding needs between District and Central Office

Bridges

Review / All / Other	Relative weights of hazards (a copy of the information entered at left)								Sum			Ranking	
	25.0	20.0	15.0	10.0	10.0	5.0	10.0	5.0	100			Rank of BPI score	
	Scaled BPI times relative weight								Raw R score	Importance factor	BPI score	Entire state	Each district
brkey	rwDeck	rwSuper	rwSubs	rwScour	rwFracCr	rwFatigu	rwOverW	rwOverH	rRawSco	rImporta	rScore	stateranl	distran
5895	5	5	8	1	0	0	6	2	25	1.33	1	1	1
9800	5	2	11	6	6	0	6	5	41	1.39	18	2	2
4667	8	2	1	2	0	0	2	5	19	1.00	19	3	1
5900	13	5	11	1	0	5	2	2	38	1.21	24	4	1
6690	8	2	9	7	0	0	6	5	36	1.16	26	5	1
6515	9	2	4	10	10	1	4	5	45	1.32	27	6	3
09001	5	8	8	7	0	1	0	5	34	1.05	30	7	1
6517	5	2	5	10	10	1	6	5	44	1.20	33	8	4
9265	5	7	4	10	10	1	9	4	50	1.26	37	9	5
5380	5	5	8	7	6	4	2	5	41	1.05	38	10	2
4700	18	11	9	5	0	0	2	5	49	1.18	40	11	2
9300	9	8	8	4	7	5	8	5	54	1.30	40	12	6
4654	23	12	8	8	0	5	0	0	55	1.27	43	13	7
27842	5	5	11	10	10	5	4	3	53	1.21	43	14	8
9114	13	5	8	7	0	5	2	5	44	1.00	44	15	3

Side note: MnDOT now uses BORIS instead of BRIM … same concept, different software platform, more details!

Statewide Risk-Based Planning

- Key component
  District Expert Review
- First-hand knowledge
  - Bridge condition
  - District needs
  - District program
- Establish the likely or desired work type

Bridge Scoping

Using the **expert review information**, we scope bridge projects by:

- Reviewing the inspection information
- Evaluate the load capacity
- Understand the service life goals for the bridge or adjacent roadway

- Evaluate the policy-driven upgrade requirements
- Recommend a work type and associated cost
- Iterate!

Project Overview and Scope

- Task 1 – Project Management
- Task 2 – Data Review
- Task 3 – Load Rating Review
- Task 4 – Material Data Collection
- Task 5 – Service Life Analysis
- Task 6 – Summary of Required Upgrades
- Task 7 – Study of Bridge Work Types
- Task 8 – Bridge Corridor Investment Plan

Corridor Management Plan

Data Review

- Review Inventory and Inspection Data from MnDOT's BRIM database
- Review plans as needed to validate data
- Highlight NBI Conditions for Deck, Superstructure, Substructure
- Highlight substandard load rating and geometric features
- Make initial assessment of proper work type
- Compare initial work type to BRIM suggested work type
- Compare to Bridge Performance Targets

Data Review

Bridge TAMP Targets	Percent Good	Percent Poor
NHS	55%	5%
Non-NHS	50%	8%

Bridges Over I-90	# of Bridges	Good (NBI 7-9)	Fair (NBI 5-6)	Poor (NBI 4 or less)
Deck	42	19 (45%*)	17	6 (14%*)
Superstructure	42	23 (55%)	18	1 (2%)
Substructure	42	20 (47%*)	22	0 (0%)

Bridges Carrying I-90 Only	# of Bridges	Good (NBI 7-9)	Fair (NBI 5-6)	Poor (NBI 4 or less)
Deck	57	31 (54%*)	26	0 (0%)
Superstructure	57	32 (56%)	25	0 (0%)
Substructure	57	25 (44%*)	32	0 (0%)

Items not meeting MN's Transportation Assess Management Plan targets are shown in **(red *)**

Data Review

Work Type	Replace	Redeck	Overlay	Maintain Only
BRIM Recommendation	67	8	2	22
No. Programmed in STIP or CHIP	24	0	3	0

Example of WSB's initial assessment

Action	Period	NBI Deck	NBI Super	NBI Sub	OSOW Route	WSB Intital Review Comment on Work Type and Timeframe
gridact	gridper	Column1	Column2	Column3	Column4	WSB Action - Initial Review
Replace	2043-48	7	7	7	UNDER	Over I-90, NBI 7's, Replace > 20 yrs
Replace	2027-32	5	6	5	ON & UNDER	Permit restrictions. Replace 5-10 ok
Replace	2027-32	5	6	5	ON & UNDER	Permit restrictions. Replace 5-10 ok
OPM	0	7	6	5	UNDER	very low ADT. OL to extend life is ok, but shear cracks

- BRIM recommends many replacements, but in later time periods
- Consider more redecks

Load Rating Review

A. Review existing ratings data

- MnDOT provided BrR files and tabulated results
- WSB reviewed previous data and tabulated results
- Identified 20 bridges that would benefit from update based on:
  - No BrR rating
  - Recent changes in condition
  - Fair condition bridges

Load Rating Review

B. Update existing ratings to LRFR

- Ensure current conditions are modelled
- Rehab or maintain work is included
- Verify material properties
- Highlight bridges with Permit Vehicle Restrictions for use in Tasks:
  - 6: Summary of Required Upgrades
  - 7: Study of Bridge Work Types
  - 8: Corridor Investment Plan

Load Rating Review

- Only 2 of 20 bridges warranted condition review
  - After review no further analysis required.
- In general, LRFR ratings were lower than the LFR ratings for HL-93
- Permit A, B, and C restrictions increased after new ratings
  - from 2 of 20
  - to 8 of 20

Load Rating Review

C. Perform strengthening evaluation (*as-authorized*)

- Determined to not be necessary

D. Perform pier cap evaluation (*as-authorized*)

- Need for this work is still pending
- Based on *new* dead load or *existing* condition

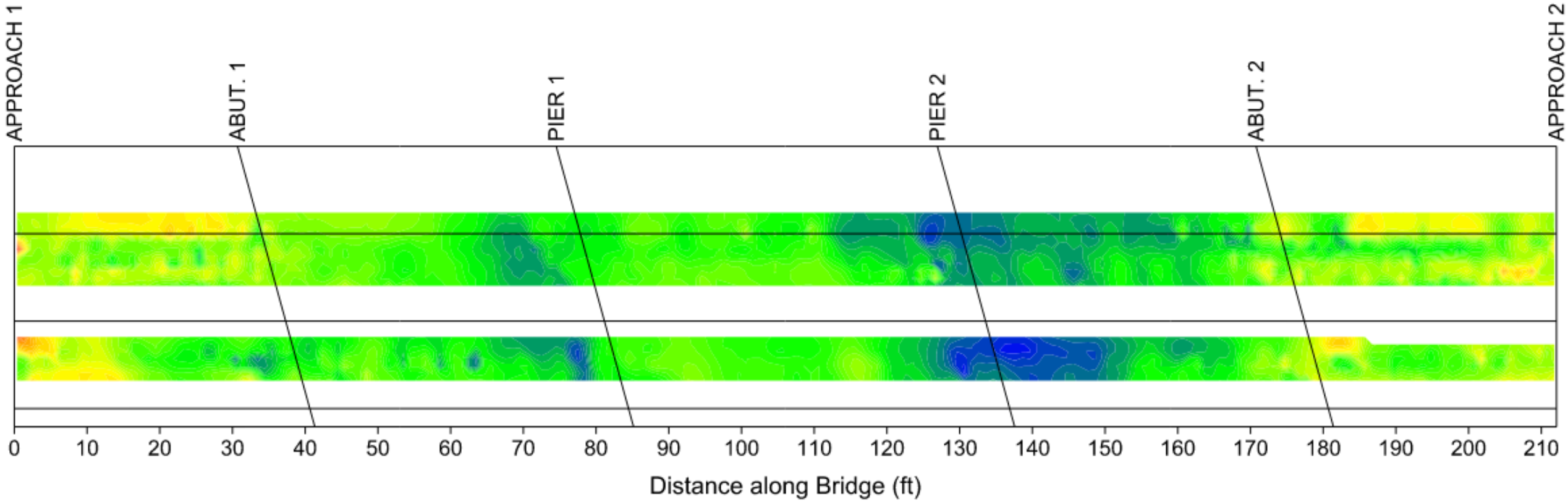
Material Data Collection

- Preliminary Deck Condition Survey
  - Phase 1
  - Phase 2
- Develop an enhanced testing plan – on-going
- Additional material data collection (as-authorized)

Material Data Collection

Preliminary Deck Condition Survey – Phase 1

- Ground Penetrating Radar (GPR) data on 80 bridges to record rebar cover in deck
- Identify low cover for areas of potential advanced deterioration
- Compared field data to anticipated cover based on rehab plans



Concrete Condition Legend	Orientation	Condition Summary				General Information
Concrete Cover Depth (in) 0.4 0.8 1.2 1.6 2 2.4 2.8 3.2 3.6 4 4.4 4.8 5.2 5.6 6	N	Avg. Concrete Cover (in)	3.6			Bridge ID: 24820 I 90 Date Tested: 05/31/2023
		St. Dev. Concrete Cover (in)	0.5			Analyzed by: SVV/MK/MTC Reviewed by: JAC/SDB Completed: 10/04/2023
		Min Concrete Cover (in)	0.9			
		Max Concrete Cover (in)	4.8			Sheet 1 of 1

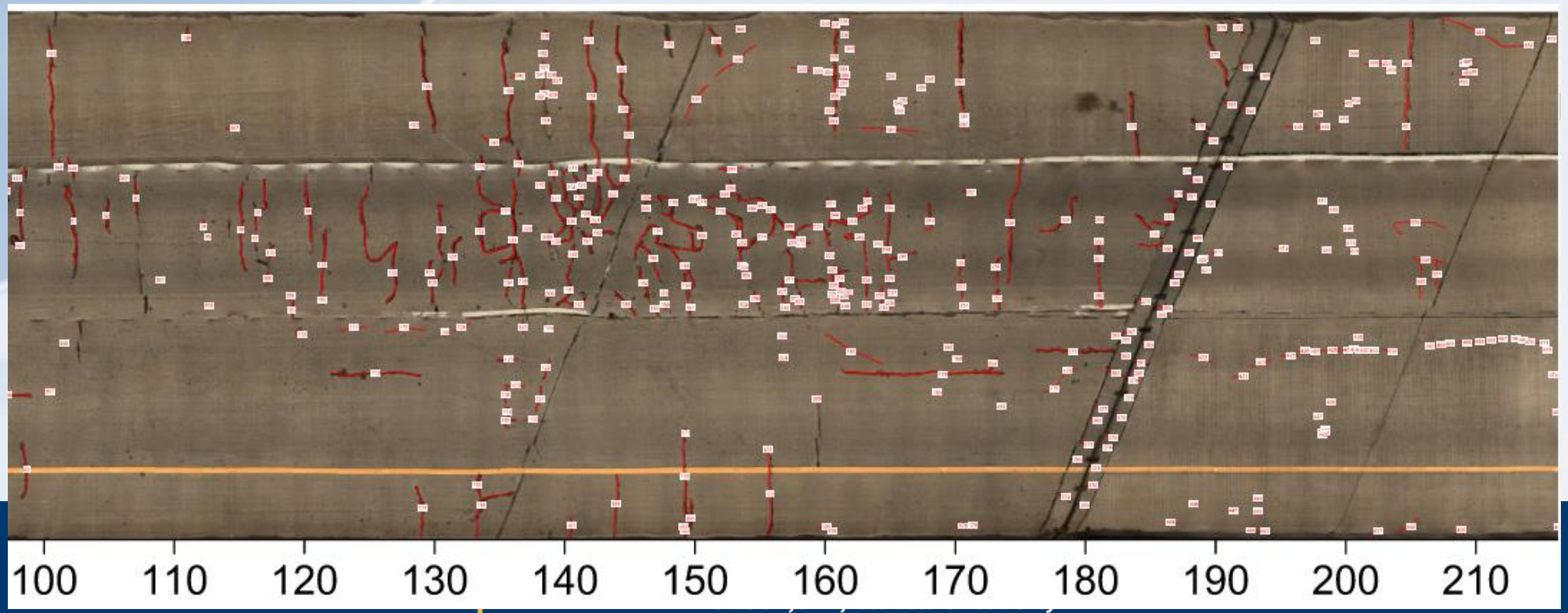
Material Data Collection

Preliminary Deck Condition Survey – Phase 1

- High Resolution Imaging (HRI) data on 40 bridges to record deck cracking
- Identify decks that require sealing or re-overlay or may need redeck

Material Data Collection

- Deck cracking quantity is typically less than recorded on inspection reports.
- Approach panels and HRI resolution are factors. Difficult to note cracks < 0.01”



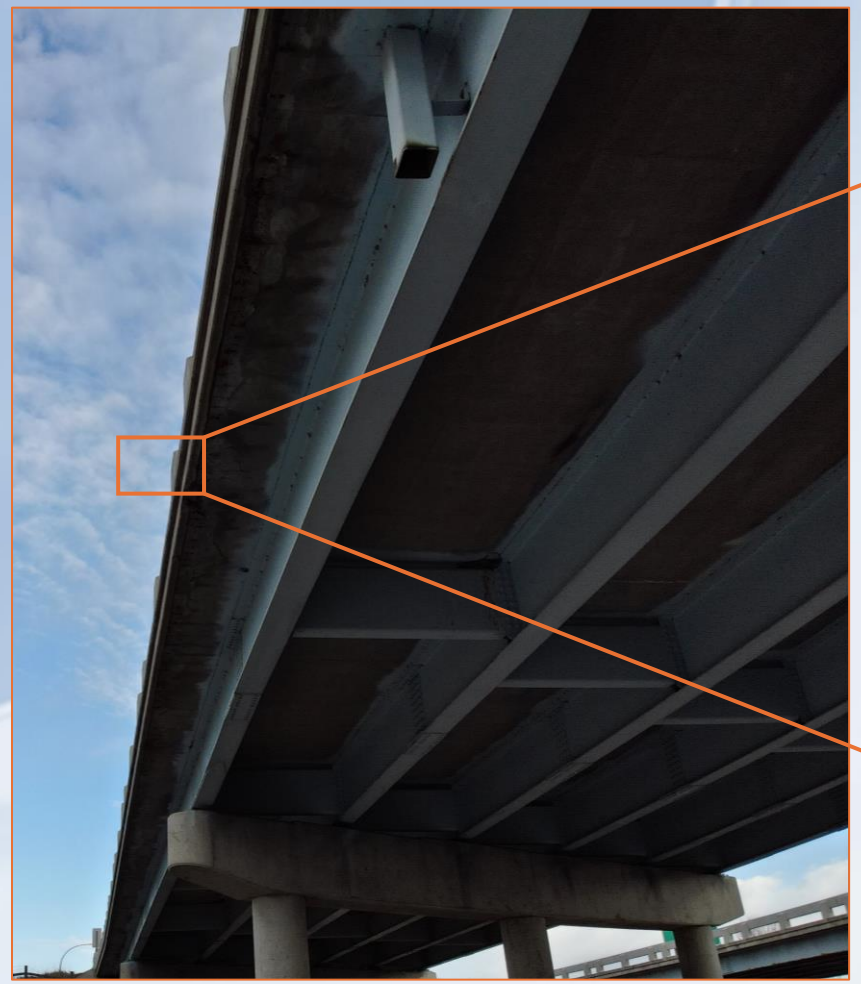
HRI

Material Data Collection

Preliminary Deck Condition Survey – Phase 2

- Capture under deck photos and drone videos of 15 bridges
- 3D reality mesh model on one bridge

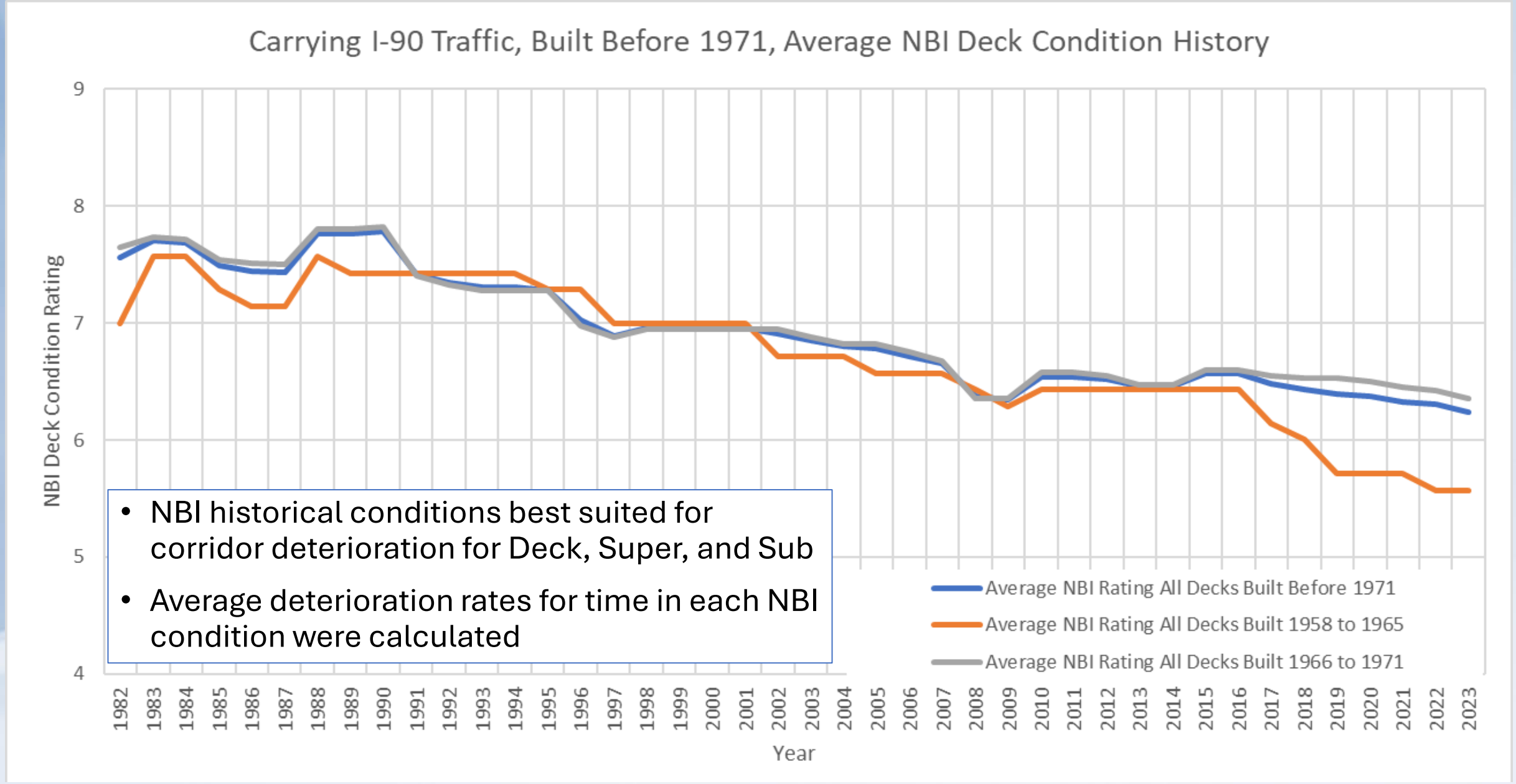
Material Data Collection



Service Life Analysis

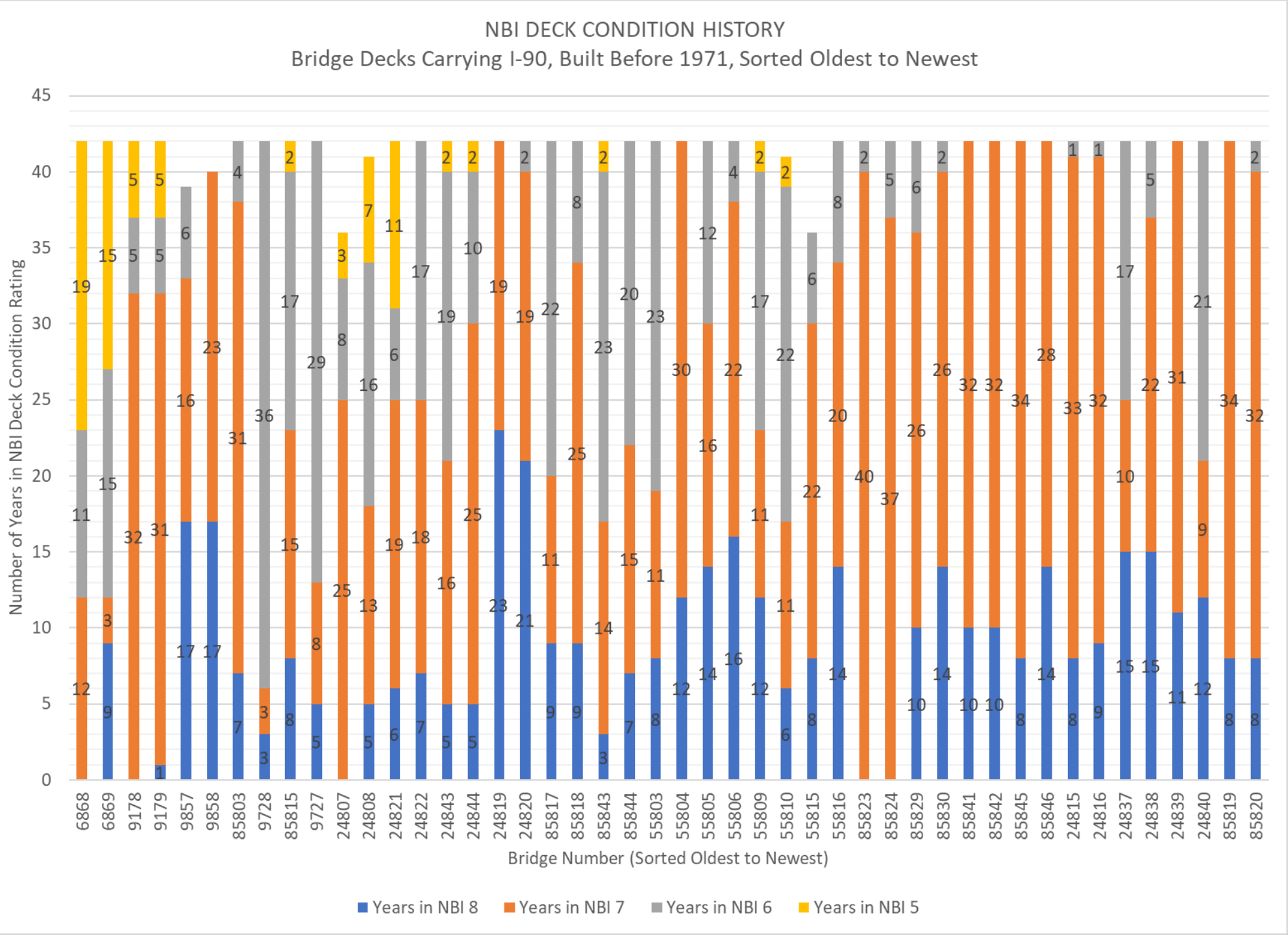
- Used NBI condition history from 1982 to 2023 to establish deterioration and remaining life
- Considered Element Level data
  - Condition definitions have changed, making this harder to work with
- Three Categories to identify any differences in deterioration

Category	Number of Bridges
Built before 1971 and carry I-90	46
Built before 1971 and over I-90	34
Built after 1990	19


Carrying I-90 Traffic, Built Before 1971, Average NBI Deck Condition History
NBI Deck Condition Rating
9
8
7
6
5
4
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Year
Average NBI Rating All Decks Built Before 1971
Average NBI Rating All Decks Built 1958 to 1965
Average NBI Rating All Decks Built 1966 to 1971
• NBI historical conditions best suited for corridor deterioration for Deck, Super, and Sub
• Average deterioration rates for time in each NBI condition were calculated

Service Life Analysis

Deterioration shown as a bar graph for each condition for each bridge



Service Life Analysis

- Years in each NBI condition shown and compared to BRIM estimates
- Estimated years to end of service life
  - Used NBI = 4 to define this for purposes of study
- Actual life > BRIM prediction indicates sound maintenance and preservation actions

Service Life Analysis

Deterioration History & Projections

Table 1A - Decks Category	Total No. Bridges	Years NBI ≥ 8 (1)	Years NBI 7	Years NBI 6 (2)	Years NBI 5 (2)	Years NBI 4 (2)
Built < 1971, carry I-90	46					
BRIM Prediction		14	16	12	10	
I-90 Data		10	21.6	11.7	5.9	0
No. Progressed to next lower NBI		41	37	13	0	0
Built < 1971, over I-90	34					
BRIM Prediction		14	16	12	10	
I-90 Data		8.9	15.8	18.3	10	7.3
No. Progressed to next lower NBI		24	26	12	6	0
Built > 1990, both carry and over I-90	19					
BRIM Prediction						
I-90 Data		7.8	5.1	6	0	0
No. Progressed to next lower NBI		10	2	0	0	0

(1) Most older bridges were already in NBI 8 when data first recorded in 1982, so I-90 data not representative of full NBI 8 year

(2) Most bridges have not fully completed cycle in NBI 6, 5, and 4 so this is not representative of full expected life

Accounting for bridge age

Table 1B - Decks Category	Average Age in 1982	Years NBI ≥ 8	Years NBI 7	Years NBI 6	Years NBI 5	Years to NBI 4
BRIM Prediction Bridges Built Before 1975		14	16	12	10	52
Built < 1971, carry I-90	15	10+15 = 25	21.6+0 = 22	11.7+5 = 17	5.9+6 = 12	76
Built < 1971, over I-90	17	9+17 = 26	16+0 = 16	18+2 = 20	10+3 = 13	75
Built > 1990, both carry and over I-90		8+12 =20	5+15 = 20	6+15 =21	0+20 = 20	81
BRIM Prediction Bridges Built After 1990		13	15			Not Available

Service Life Analysis

Consider:

- Current NBI
- Current Age
- Duration in current NBI

Apply deterioration based on average time from tables:

- Calculate expected years remaining
- Add 20 years for NBI 8 or 9

						NBI Ratings					Deck Remaining Service Life										
					Super load (OSOW)	Good-fair-poor calc			Current Age of Bridge	WSB Deter'n Curve (over or under)	Total Years in NBI 7	Total Years in NBI 6	Total Years in NBI 5	Current NBI Deck Condition	Years Deck in Current NBI Condition	Deck Remaining Years in NBI 7	Deck Remaining Years in NBI 6	Deck Remaining Years in NBI 5	Expected Remaining Life - Deck	Bridge Age when Deck becomes NBI 4
brkey	yearbuil	facility	featint	OSOW_ROUT	D	Deck	Super	Sub	Columi	Columi	Columi	Columi	Columi	Columi	Columi	Columi	Columi	Columi	Column	Column
24806	1967	CSAH 26	I 90	UNDER	7	7	7		57	2	17	18	13	7	22	-5	13	13	26	83

Service Life Analysis

Combine data → Predict remaining service life

								Method 1 Summary	
				Expected Remaining Life - Deck (Years)	Expected Remaining Life - Superstr (Years)	Expected Remaining Life - Substruct (Years)	Least Number of Years for Deck, Super, or Sub to get to NBI 4 - Method 1	Bridge Age when Deck, Super, or Sub Reaches End of Life - Method 1
brkey	yearbuil	facility	featint	Column10	Column11	Column11	Column105101(	Column105101(
24806	1967	CSAH 26	I 90	26	40	46	26	83
24807	1968	I 90	I 35	9	33	11	9	65
24808	1968	I 90	I 35	5	27	1	1	57
24809	1970	CR 61	I 90	36	24	12	12	66

Service Life Analysis

Identified number of years for Deck, Super, or Sub to move into an NBI 4 based on current condition.

Use to inform Tasks 7 and 8

Years to NBI = 4	No. of Bridges
0 – 10	25
11 – 20	26
> 20	30

Summary of Required Upgrades

- Identified geometric and load deficiencies
- Which deficiencies would require replacement or upgrades
- Consider required upgrades *by project type*:
  - Roadway Only Projects
  - Bridge Preservation Projects
  - Bridge Rehabilitation Projects
- Consider MnDOT minimum standards included in Bridge Preservation and Improvement Guidelines (BPIG)

Categories considered:

- Vertical Clearance
- Roadway Width on bridge
- End Posts and Barriers
- Pier Collision Protection
- Pier Evaluation
- Load Rating / Strengthening
- Fatigue Prone Details

Bridge # and Location				Vertical Clearance		Roadway Width On Bridge			
Bridge Number	Facility On Bridge	Feature Crossed	Beam Type Code	Minimum Vertical Clearance, ft	Meets BPIG Req's. for Rehab?	Deck Roadway Width	Roadway Category	Meets BPIG for Rehab?	Design Exception?
24806	CSAH 26	I 90	5	16.5	Yes	29.5	5	Yes	Yes
24807	I 90	I 35	4	16.2	No	46.5	2	No	No
24808	I 90	I 35	4	16.2	No	41.3	2	No	No
24809	CR 61	I 90	5	16.5	Yes	36.0	3	Yes	No

Bridge # and Location	Barrier and End Post Adequacy							Pier Protection Required				
Bridge Number	Speed Limit on Bridge	Current Barrier Code	End Post Satisfactory? Orange = Barrier ok, End Post NG	Barrier meets MASH TL-3 for high-speed roadway?	Meets MASH TL-2 for low speed?	End Posts meet MASH TL-3	End Posts meet NCHRP 350	No. of Columns on Multi Col Pier	Lateral Clearance to Side Pier	Protection Req'd	Type of Existing Protection	Consider Pier Protection for Rehab Projects?
24806	55	3	-	NO		-		2	10	Yes	Strut 2	Yes
24807	70	22	S	YES		Yes		2				Yes
24808	70	3	NS	NO		No		2				Yes
24809	50	3	NS	NO		No		3	30	No	None - G	Yes

Bridge # and Location	Pier Evaluation Required (Condition Only)			Load Restriction and Strengthening (Existing)					Steel Beam Fatigue Prone Details		Identified by Dist for Replacement
Bridge Number	Element #234 Percent in CS3 (0% in CS4)	Element #883 Shear Cracking Condition	Pier Evaluation Req'd	Permit Code A Restriction	Permit Code B Restriction	Permit Code C Restriction	Inventory Rating (HS or HL93)	Is Strengthen Required?	Fatigue Detail Class	Non-Redundant Steel Members?	
24806	0.0%	CS2	No	1	1	1	HS 23.2	NO			
24807	8.0%	CS2	No	1	2	2	HS 17.2	YES - Existing	C'	Yes?	Yes
24808	8.9%	CS2	No	1	1	2	HS 17.5	YES - Existing	C'	Yes	Yes
24809	15.0%	CS2	Yes	1	1	1	HS 12.9	NO			

Summary of Required Upgrades

- Different Upgrade Needs Depending on *Project Type*
- Upgrade needs will push some bridges to replacement instead of rehab
- Barrier or end post work needed on most bridges
- Vertical clearance upgrades needed on many bridges
- Bridge Strengthening required on many bridges

Summary of Required Upgrades

	Roadway Projects w/ no Bridge Work								Major Bridge Preservation								Bridge Rehabilitation							
Bridge Number	Vertical Clearance	Roadway Width on Bridge	Barriers	End posts	Pier Collision Protection	Pier Evaluation	Bridge Strengthening	Fatigue-prone details	Vertical Clearance	Roadway Width on Bridge	Barriers	End posts	Pier Collision Protection	Pier Evaluation	Bridge Strengthening	Fatigue-prone details	Vertical Clearance	Roadway Width on Bridge	Barriers	End posts	Pier Collision Protection	Pier Evaluation	Bridge Strengthening	Fatigue-prone details
24806				X	X						X	X	X					2	X	X	X			
24807	3				X								X				X	X			X		X	
24808	3			X	X						X	X	X				X	X	X	X	X		X	X
24809				X	X						X	X	X	X					X	X	X	X		
24810	3			X	X						X	X	X	X			X	2	X	X	X	X	1	X
24813	3			X	X						X	X	X	X			X		X	X	X	X		X
24815				X							X	X		X					X	X		X	X	X
24816				X							X	X							X	X			1	X
24817	3			X	X						X	X	X				X		X	X	X			

Data Review

+

Load Rating Review

+

Material Data Collection

+

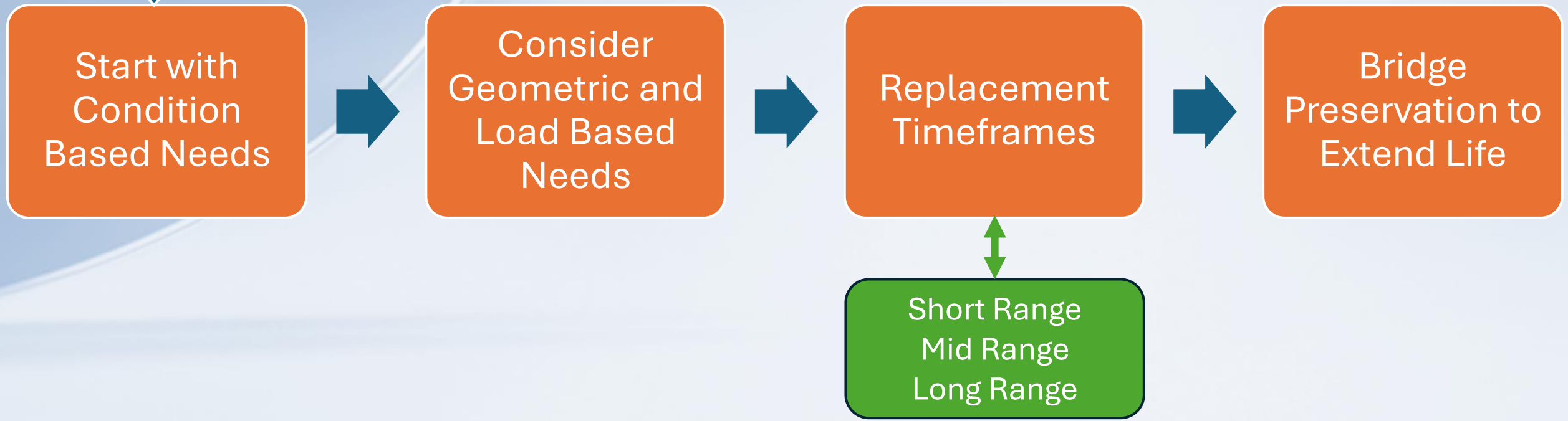
Service Life Analysis

+

Summary of Required Upgrades

→ Study of Bridge Work Types

Study of Bridge Work Types



Study of Bridge Work Types

Consider these Work Types vs. 2023 BRIM predictions:

Task 7 Summary - Type of Project	Number of Projects			BRIM Scoping	
Replace 0-10	23	54		Replace	67
Replace 10-20	17				
Replace 20 - 30	14				
Redeck	9	15		Redeck	8
Redeck & Raise	6				
OL & Joints	20	30		OPM	24
OL & Joints - 30+ years	10				
Total Bridges	99			Total	99

Bridge Corridor Investment Plan

- Develop Project Recommendations
- Funding Scenarios which will align with MnDOT's Statewide Highway Investment Plan (MnSHIP)
  - Consistent high-level funding available
  - Consistent low level funding constraints
  - Variable funding required to complete all initial work within 20-year window

Bridge Corridor Investment Plan

- Consider bundling projects
- Consider tying with Roadway projects
- Compare to MnDOT processes – TAMP and STIP/CHIP
- Coordinate with new Corridor Planning Director and newly developed district life cycle and performance targets

What's Next?

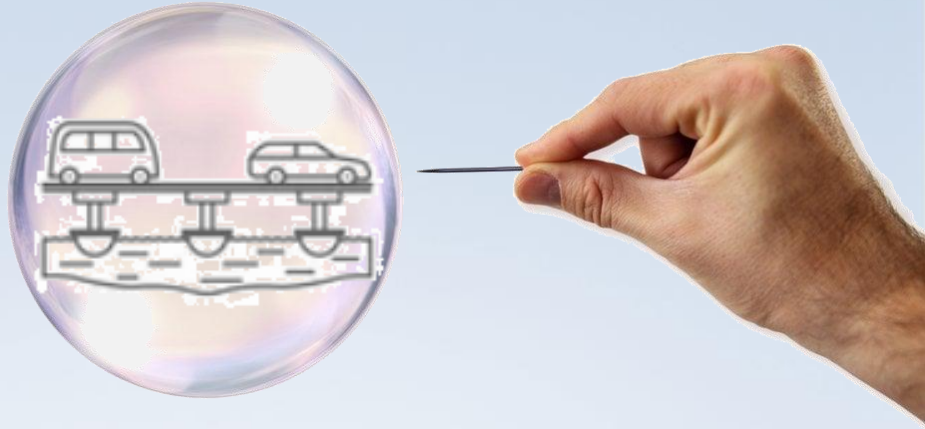
MnDOT District 6

- Inform bridge decisions for projects already in the CHIP (10-year plan)
- Formalize scoping documents for projects already in the CHIP
- Plan projects 10 to 20 years out

MnDOT Bridge

- Use the lessons learned to refine our internal scoping process
- Work with other Districts or other Corridors

Thank You!



Don’t Pop The Bubble

MnDOT D6 I-90 Corridor Management Plan

Nick Haltvick, P.E. (MN)

Minnesota Department of Transportation

nick.haltvick@state.mn.us