

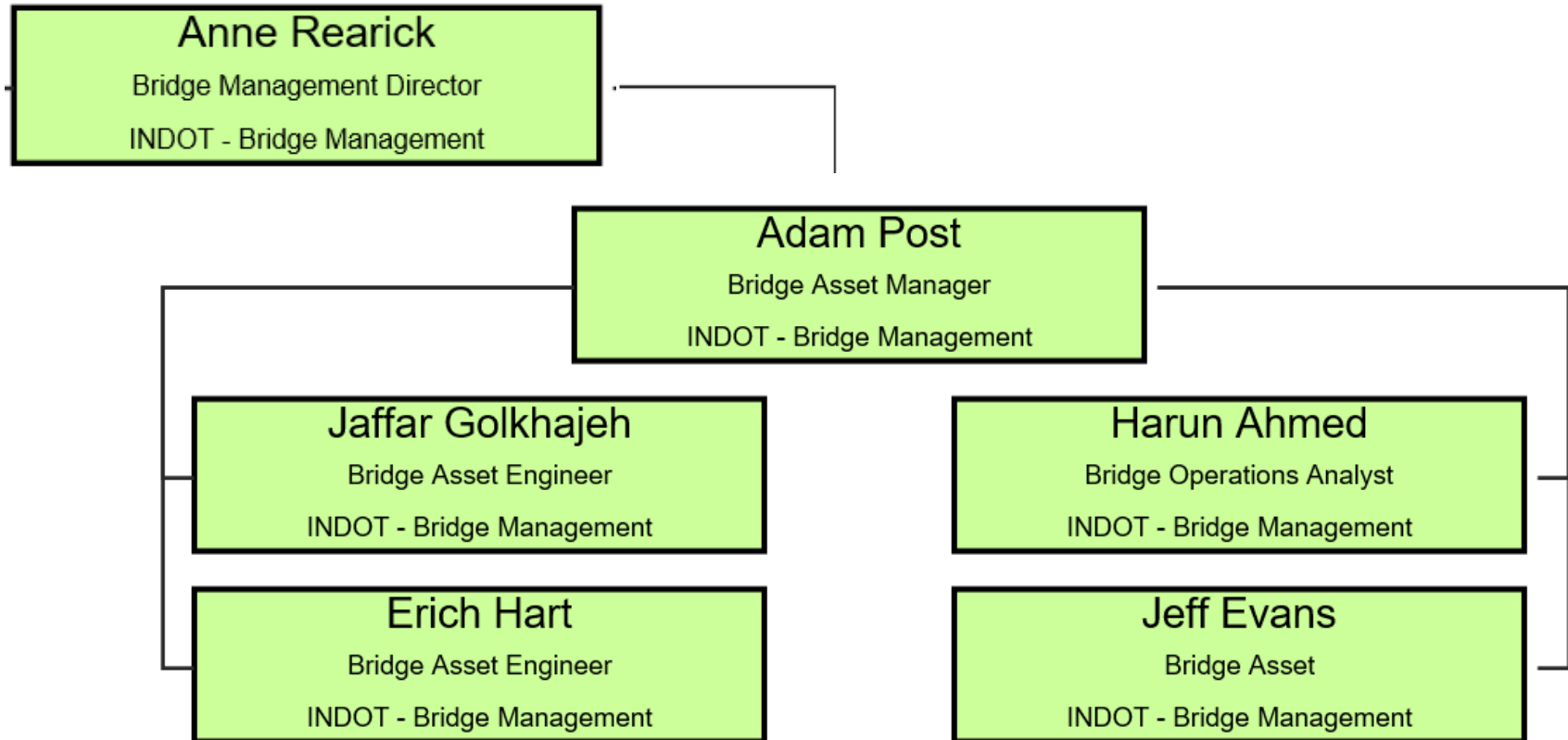


Bridge Inspection Workshop Introduction to Bridge Asset Management

Adam Post & Erich Hart
Bridge Asset Management



INDOT CO Bridge Asset Team

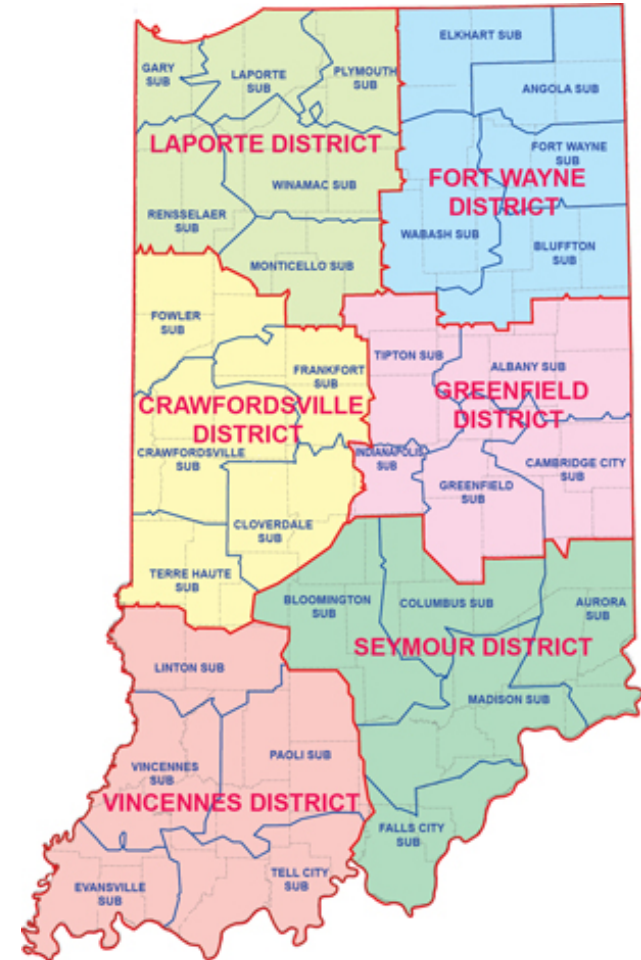


INDOT District Bridge Asset Team



■ 6 District Bridge Asset Engineers (BAEs)

- Chris Wheeler – Crawfordsville
- Keith Lytton – Fort Wayne
- Darryl Wineinger – Greenfield
- Mark Pittman – LaPorte
- Adam Pyle – Seymour
- Jason Heile - Vincennes

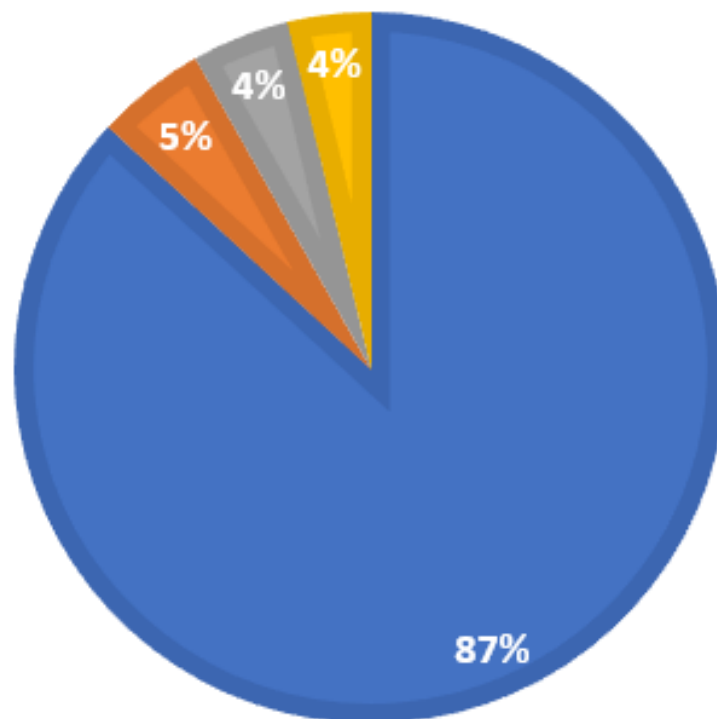


INDOT Bridge Program



INDOT BRIDGE PRESERVATION

■ Capital (Call) ■ Border Bridge ■ BCPMA ■ Small Culvert



INDOT Bridge Program



- **Bridge Preservation (\$400-500M budget)**
 - Border Bridge Program
 - +/- \$20M per year
 - Won't score well against other projects
 - BCPMA (Preservation) \$18M / year
 - \$3M per district
 - 2 year program
 - Projects selected by District and score 100 if meet criteria



INDOT Bridge Program



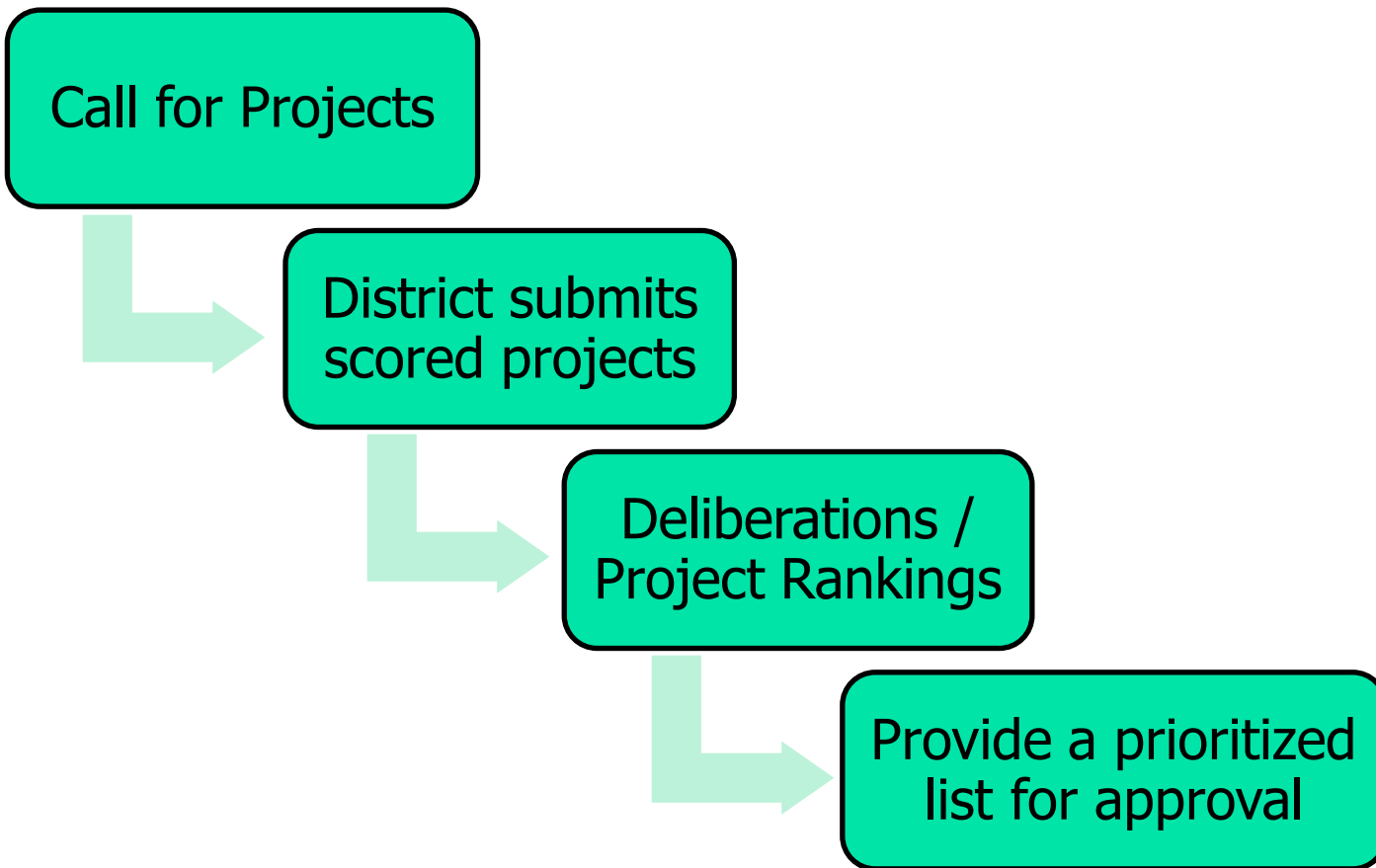
- **INDOT Bridge Preservation (cont'd)**
 - Small Culvert (<4' structures) \$15M/year
 - Projects selected by District and score 100 if meet criteria
 - Can't be done Road Project, or Maintenance project and only for cross pipes
 - 5 Year Bridge & Lg Culvert Call (approx. \$350-450M)
 - Minor Projects – Thin and rigid overlays, Painting, scour
 - Major – Deck/Super replacement, Bridge/culvert replacement



INDOT Bridge Program



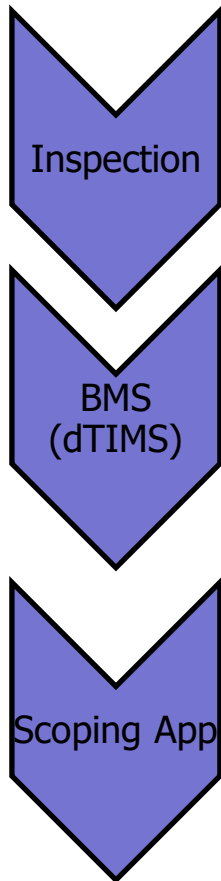
■ Programming Steps (5 year Call)



Project Forecasting (Call)



■ How do the BAEs come up with their list of projects?



- Data entered into AssetWise / BIAS
- Inspection data automatically sent to dTIMS

- NBI data from BIAS
- Bridge History from SPMS / BIAS
- Program output recommends work type and year for each asset

- dTIMS output given to BAE's as a starting point for their list
- BAEs review dTIMS results, inspection reports, and site visit
- Adjustments may be made to treatment/year and entered into App
- Enter scope, CN cost, bridge score, R/W, MOT, Utilities into the App



Bridge Management Systems



■ Bridge Management Systems (BMS)

- What is a Bridge Management System (BMS)?
- INDOT's Bridge Management System
- How is it impacted by bridge inspection?



Bridge Management System



■ What is a Bridge Management System (BMS)?

- Bridge Management System (BMS): systematic data-driven approach for using the available bridge data to help objectively make decisions regarding maintenance, rehabilitation and replacement (bridge preservation).
- A system that helps decision makers understand the trade-offs associated with allocating limited funds over a network.
- All personnel, procedures, documents, manuals, hardware and software



Bridge Management System



■ Major parts of INDOT's BMS?

- Bridge Inspectors & BIAS (AssetWise)
 - Where we get our information for decision making
 - BIAS: consistent; ease of automation; data integrity
 - Bridge ID, size, type, component conditions, ages, etc.
- INDOT's Bridge Asset Business Rules (Scoring Rules)
 - Got to have them. Need to be able to repeat process
 - Rules & policies agreed upon by our 6 district asset engineers
 - These rules and policies lead to standardized tables of treatments, triggers, resets and scoring tables.
 - They also document how we compute benefit and costs





■ Business Rule - Treatment Thresholds

	TRIGGERS					RESETS			
WT	WS	DC	SP	SB		WS	DC	SP	SB
Thin Deck Overlay (only 2 allowed)	>=6.0 <= 8.5	>= 5.5	>=5.0	>=5.0		+1 (6/7) Hold 8 Years (8)	Hold 8 Years		
Deck Overlay (rigid) (only 2 allowed)	>=2.5 <=6.5	>=5.0	>=5.0	>=5.0		9	+2 (5) +1 (6/7)		
Deck Replacement	<10	<5.5 ↖5	>=5.0	>=5.0		9	9		
Superstructure Replacement	<10	<10	<5.0 ↖=4	>=5.0		9	9	9	
Bridge Replacement	<10	<10	<10 *<5.0	<=4.5 *<5.0		9	9	9	9

Kept 15 year interval rule (for now) for all major WT's except Thin Deck Overlay. Matched Thin Deck interval to Hold Years (8 years). Want to allow Thin Deck Overlay on new decks.

Red: revisions to Major Triggers **Green:** Alternate Trigger for Bridge Replacement (How evolved???)



Bridge Management System



■ Business Rules – Score Table

- Scoring table for possible Bridge Deck Overlay
- Higher scores given to lower WS (5, 4 or 3's) with higher DC (6, 7 or 8's)

Wearing Surface Scoring Table (Use for Deck Overlay Projects)

Wearing Surface Condition	Score Values for Wearing Surface Condition Assuming Superstructure & Substructure both > 4 (0 otherwise)										
	Deck Condition										
		0	1	2	3	4	5	6	7	8	9
	0	0	0	0	0	0	0	1	6	6	6
	1	0	0	0	0	0	0	3	7	7	7
	2	0	0	0	0	0	1	4	8	8	8
	3	0	0	0	0	0	2	6	9	9	9
	4	0	0	0	0	0	4	8	10	10	10
	5	0	0	0	0	0	6	10	10	10	10
	6	0	0	0	0	0	5	8	9	9	9
	7	0	0	0	0	0	2	2	4	4	4
	8	0	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	0	0	0



Bridge Management System



■ Other Major Parts of INDOT's BMS

- Two other tools to discuss
- Score Sheet
 - Scores a given treatment for a given bridge
 - Looks at one bridge at a time.
- Network Optimization Software
 - Looks at all bridges as a network and considers all treatments
 - Looks at the network over a specified analysis period
 - We typically use 20 years.



Extra – INDOT Bridge Project Scoring



BRIDGE SCORE INPUT

Des #			
NBI #	80596		
AADT	3500 <= AADT < 5000	3820	
Functional Classification	Other Principle Arterial (Urban)	14	
Total Estimated Cost	\$600,000	Not Found	<= (SPMS)
Fiscal Year	2023		
Proposed Treatment	Deck Overlay		

Bridge Inspection Information		Override	Scores
Structure Length	Dec Ft 282.2	282.2	
Width Out to Out	Dec Ft 50.3	50.3	9
Wearing Surface Rating	1-9 6	6	9
Deck Rating	1-9 7	7	0
Superstructure Rating	1-9 7	7	0
Substructure Rating	1-9 8	8	0
Culvert Rating	1-9 0		
Geometry (Override only)	1-9 9	Override for super/sub if <6	N/A
Paint	1-9,N N		
Scour Critical	1-9,N N		
Fracture Critical	Y/N N		
Hydraulic Adequacy	1-9,N N		
Historical Significance	1-3 3		

Developed by R.E. Montgomery and modified by Jeffrey Goldhagen in accordance with SAMT rules for FY 2023 call & ACP on 7/7/17

Proposed Treatment Added Life	20
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	Life	Score
Deck Overlay	20	9
Deck Replacement	35	0
Superstructure Replacement	55	0
Total Replacement	75	0
Thin Deck Overlay	12	9

BRIDGE SCORE SHEET

Bridge #	031-34-08829	Location	US 31 SB/NB, mi 01.40 S SR 931
Project Status	Not Found		
NBI	80596		
District	03 - Greenfield		
Route	US35/SR22WB CR400N Work Type (SPMS)	Not Found	
County	034 - HOWARD		
Ref Post	161 + 8	Trans System (SPMS)	Not Found
Area Of Deck	14194.66 SF	Prop Treatment	Deck Overlay

The Proposed Treatment for this Structure is Deck Overlay

CONDITION SCORE	9	X 5	=	45
COST EFFECTIVENESS SCORE	8	X 3	=	24
FUNCTIONAL CLASSIFICATION	6	X 1	=	6
AADT SCORE	3	X 1	=	3
SUPPLEMENTARY	0	X 7	=	0
TOTAL PROJECT SCORE				78



Extra – INDOT Bridge Project Scoring



- Different weights are assigned to each factor based on importance
- Scoring of 0-100 with 100 being the highest priority projects

Scoring Factor Number (SF)	Bridge Scoring Factor Description	Score	Weights to Convert to 100 Point Scale (W)	Maximum Possible Weighted Score
# 1	Condition	0-10	5	50
# 2	Cost-Effectiveness	0-10	3	30
# 3	Functional Classification Priority	0-10	1	10
# 4	AADT Impacts	0-10	1	10
Sub-Total				100
Supplementary (S) Factor	Earmarks & Other Financial Contributions by External Means	0-5	7	35
Grand Total				135



Bridge Management System

■ The Future (and present)



- **Network Optimization Software – dTIMS BA - Deighton**
 - Database Application that looks at the entire network of bridge assets, selects treatments and makes trade-offs based on what creates the most benefit to the network with limited budget.
- Pulls necessary data directly from BIAS and SPMS
 - Most data from BIAS. Committed projects from SPMS
- Programmed with INDOT's Business Rules
 - Business Rules = Treatments, Triggers & Resets
 - Knows when treatments allowed and their impacts (resets) to conditions
 - Cost Estimating Lookup Tables & Budgets
 - Component Deterioration Curves



Bridge Management System

■ This sounds like voodoo



- Optimization software is not a black-box
 - It is repeating steps we have done by hand in the past and have documented in our business rules
 - It does all these steps, for every bridge, for every treatment, for every year in the analysis
 - It combines the above into many strategies per bridge
 - It computes costs and benefits for each strategy for the length of the analysis
 - It combines the bridge strategies into plans based on allowable budget.

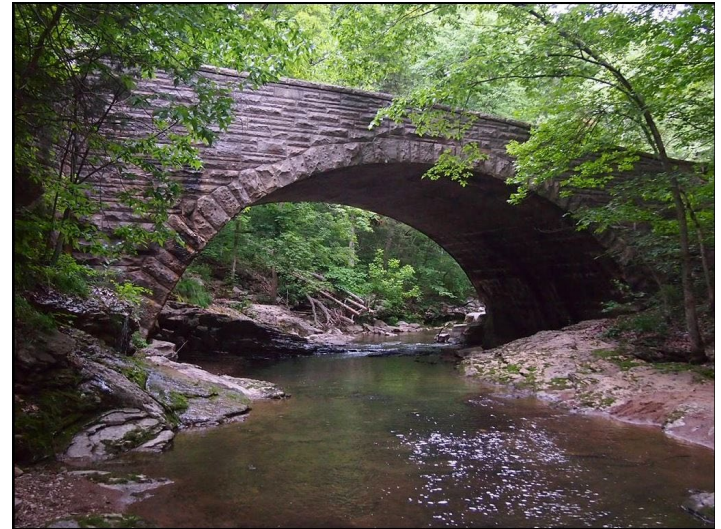


Bridge Management System



■ Why do I want software to do this?

- 20-year analysis
- Approximately 5,800 bridge assets
- dTIMS will generate approximately 370,200 Strategies and 628,000 Treatments.
- 1 to 3 treatments per strategy.
- Averaging 64 strategies per bridge
As few as 9 for some bridges and as high as 100 for others.



Bridge Management System



■ What do we do with all these Strategies???

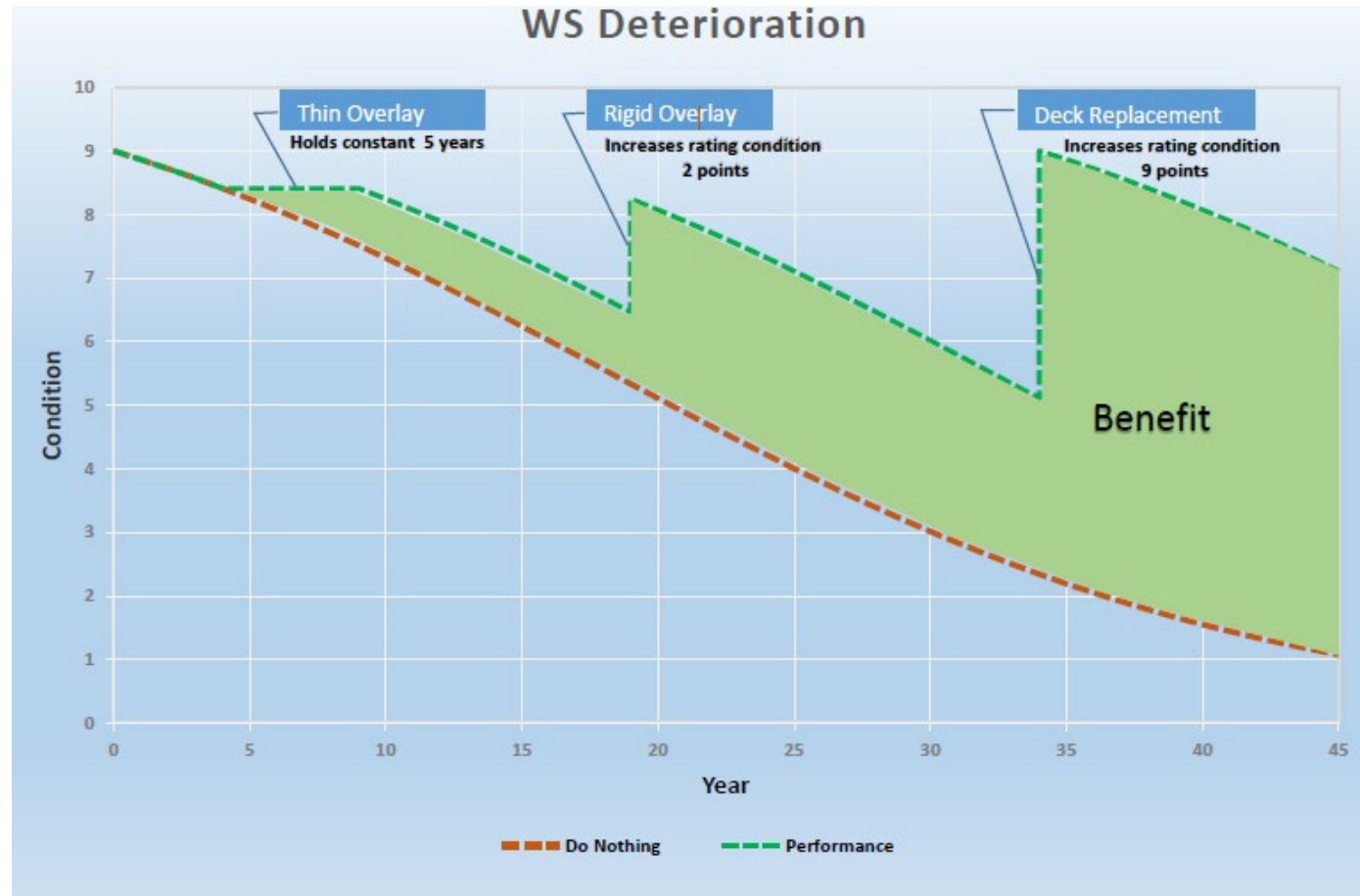
- Optimize to get greatest benefit for available money
 - Like other software dTIMS has an optimization engine that uses mathematical tools and optimization strategies. Also does a lot of brute force number crunching
 - Benefit is referred to as the optimization function and at INDOT we currently use Bridge Quality Index (BQI). BQI is the aggregate of 6 components: WS, DC, SP, SB, Load Rating & Geometry
 - dTIMS actually computes the area between the Do-Nothing BQI and the Performance BQI (Do-Something BQI)
 - Maximizes the cumulative BQI for entire network over the full length of the analysis.



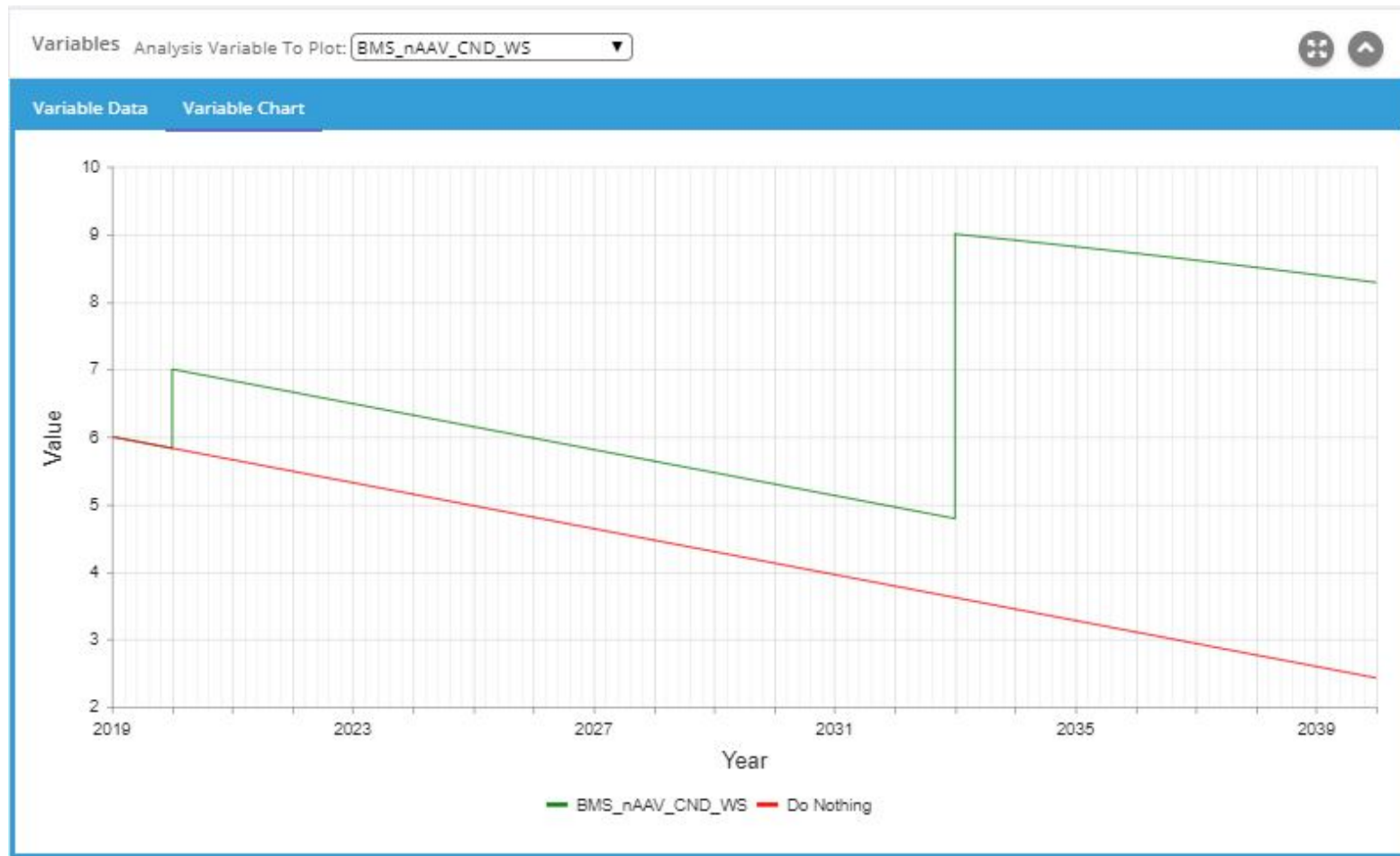
Bridge Management System



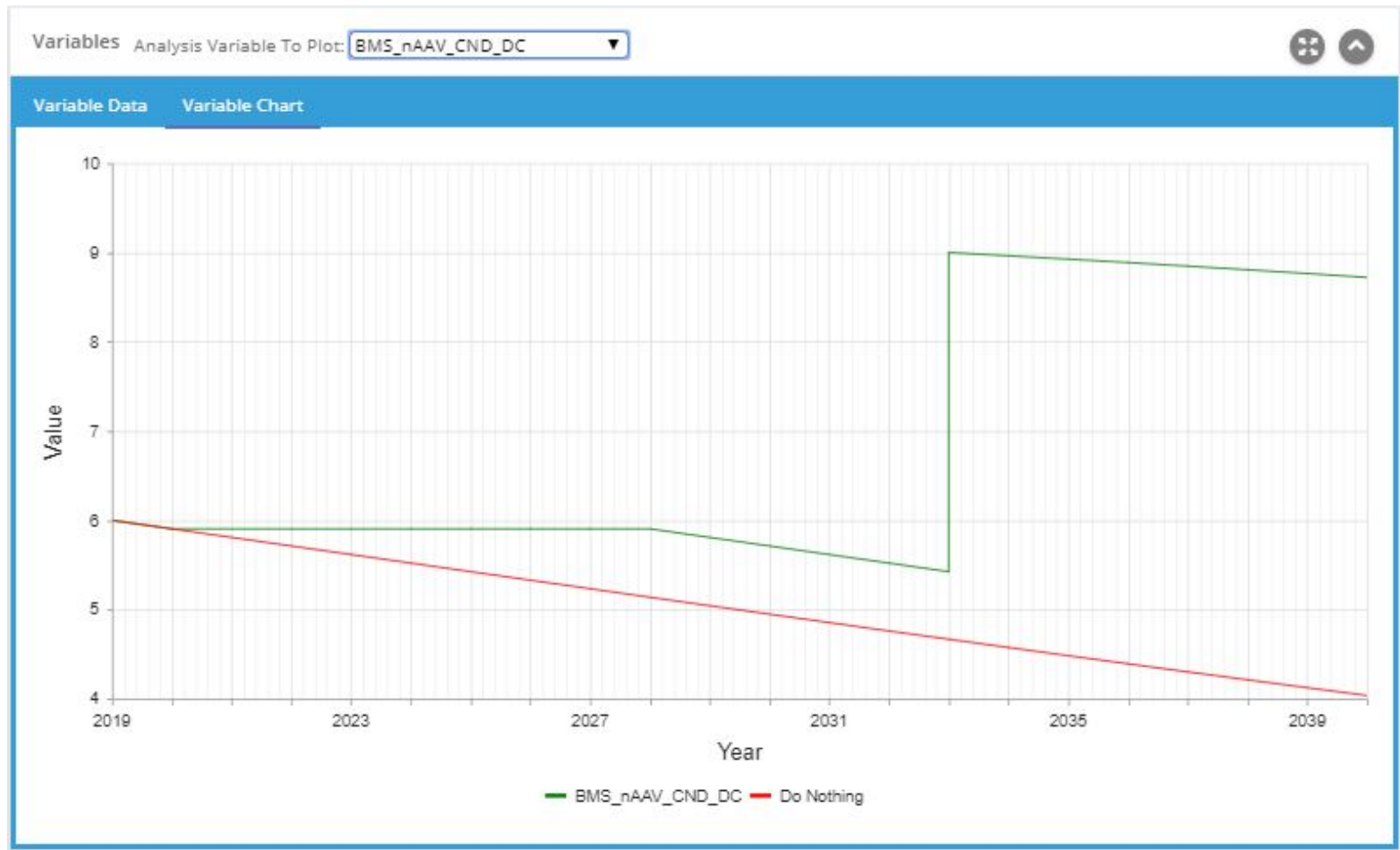
■ Benefit



dTIMS Business Analytics



dTIMS Business Analytics



dTIMS Business Analytics



Element Data

Export to Excel

Drag a column header and drop it here to group by that column

RoadName	Name	From	To	Lane
3830000005000001	043760	9.498	9.621	489
38300000013000001	043770	2.458	2.580	490
38300000017500001	043810	4.434	4.556	491
38400000013000001	041040	4.845	4.993	492
38400000067000001	041300	2.832	2.924	493
38400000067000001	041310	2.893	2.985	494
384000000347000001	015050	3.366	3.504	495
384000000886000001	080650	0.894	1.032	496

401 - 500 of 5980 items

Strategy Data Efficiency Chart Strategy Chart

Export to Excel Select Strategy Reset Strategy Reset All Strategies

Year	First Major	Benefit / Cost	PV Benefits	PV Cost
2025	BMS_DeckReplacement	0.004196932	\$335.12	\$79,849.58
2026	BMS_DeckReplacement	0.004030933	\$318.77	\$79,081.80
2027	BMS_DeckReplacement	0.003860609	\$302.37	\$78,321.40
2028	BMS_DeckReplacement	0.00368621	\$285.93	\$77,568.31
2029	BMS_DeckReplacement	0.003507981	\$269.49	\$76,822.46
2030	BMS_DeckReplacement	0.003321674	\$252.73	\$76,083.78
2020	BMS_ThinDeckOverlay	0.002870016	\$244.10	\$85,051.92
2021	BMS_ThinDeckOverlay	0.002863437	\$243.23	\$84,944.78
2031	BMS_DeckReplacement	0.003133884	\$236.15	\$75,352.20
2020	BMS_ThinDeckOverlay	0.002740216	\$231.11	\$84,341.24
2021	BMS_ThinDeckOverlay	0.00273653	\$230.51	\$84,234.11
2032	BMS_DeckReplacement	0.002944773	\$219.76	\$74,627.66



Treatments

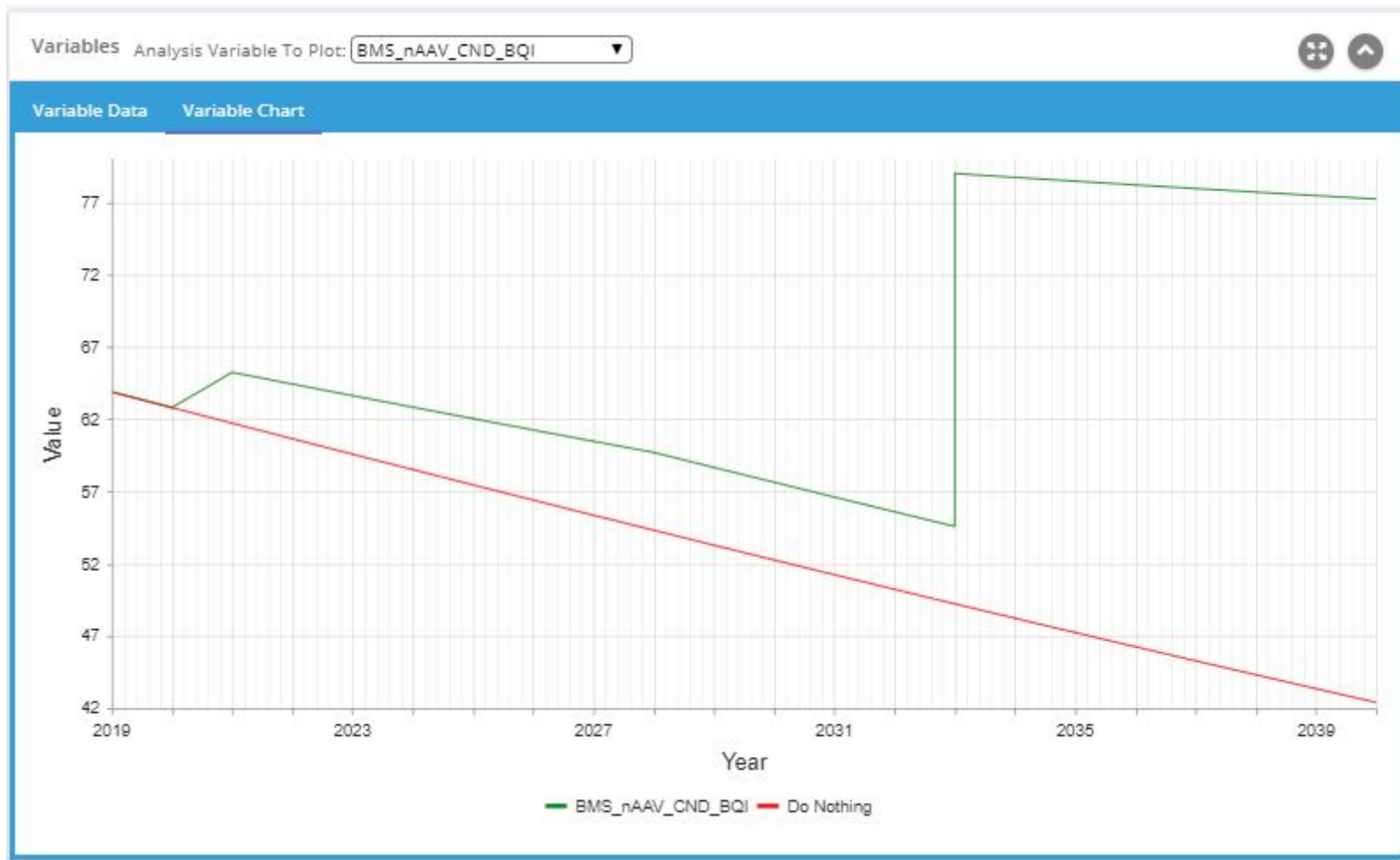
Strategy Treatments Original Strategy Treatments

Export to Excel

Year	Treatment	Treatment Type	Budget Category	Financial Cost	Economic Cost
2020	BMS_ThinDeckOverlay	Major	BMS_Maintenance	\$145,515.83	\$0.00
2033	BMS_DeckReplacement	Major	BMS_Deck_Replace	\$1,607,277.84	\$0.00



dTIMS Business Analytics



Bridge Management System



■ INDOT's BMS

- Bridge Optimization Software – Summary
 - Bridge Inspection is everything (key to early forecasting)
 - Documented Business Rules
 - Score Sheets (starting place)
 - Network Optimization Software (maybe a long-term goal)
 - All work together as a system to evaluate data and focus resources (\$\$\$)
 - Defend investment decisions (trade-offs).



Bridge Management System



- How is BMS impacted
- by Bridge Inspection



Bridge Management System



■ Better be obvious by now!

- Inspection Data / BIAS – All starts with the inspection data.
- Accurate reporting of condition ratings dictate the quality of forecasting we generate from score sheets and optimization software
- Difference in a single point for a single condition will change what is forecasted
- Condition ratings from the last 26 years are used to develop our deterioration curves. Cleaner data means better deterioration curves and better forecasting.



Bridge Management System



■ Deterioration Curves – A field unto themselves

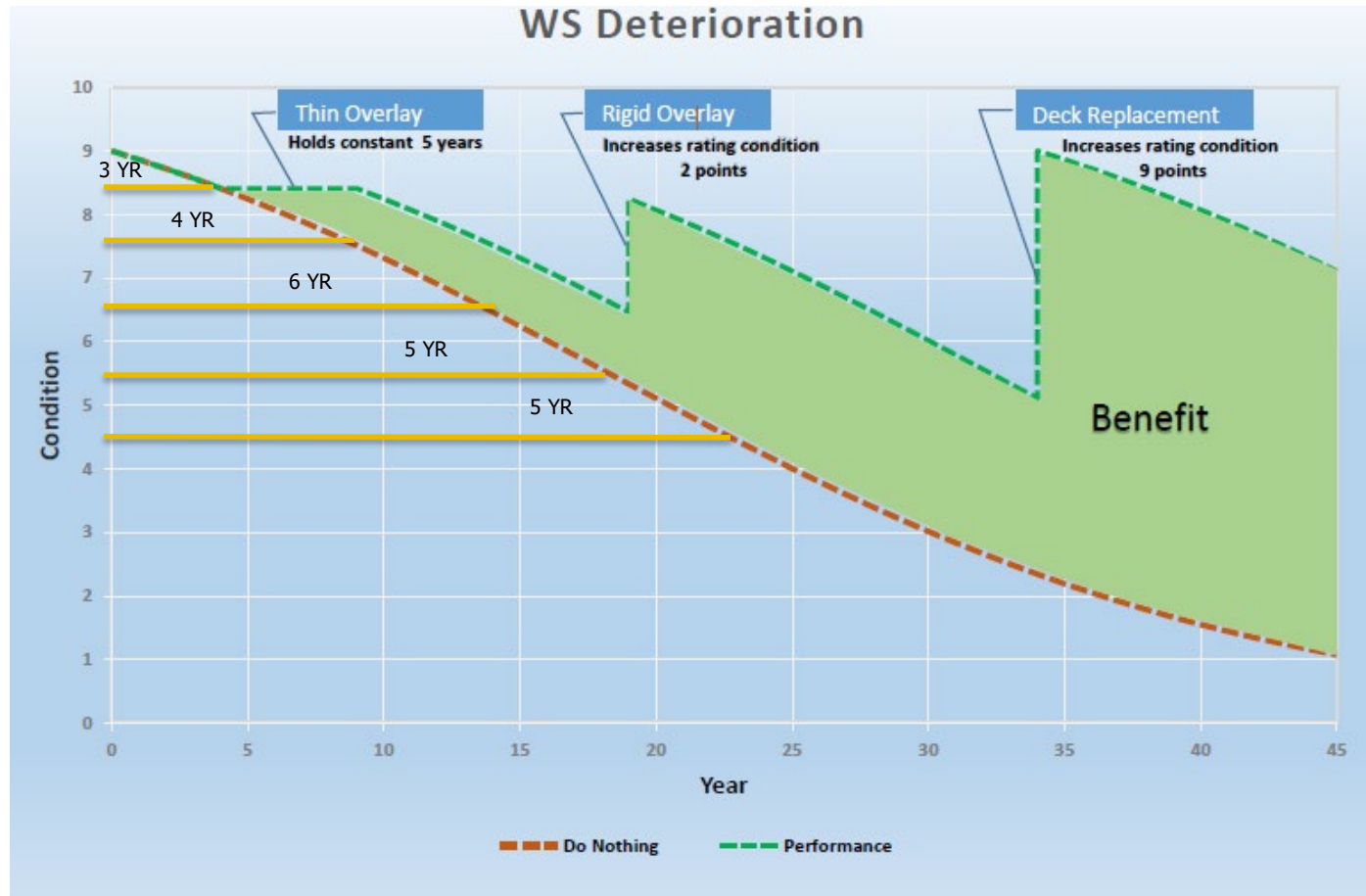
- Many publications out there explaining deterioration curves and how to develop
- We use 26 years of Fed Tape Data
- A lot of work Filtering out censored data (cleaning)
 - Can only use about 18% of the data
 - Data can be censored by rehabilitation projects, anomalies, noise (mind changing)
- Cluster the data
- Determine residency at each condition state
- Fit new deterioration curve to residency times.



Bridge Management System



■ Deterioration Curves



Questions?



■ Questions & Feedback?

■ Contact

- Adam Post – apost@indot.in.gov
- Erich Hart – ehart@indot.in.gov

Thank you!



Bridge Management System



■ Extra if time

- Common issues that censor data
 - Bridge Rehab Projects (Expected)
 - Reside too long in single condition state:
 - Burn through condition states too fast
 - I.E.: DC = 9(1 YR), 8 (2 YR) 7 (6 YR)
 - Noise / Anomalies: Spikes (up or down)
 - Un-Explained Increases – No Associated Treatment
 - Condition rating drops by 2 or more



Bridge Management System



- **Extra if time.**
- **Can other entities use similar process (YES)**
 - Entities could start with INDOT's full dTIMS model.
 - Start with INDOT deterioration curves
 - Start with INDOT Business Rules
 - Start with INDOT unit costs
 - **Entities would need to update their own bridge history**
 - Project history key to determining component ages vs. bridge age.
 - After running, entities could vary any of the above to better meet their own needs.
 - Could avoid many years of development time



Bridge Management System



■ Extra if time

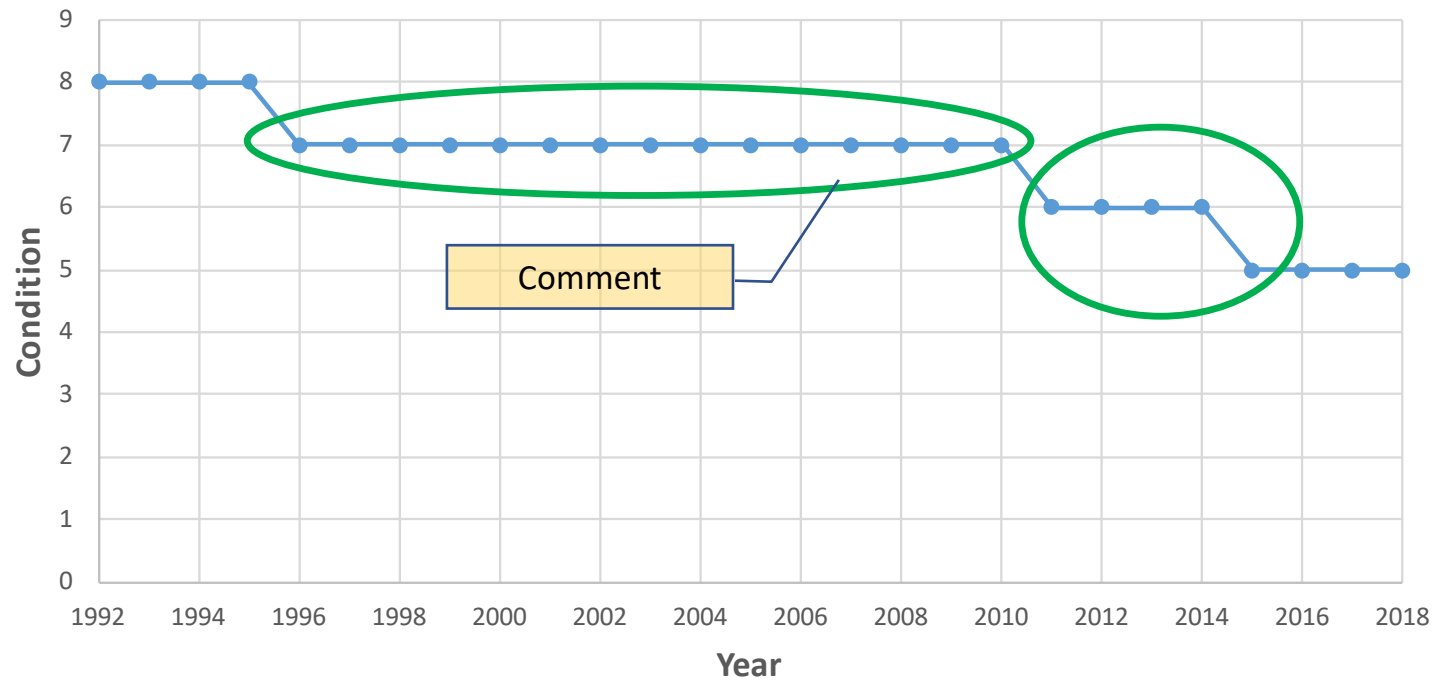
- Condition Ratings – Resets (What dTIMS forecasts)
 - Treatments are typically triggered and reset based on the following
 - Bridge Thin Deck Overlay: Reset WS+1 (≤ 8), Hold DC for 8 years
 - Bridge Deck Overlay: Reset WS = 9, DC = 7
 - Bridge Deck Replacement Reset WS & DC = 9
 - Replace Superstructure Reset WS & DC & SP = 9
 - Bridge Replacement Reset all to 9
- What happens in field? What have we paid for?
 - After treatment performed in field (construction) are we comfortable raising DC from 5 to 7 after an overlay with 10% partial depth patching and say 100 SFT of full depth. When done, still seeing original cracking bottom side of deck.



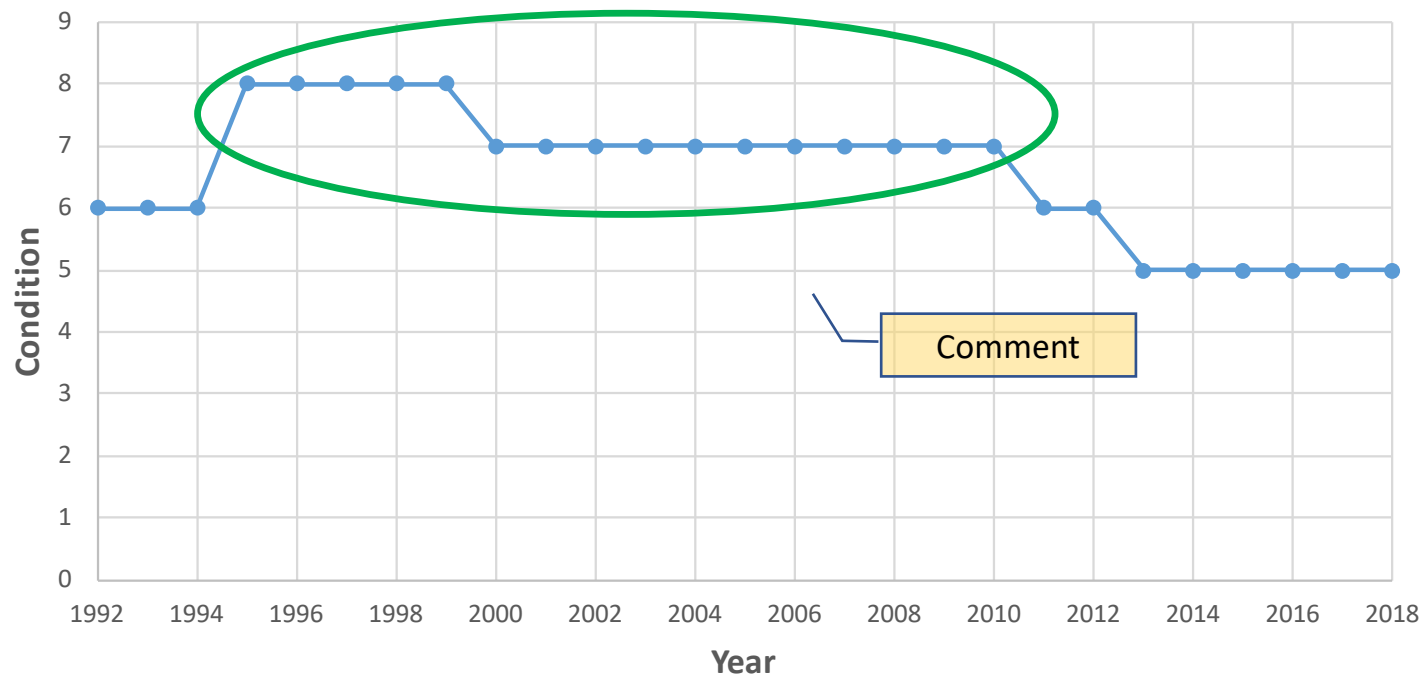
DECK CONDITION

Sample Charts

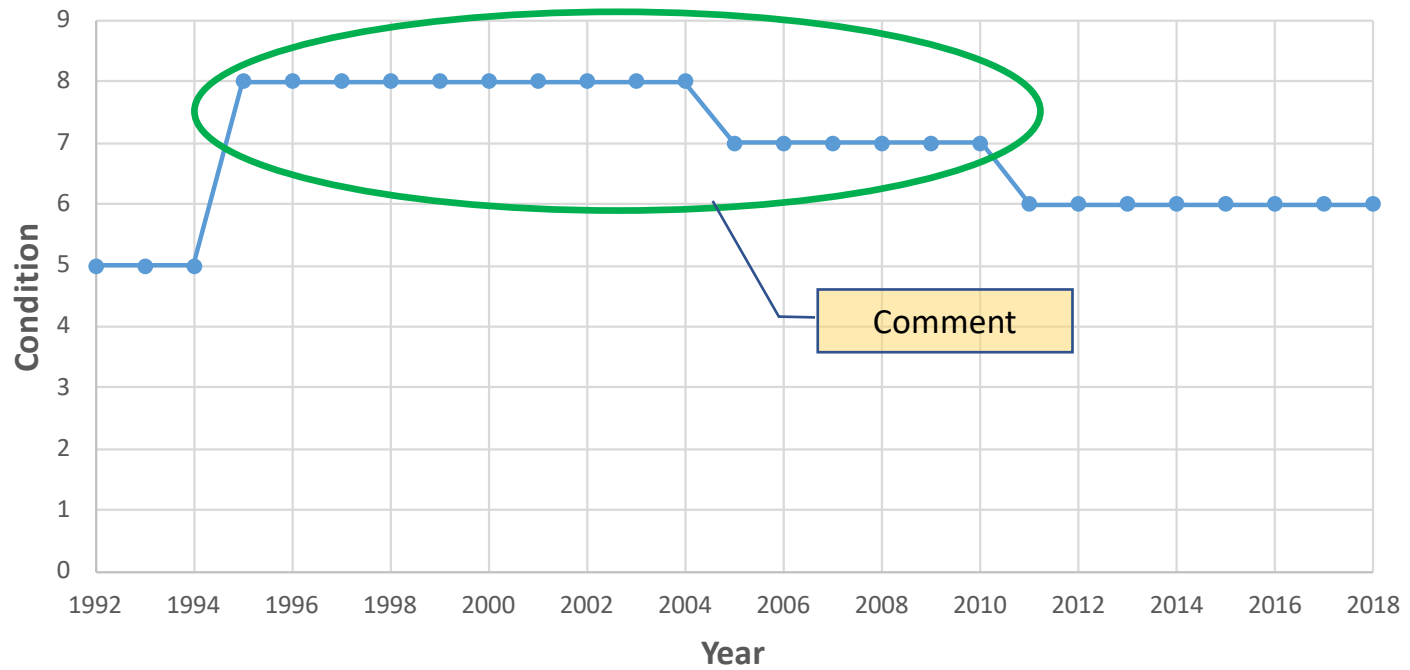
Deck Condition - Region: Central, FC: Collector/Arterial (NBI: 3200050)



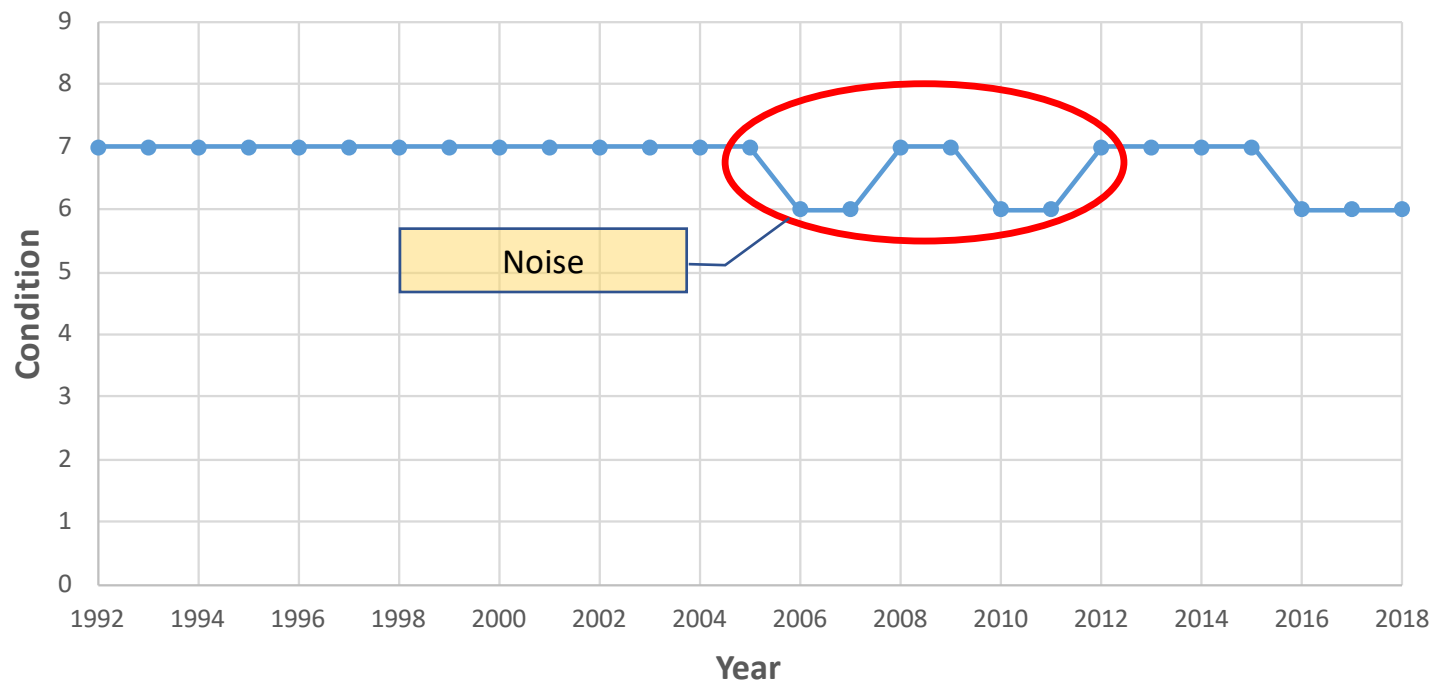
Deck Condition - Region: Central, FC: Collector/Arterial (NBI: 3400113)



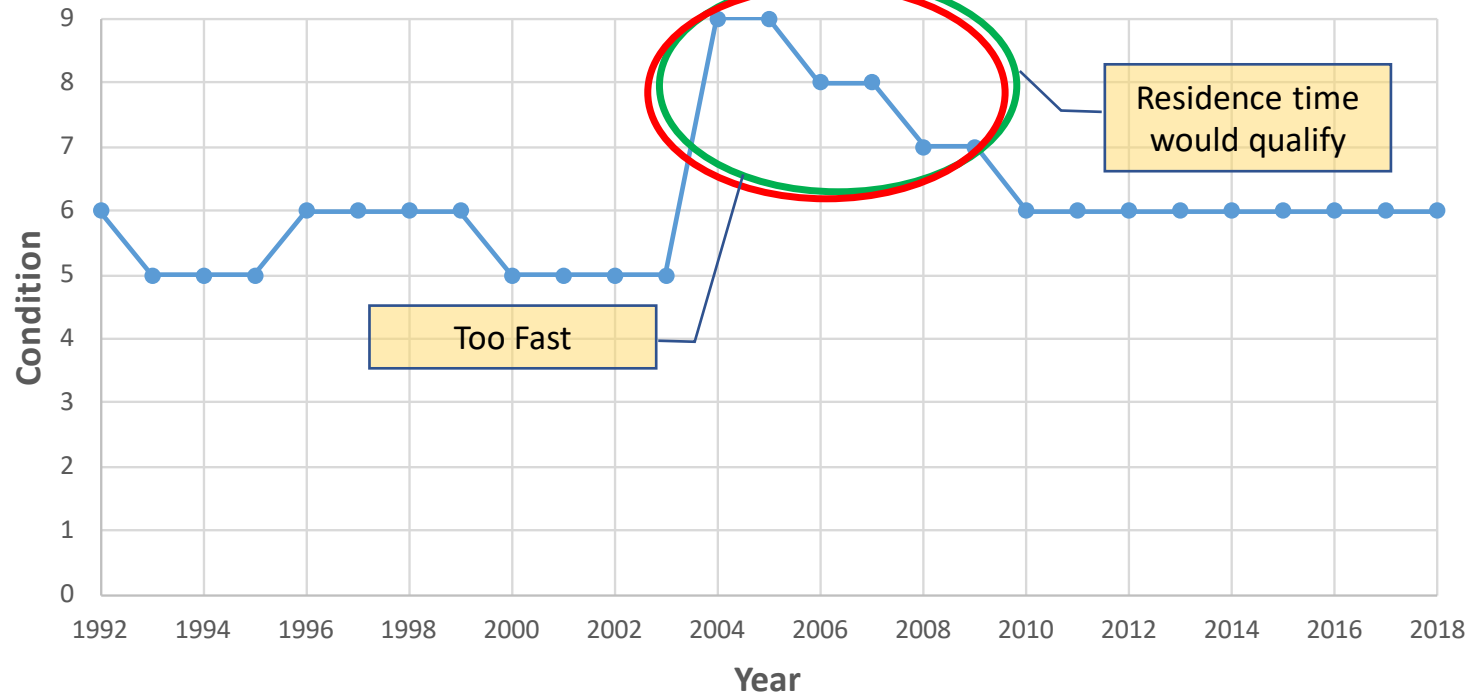
Deck Condition - Region: Central, FC: Collector/Arterial (NBI: 3400113)



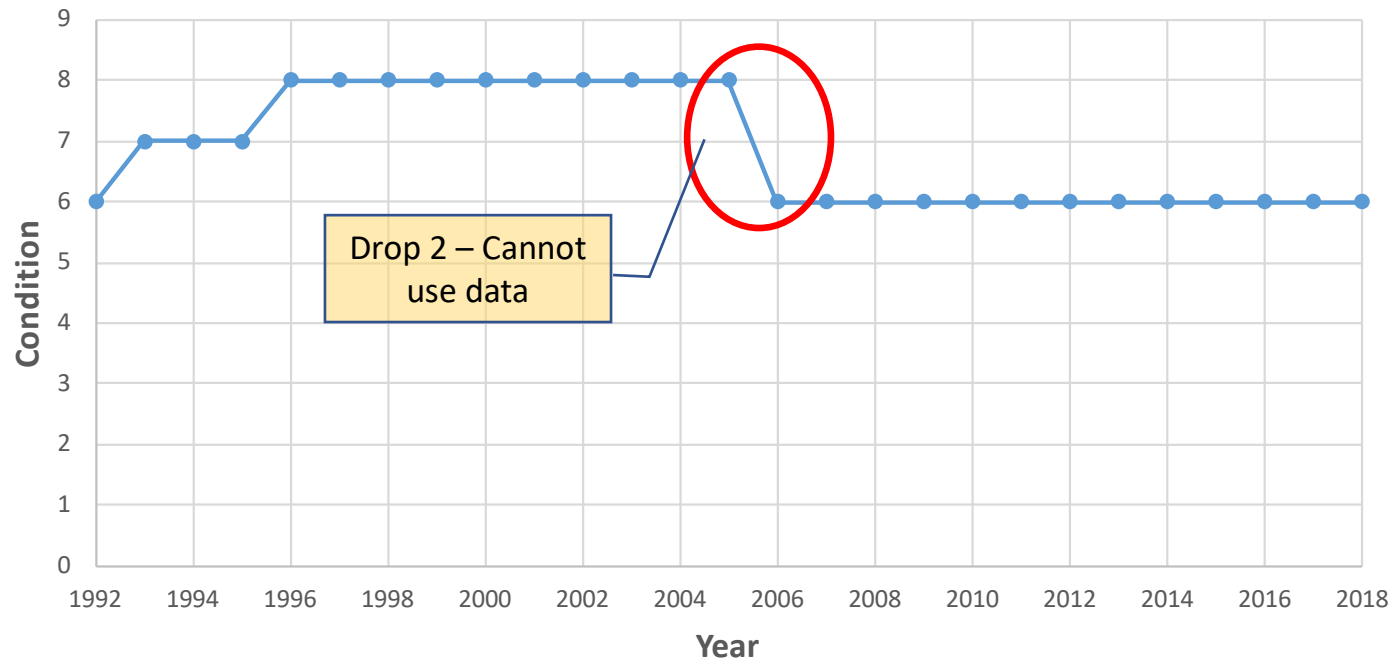
Deck Condition - Region: Central, FC: Collector/Arterial (NBI: 330)



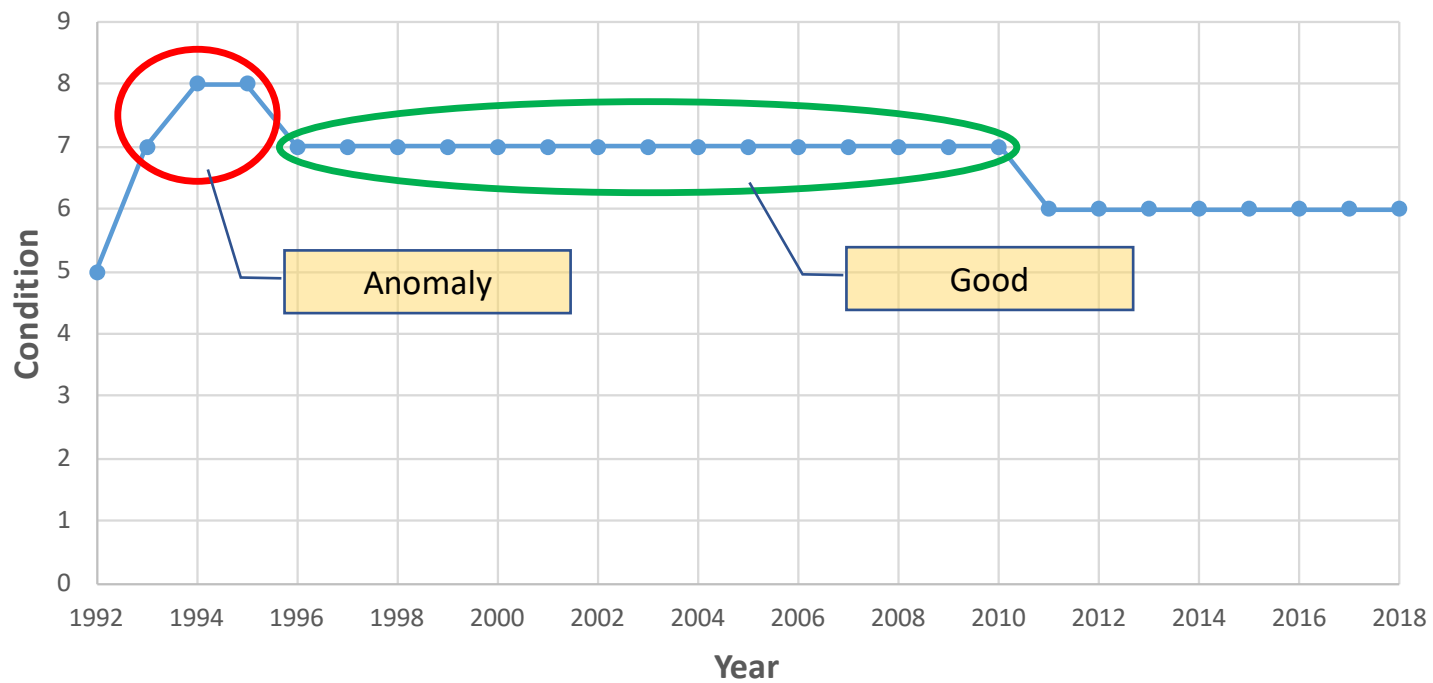
Deck Condition - Region: Central, FC: Collector/Arterial (NBI: 4580)



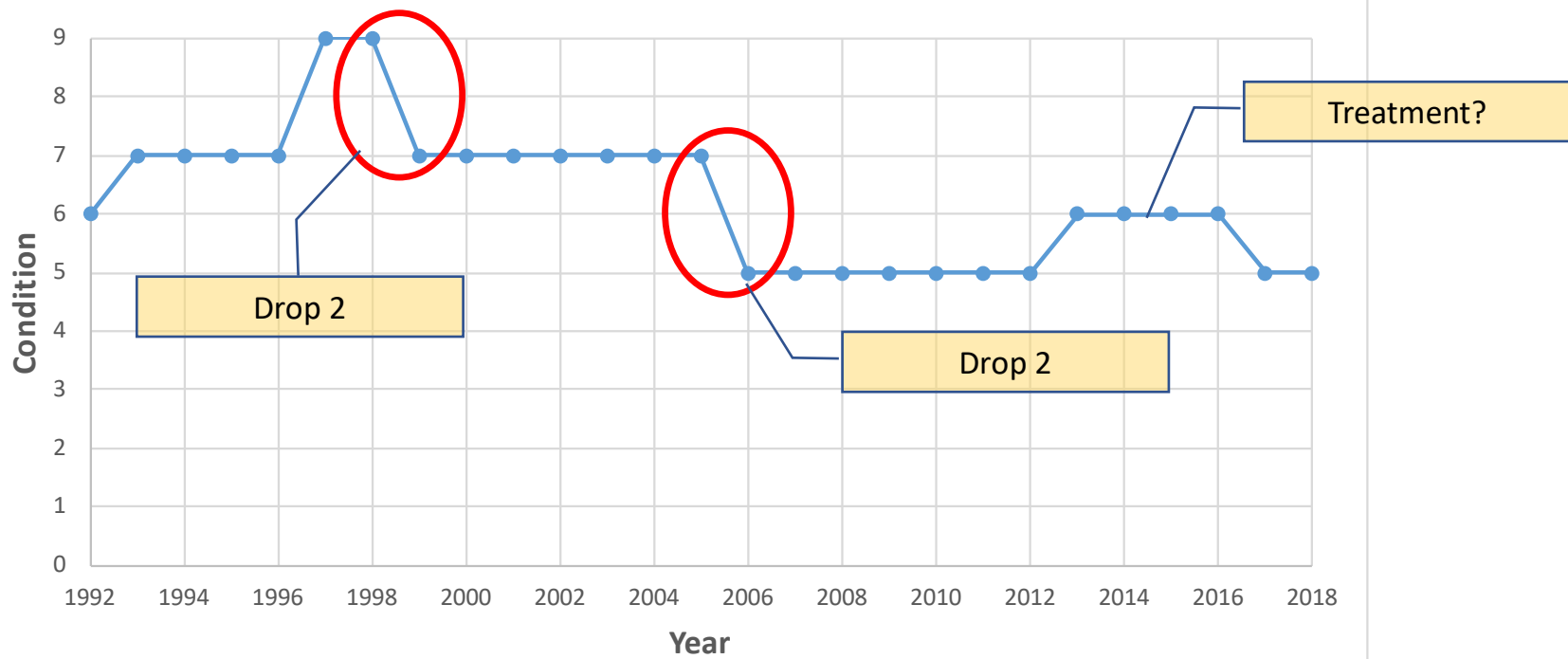
Deck Condition - Region: Central, FC: Collector/Arterial (NBI: 4640)



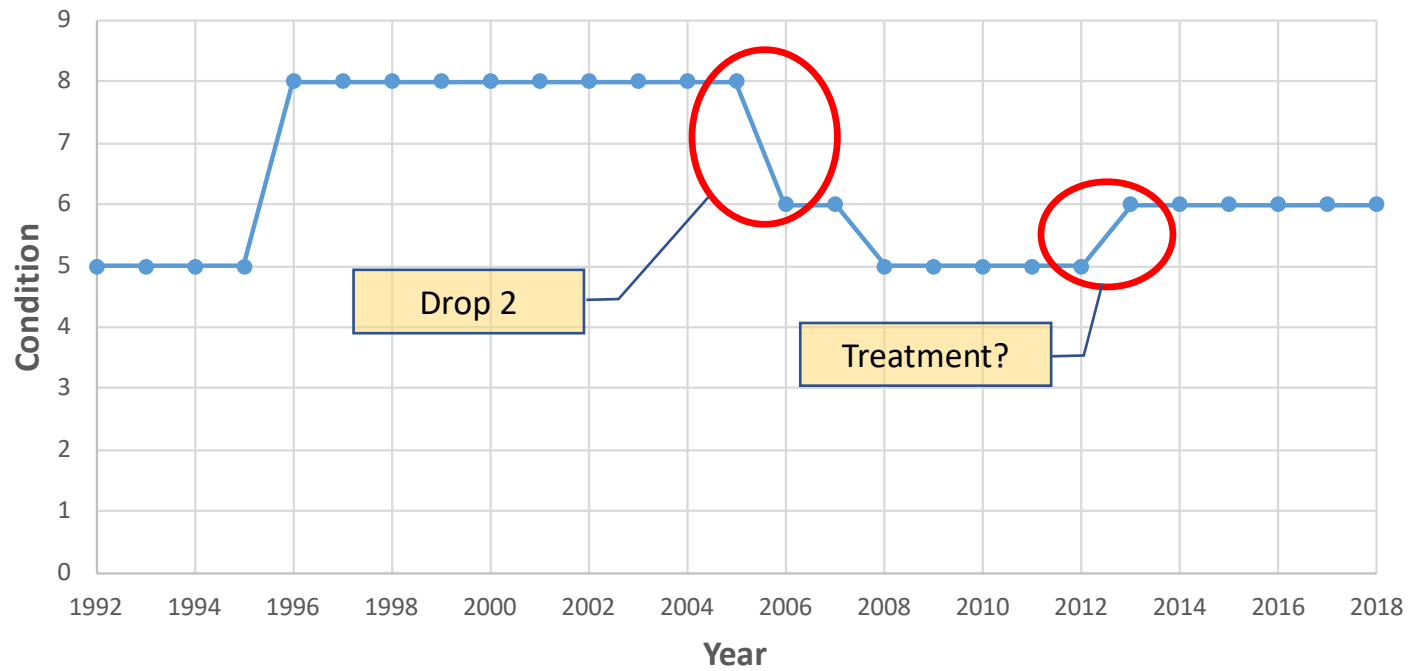
Deck Condition - Region: Central, FC: Collector/Arterial (NBI: 5000)



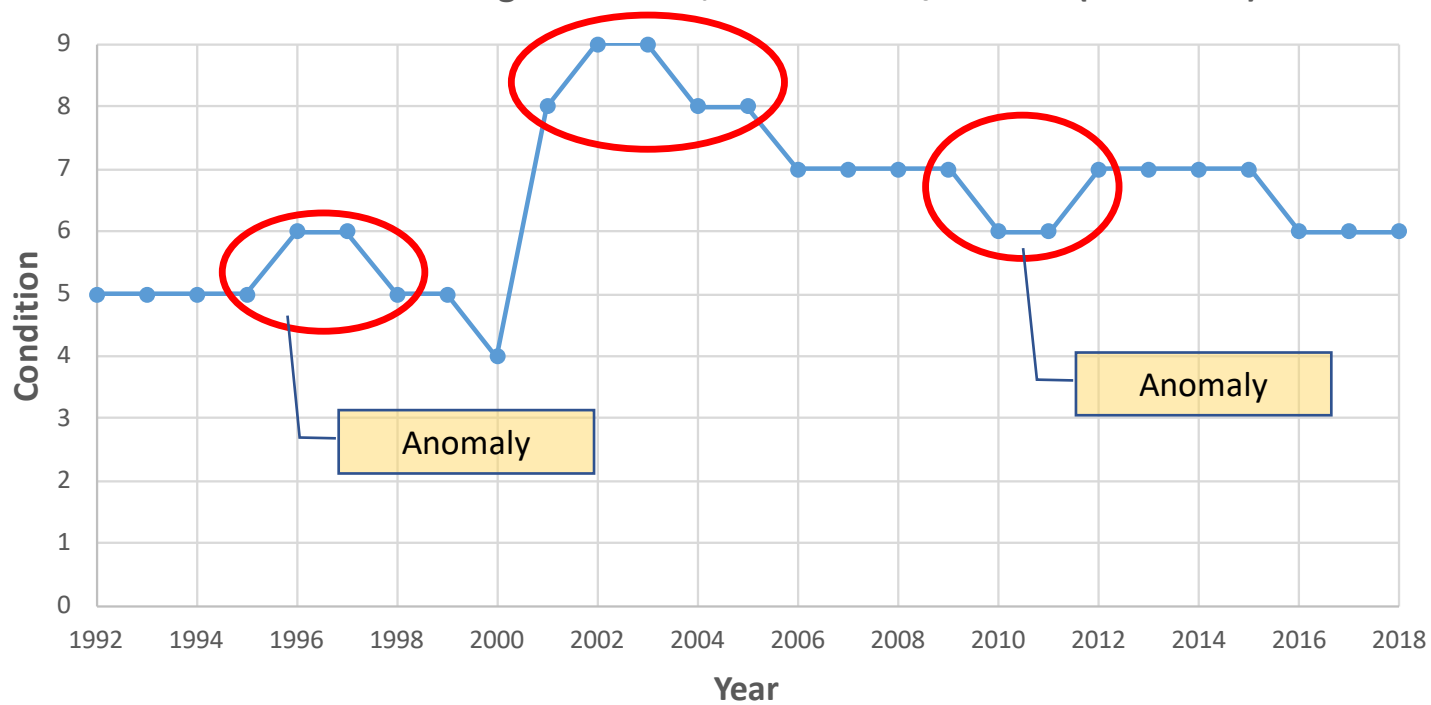
Deck Condition - Region: Central, FC: Collector/Arterial (NBI: 6300)



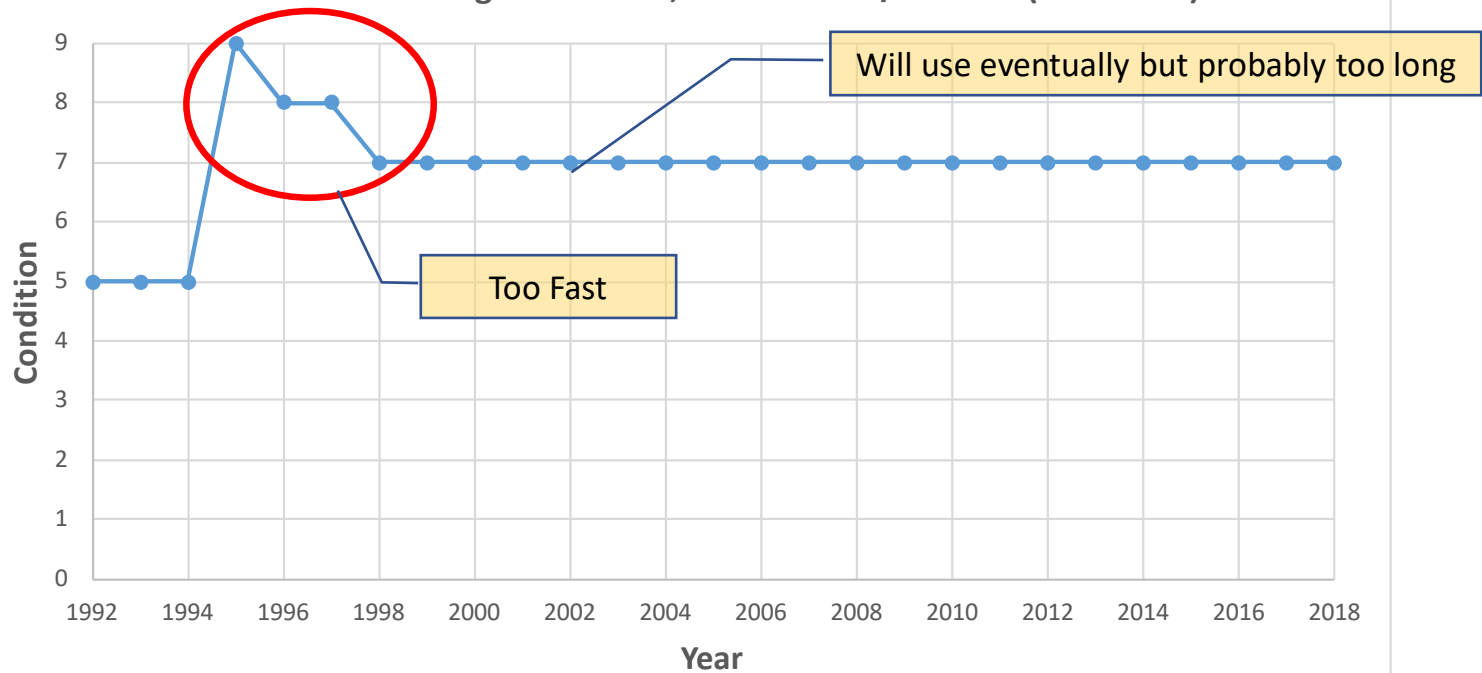
Deck Condition - Region: Central, FC: Collector/Arterial (NBI: 6310)



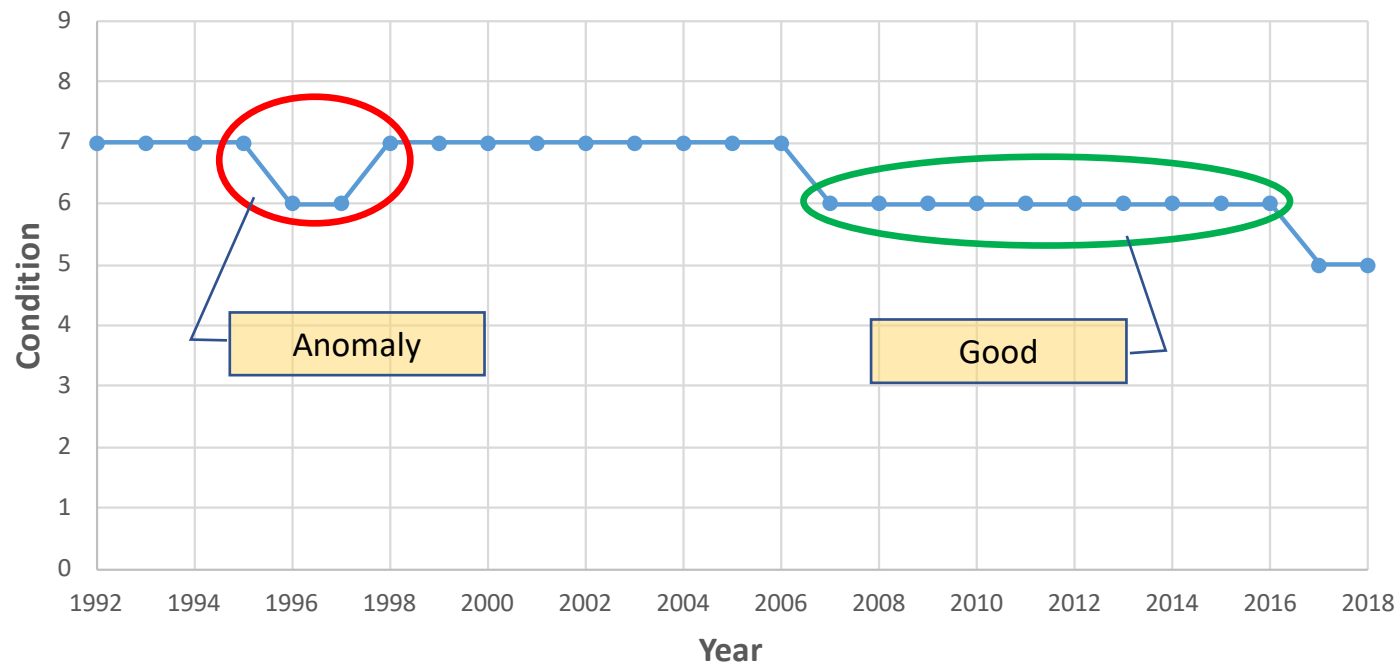
Deck Condition - Region: Central, FC: Collector/Arterial (NBI: 6620)



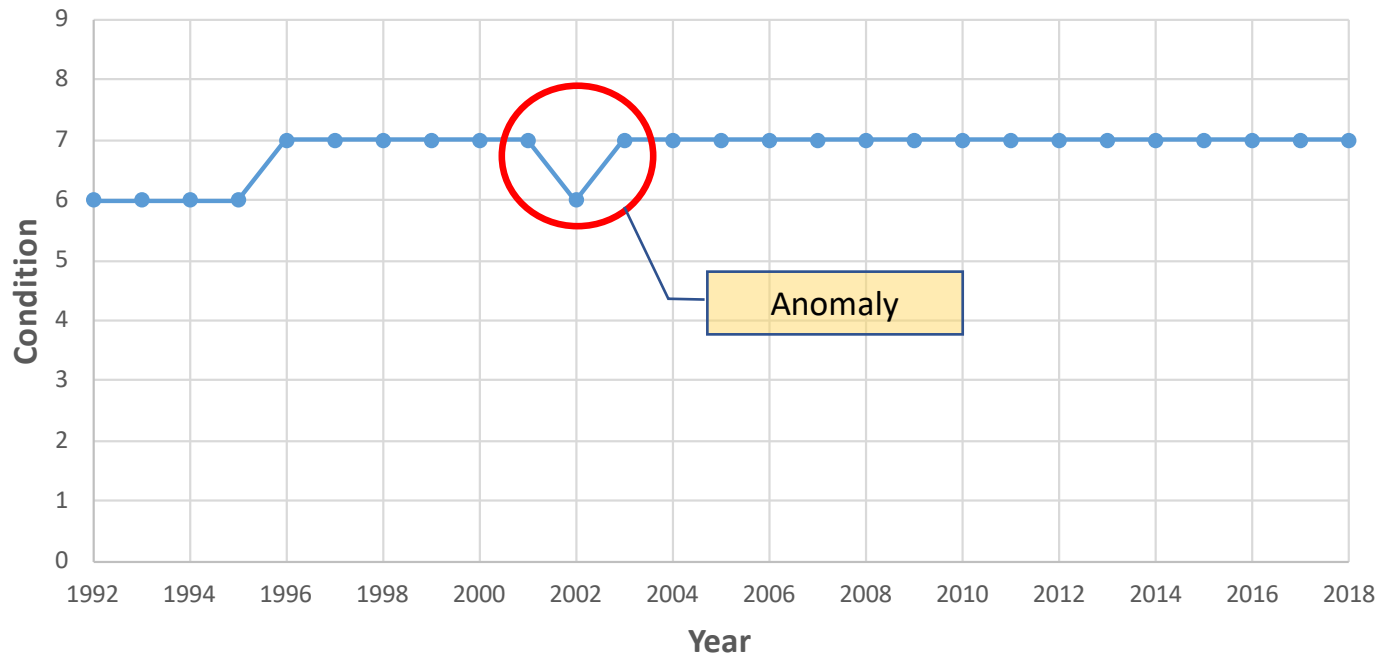
Deck Condition - Region: Central, FC: Collector/Arterial (NBI: 6800)



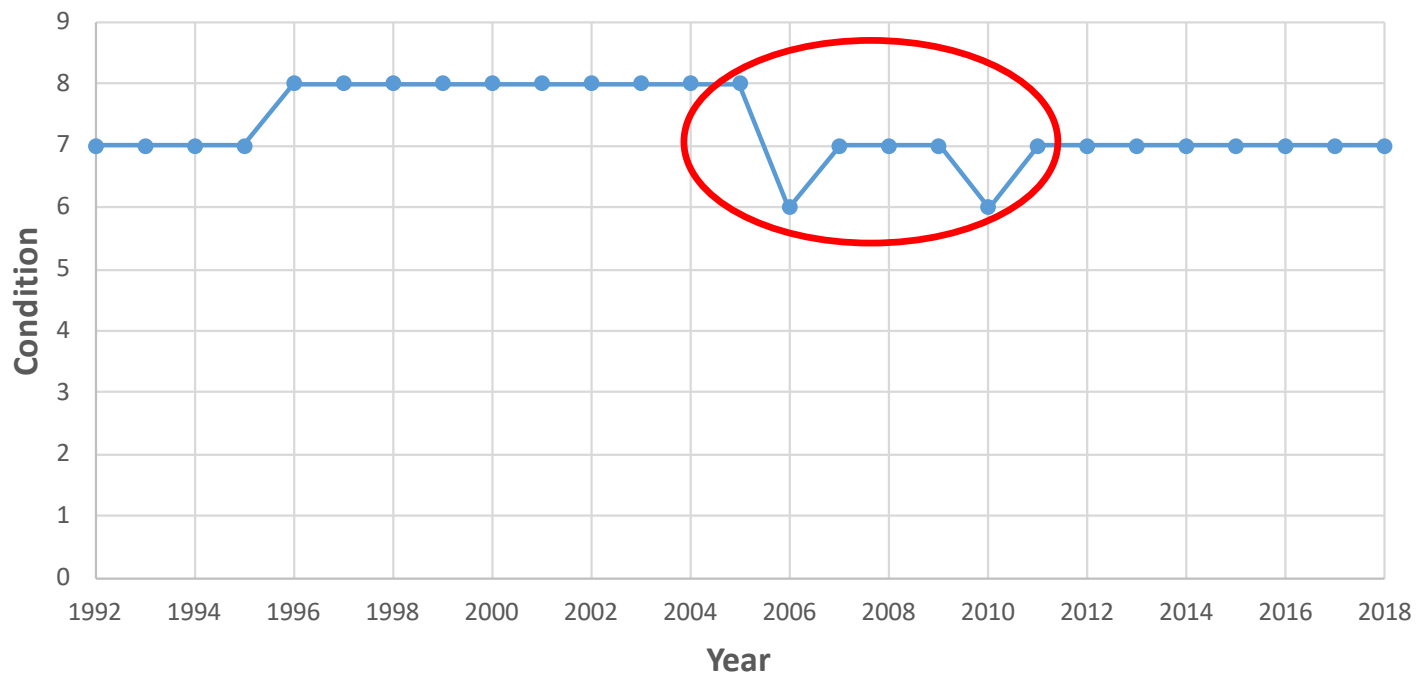
Deck Condition - Region: Central, FC: Collector/Arterial (NBI: 7050)



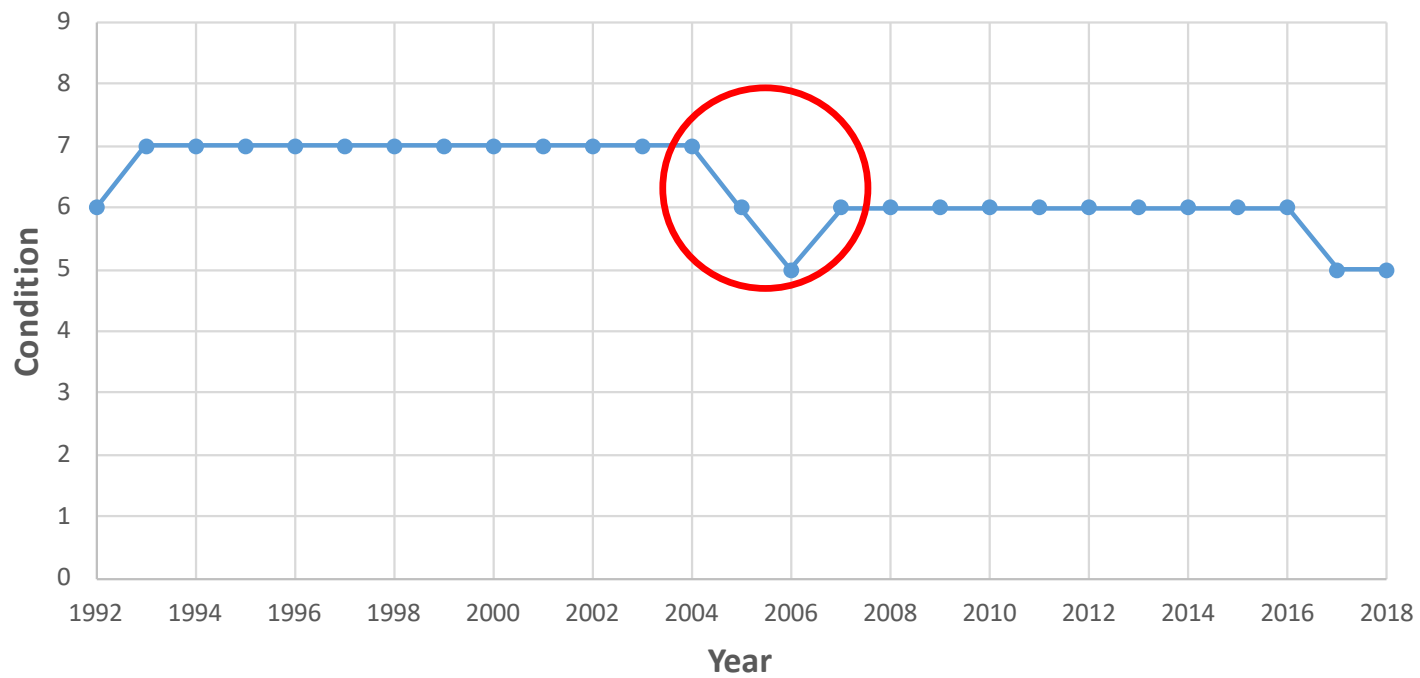
Deck Condition - Region: Central, FC: Collector/Arterial (NBI: 7870)



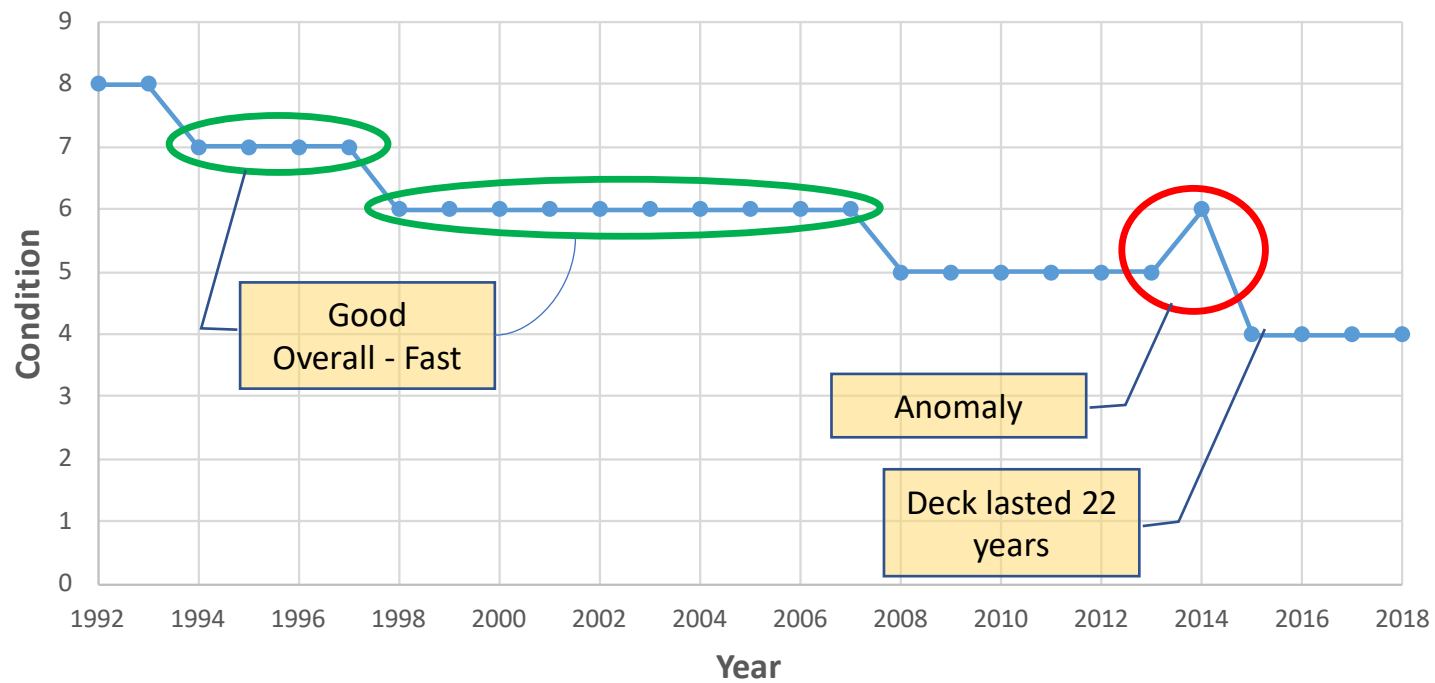
Deck Condition - Region: Central, FC: Collector/Arterial (NBI: 12870)



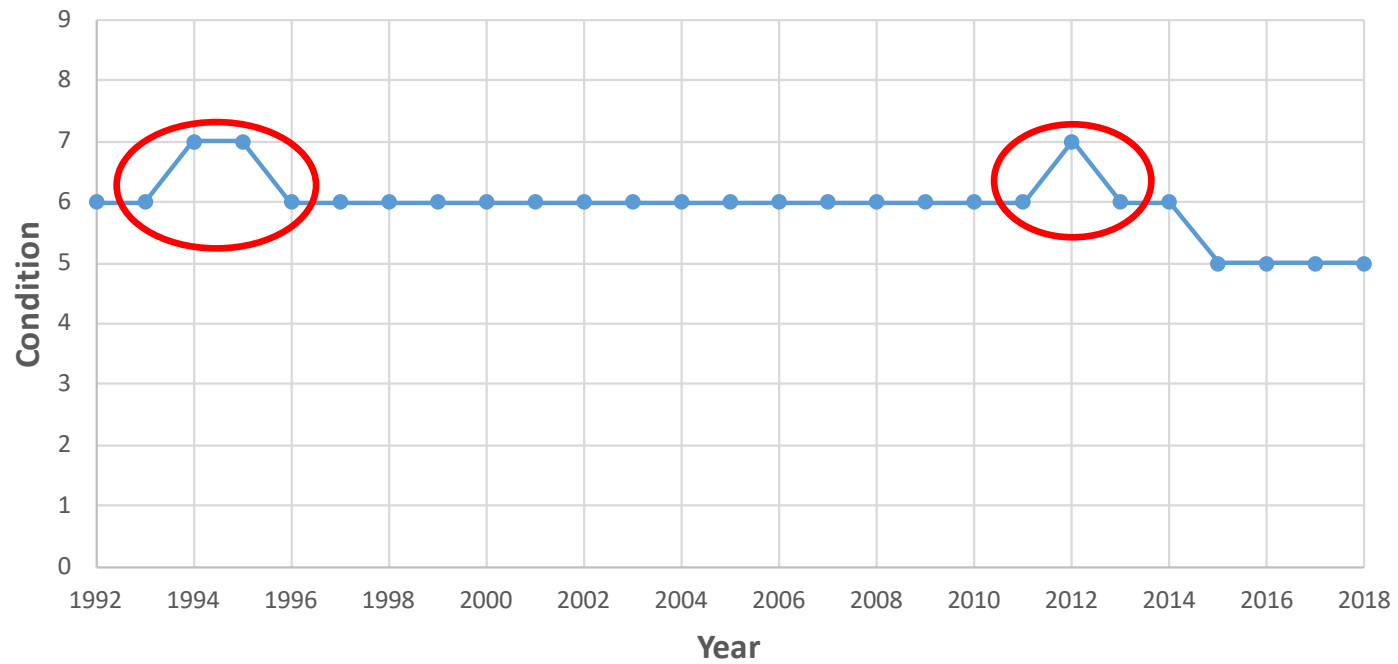
Deck Condition - Region: Central, FC: Collector/Arterial (NBI: 12950)



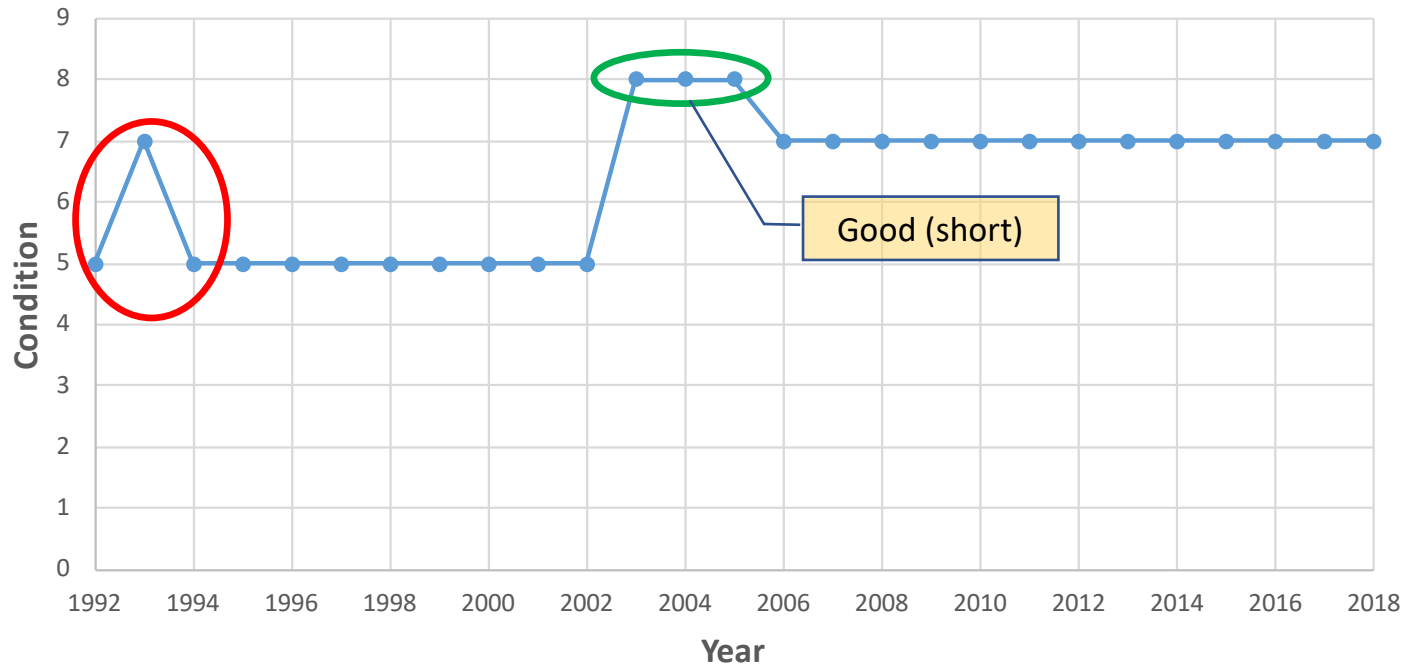
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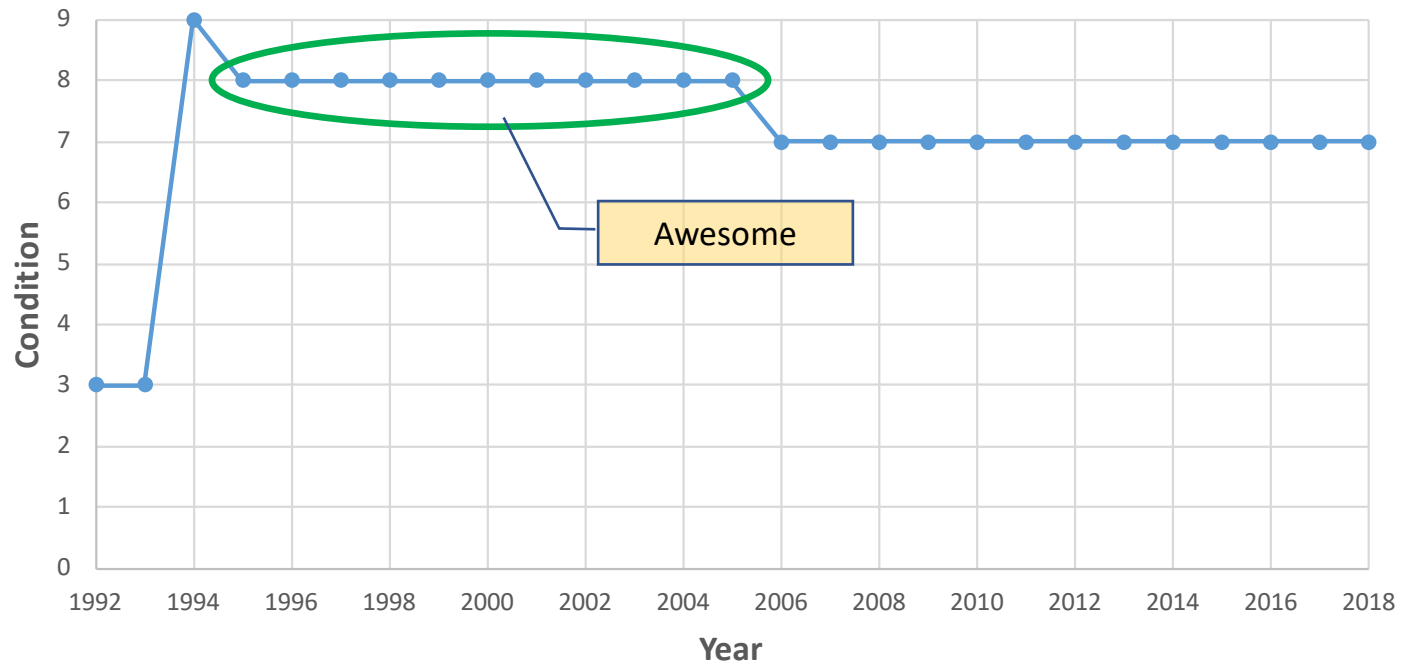
Deck Condition - Region: Central, FC: Collector/Arterial (NBI: 13740)



Deck Condition - Region: Central, FC: Collector/Arterial (NBI: 13990)



Deck Condition - Region: Central, FC: Collector/Arterial (NBI: 14020)



Deck Condition - Region: Central, FC: Collector/Arterial (NBI: 1800159)

