BrR API Tools for OSOW Permitting and Batch Analysis Reporting

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Wisconsin DOT

AASHTOWare RADBUG Meeting
Madison, WI

August 9, 2023

What's an API?

Application Programming Interface (API) for Virtis

Barut, Joseph - DOT

Reply | Reply All | Forward

To Dietsche, Joshua S - DOT; Young, Kelly C - DOT; Pence, Alex W - DOT; McDaniel, Travis - DOT

Fri 1/25/2013 2:02 PM

Cc Becker, Scot - DOT; Oliva, William - DOT

You forwarded this message on 9/13/2016 10:18 AM.

Hi all,

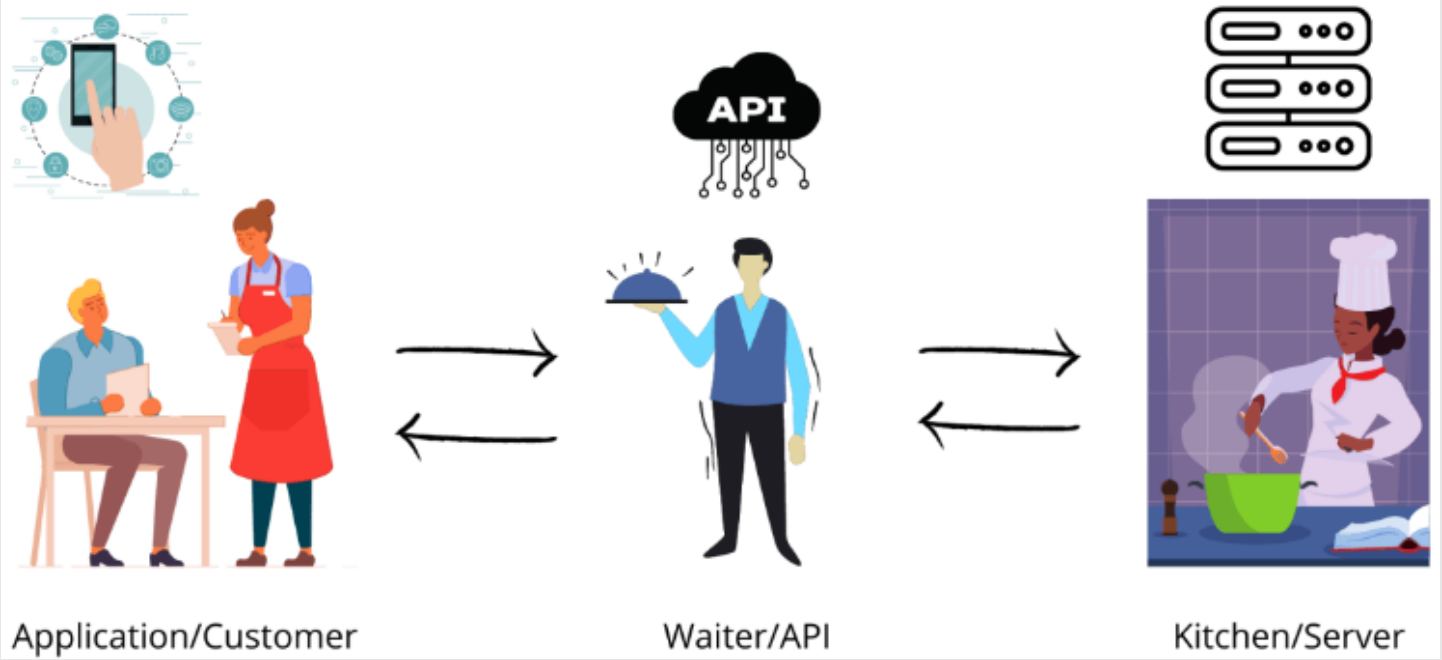
I am geeked up (not from drugs) from learning that Virtis has an API. API stands for application programming interface, and it's a way for a software (call it A) to allow another software (call it B) to interact (or interface) with it. Basically Software A is saying to Software B or any other software: I have these methods/functions that I'm letting you run. You run whichever you find useful, and it's up to you what to do with the results.

Depending on what methods it includes, the Virtis API may allow us to automate some of our rating and permitting processes, especially in batch mode, as well as data exchanges between the Virtis database and other databases/data stores. I hope to get more information soon. I'll keep you posted.

Thanks,
Joe B.

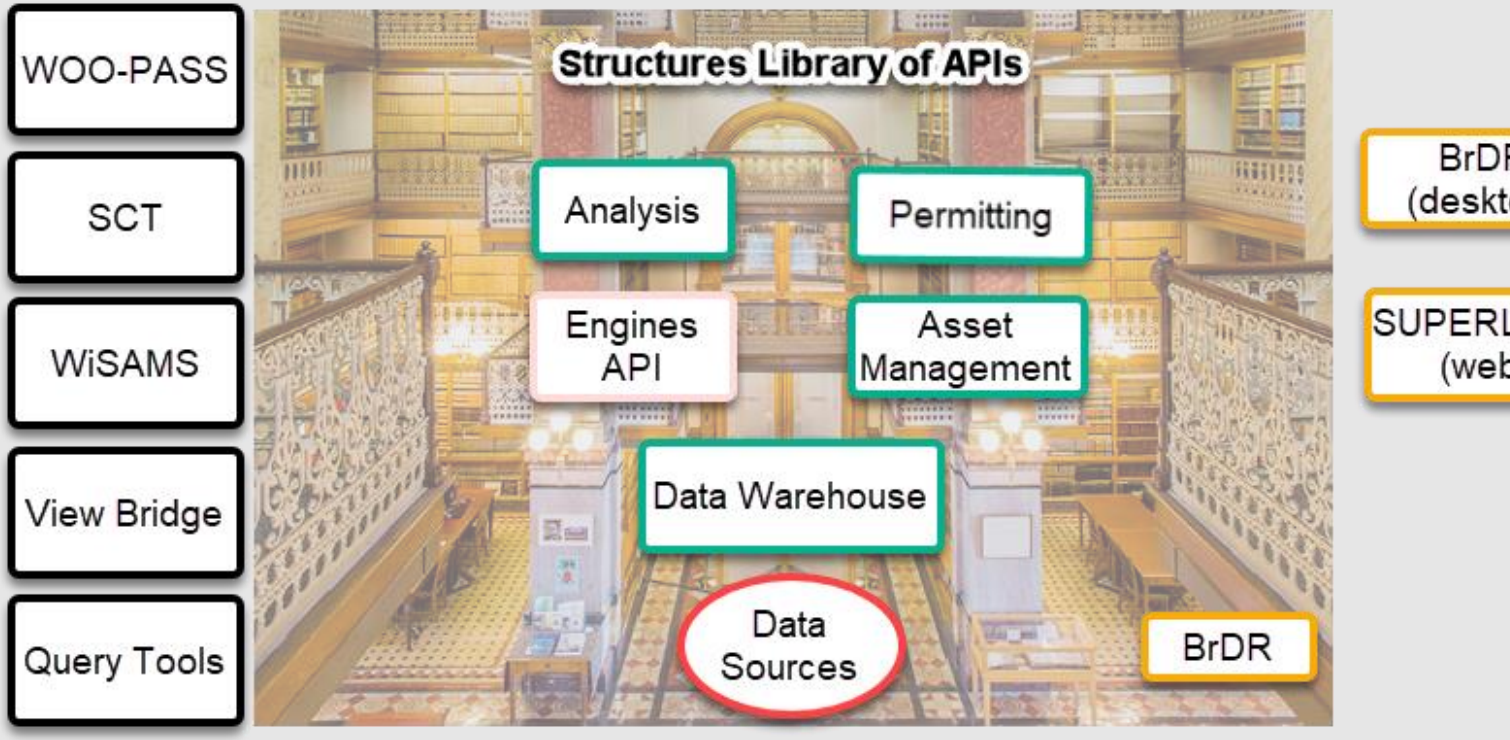
Just Use the Dang Picture!

- Who
- What
- When
- Where
- Why



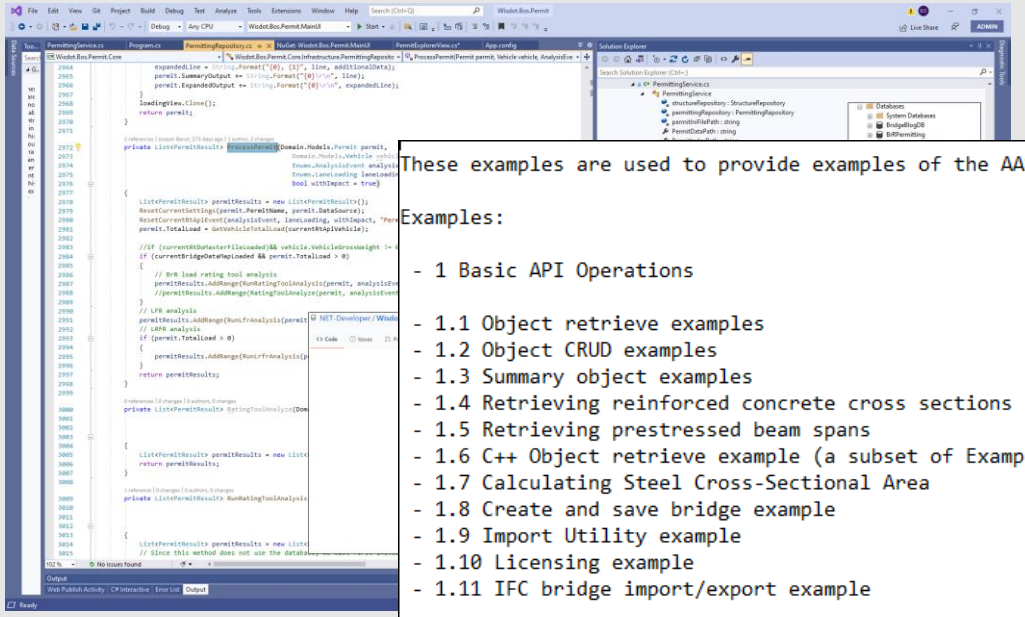
WisDOT Structures Library of APIs

- Permitting with BrDR LRT API
- Batch Analysis & Reporting with BrDR Analysis API
- Data Warehouse



Automation Unit & Development Tools

- 3 FTE
  - 2 FTE with civil engineering and CS backgrounds
  - 1 FTE with CS background
- Microsoft shop: C#.NET, Visual Studio, SQL Server DBMS & Management Studio
- GitHub



```
These examples are used to provide examples of the AASHTOWare Bridge API

Examples:

 - 1 Basic API Operations

 - 1.1 Object retrieve examples
 - 1.2 Object CRUD examples
 - 1.3 Summary object examples
 - 1.4 Retrieving reinforced concrete cross sections
 - 1.5 Retrieving prestressed beam spans
 - 1.6 C++ Object retrieve example (a subset of Example 1.1) [Not in solution]
 - 1.7 Calculating Steel Cross-Sectional Area
 - 1.8 Create and save bridge example
 - 1.9 Import Utility example
 - 1.10 Licensing example
 - 1.11 IFC bridge import/export example


 - 2 Analysis Examples

 - 2.1 Analysis API
 - 2.2 Simplified Analysis API (LFD)
 - 2.3 XML-based Analysis API
 - 2.4 Rating Tool API
 - 2.5 Simplified Analysis API (LRFR)


 - 3 Engine

 - 3.1 Creating a 3rd-party engine
 - 3.2 Creating a 3rd-party engine properties UI window
 - 3.3 Retrieve Engine Properties from Bridge Object
```

OSOW Permitting

OSOW Permitting: Background

- WisDOT has history with automated OSOW Analysis
- Structural Evaluation Program (SEP) developed internally (1990s)
  - Load Rating Models for In-House Software (Steel, PS Girders, Slabs)
  - Database of Rating Files maintained by Rating Unit
  - SEP connected to Routing System + Separate UI for Rating Engineers

SEP Input:

kelly.bri - Notepad

File Edit Format View Help

B-13-91
B-13-92
B-13-100
B-37-79

kelly.tr1 - Notepad

File Edit Format View Help

16	0
20	13.25
20	4.5
20	12.5
20	4.5
20	31.67
20	4.5
20	4.5
20	12.5
20	4.5
20	4.5

SEP Output:

B290033 *** OK
B290035 *** OK
B290037 *** OK
B290047 *** OK
B290[illegible] *** OK
B290143 *** NOT IN CURRENT DATABASE
B290054 *** OK
B410275 *** OK
B410029 *** OK
B410058 *** OK
B410032 *** OK
B410252 *** OK
B410028 *** SLOW DOWN TO 5 MPH
B410257 *** OK
B410027 *** OK
B410031 *** OK
B410110 *** OK
B410112 *** OK
B410116 *** OK
B410105 *** OK
B410089 *** OK
B410011 *** OK
B410012 *** OK
B280076 *** OK
B280584 *** OK
B280037 *** OK
B280039 *** OK
B130163 *** OK
B130159 *** OK
B130791 *** OK
B130503 *** NOT IN CURRENT DATABASE
B130499 *** NOT IN CURRENT DATABASE
B130584 *** OK
B130289 *** OK
B130542 *** OK
B130105 *** OK
B130103 *** SLOW DOWN TO 5 MPH

"NOT IN CURRENT DATABASE" requires review by Rating Unit

"SLOW" – OK with impact factor = 1.0

Older In-House Rating Models

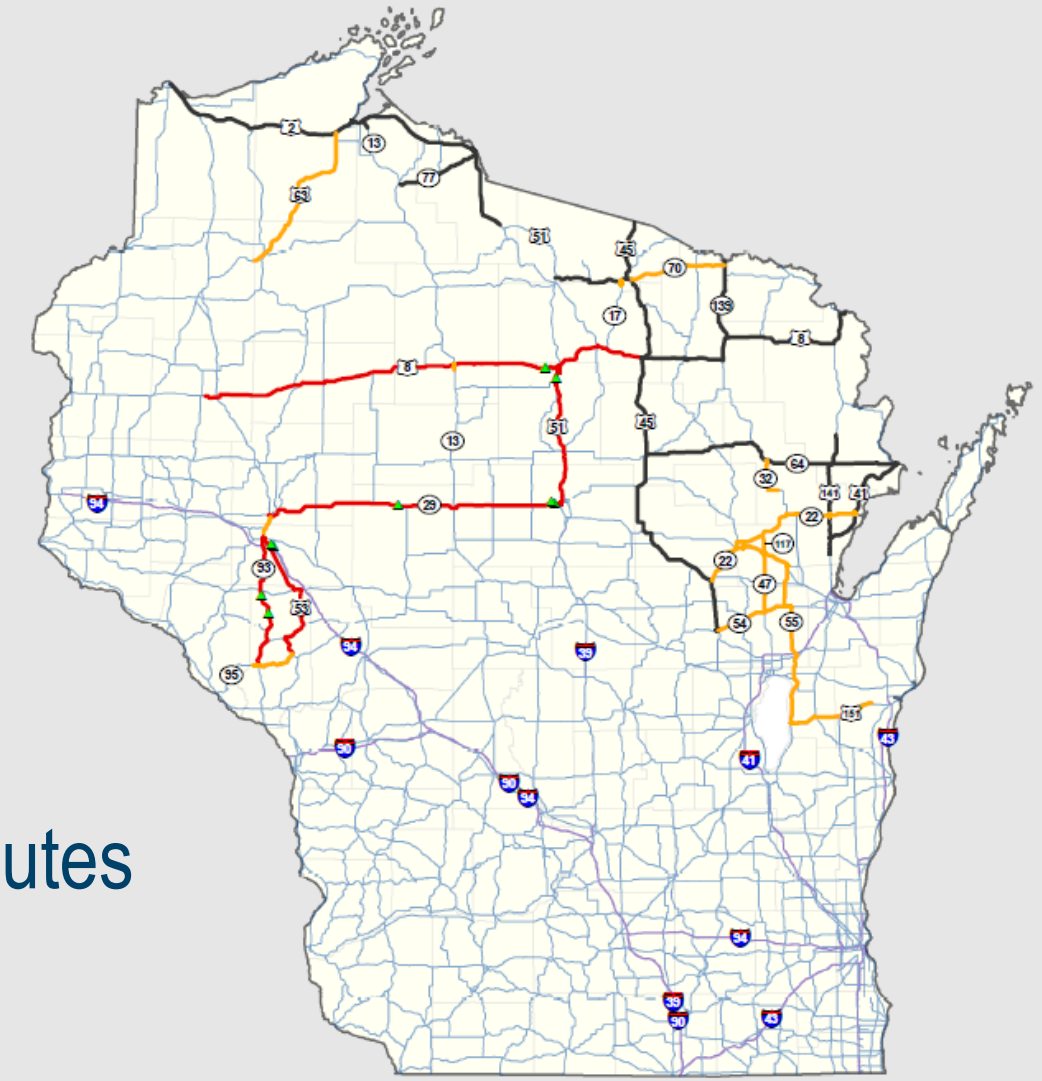
```
Bridge B-13-0091
4.00    4.00    10.00   0.00    0.00    0.00    110.00  1.00    0.00    25.00
0.00    0.00    0.00    0.00    0.00    0.00
0.00    0.00    0.00    0.00    0.00    0.00
0.00    0.00    0.00    0.00    0.00    0.00
0.00    0.00    0.00    0.00    0.00    0.00
01100010
43.00   1.41    680.00
56.50   1.41    680.00
99999.002.00    0.00
99999.001.00    0.00
1.00    43.00   25.42   25.42
2.00    39.00   10.00   0.75
2.00    43.00   10.00   1.20
3.00    39.00   10.00   0.75
3.00    43.00   10.00   1.20
4.00    43.00   84.00   7.00
9.00    43.00   20.00   27.00
10.00   43.00   20.00   27.00
5.00    43.00   99999.000.49
1.00    56.50   25.42   25.42
2.00    4.00    10.00   1.20
2.00    52.00   10.00   0.75
2.00    56.50   10.00   1.31
3.00    4.00    10.00   1.20
3.00    21.25   10.00   0.75
3.00    35.25   10.00   0.94
3.00    52.00   10.00   0.75
3.00    56.50   10.00   1.31
4.00    56.50   84.00   7.00
9.00    56.50   20.00   27.00
10.00   56.50   20.00   27.00
5.00    56.50   99999.000.49
300.00  0.00    1.00
0
0
```

OSOW Permitting: Background

- BrR Analysis features to improve WisDOT OSOW Permitting
  - Model Accuracy
    - Steel Stiffeners, Rebar Development Length, Detailed Calc Reports, Multiple Elements
  - Control Options
    - Elastic / Plastic for Steel, Include / Ignore Shear for Concrete
  - Deterioration / Damage Modeling
  - Non-Standard Gauge Analysis
  - Future
    - LRFR, Additional Bridge Types / Elements
    - Potentially phase out old LFR analysis programs

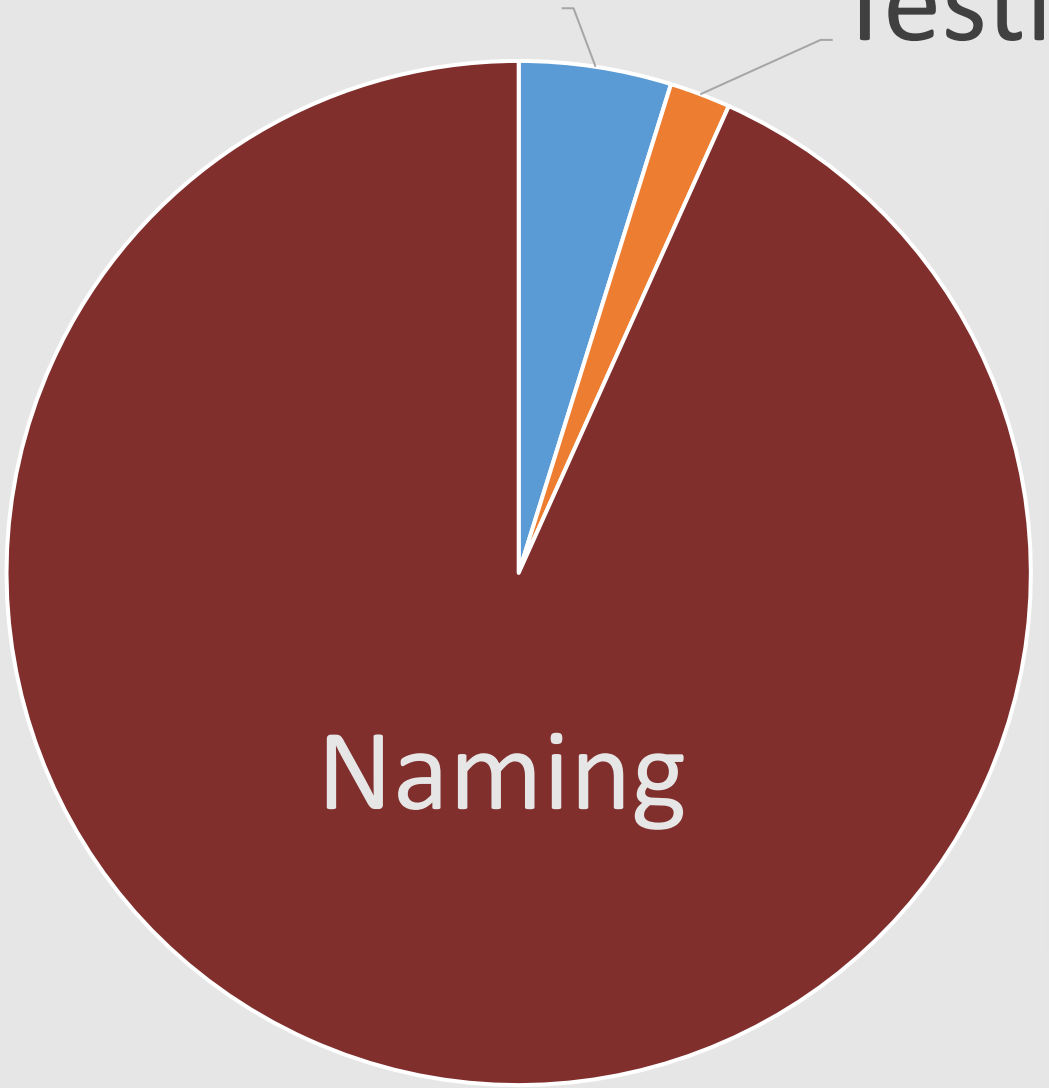
OSOW Permitting: Needs

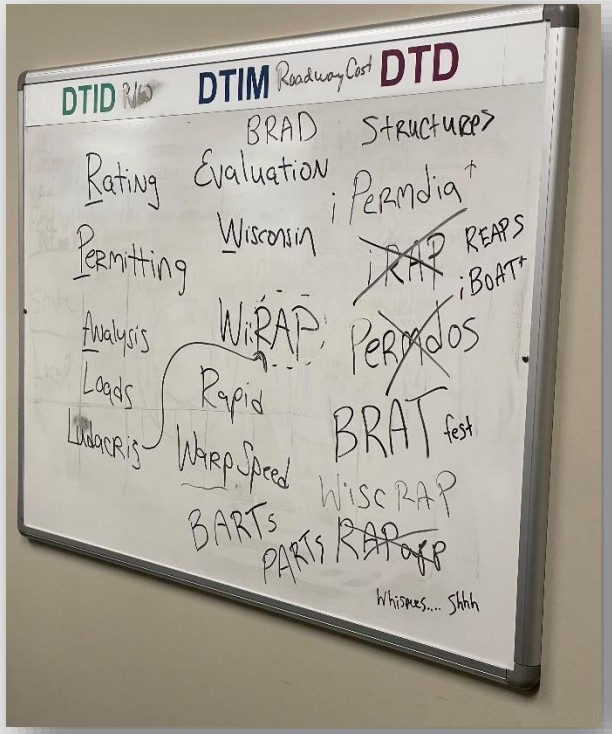
- BrR integration with SEP
  - Used by WisDOT's OSOW Web App
    - Bentley Superload
- Speed and Automation are Priorities
  - 2020 OSOW System Upgrade
- Legislative Proposals for Annual Permit Routes
  - Michigan Timber Hauling Truck Routes
  - Implements of Husbandry



OSOW Permitting: BrR Integration

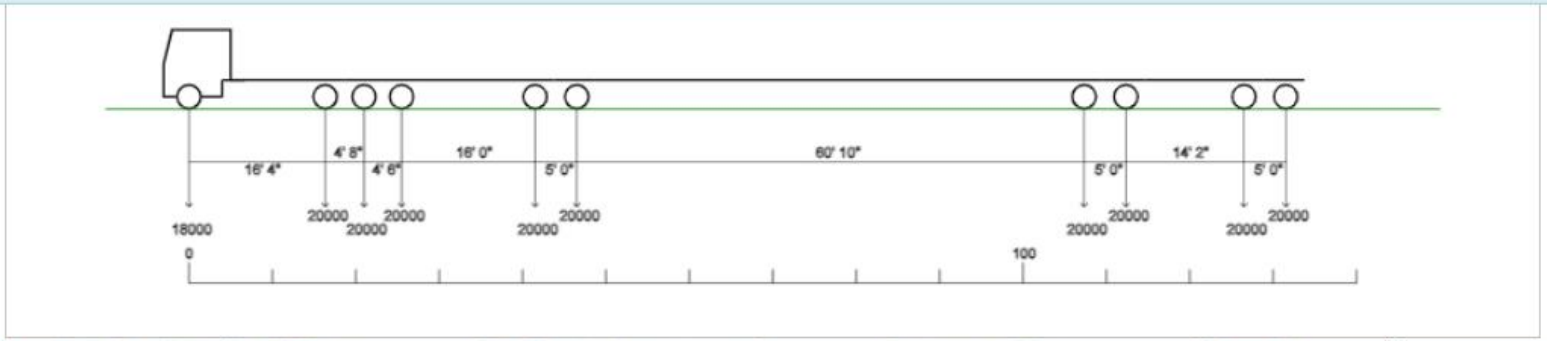
- BrR API for Permit Analysis
- Generation of Precomputed Results (via Rating Tool)
- Coordination with Bentley
  - IT Coordination (Licensing, Installation, Database File Transfer)
  - Legal Coordination
  - Testing Environment





Wisconsin
Oversize
Overweight
Permitting &
Analysis
Software
System

Route Check



The problem areas are shown on the trip drawn in red (or your customized failure color). Zoom in to see the problem areas and click on the failed items for details.

Please note that bridge office reviews can take up to 3 days to process.

Use the Restrictions link to view the restrictions that affect this trip request. Please note that based on permitting rules, some of the restrictions shown here may not be included on the permit.

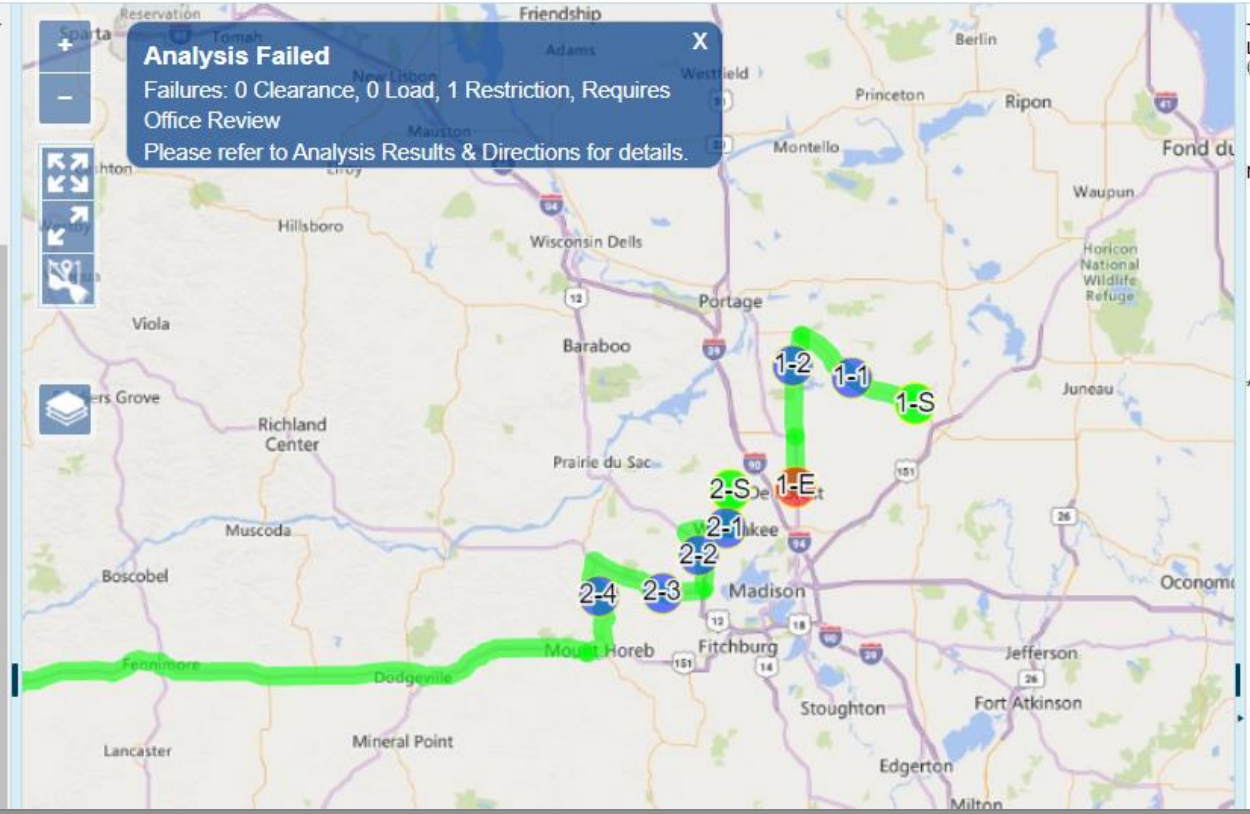
Previous Route Method Used

Generate a Trip

New Trip Directions

Start on WI-16 WB at MP Columbia 133.23 (In Fountain Prairie at Cth CD), WI-22 SB, US-51 SB, End on US-51 at MP Dane 65.80 And on WI-113 SB at MP Dane 15.02 (In Vienna at Cth V), WI-19 WB, US-12 EB, US-14 WB, WI-78 SB, US-18 WB, End on US-18 at MP Crawford 0.00 (State Border of Ia)

Detailed Trip Directions



IA)

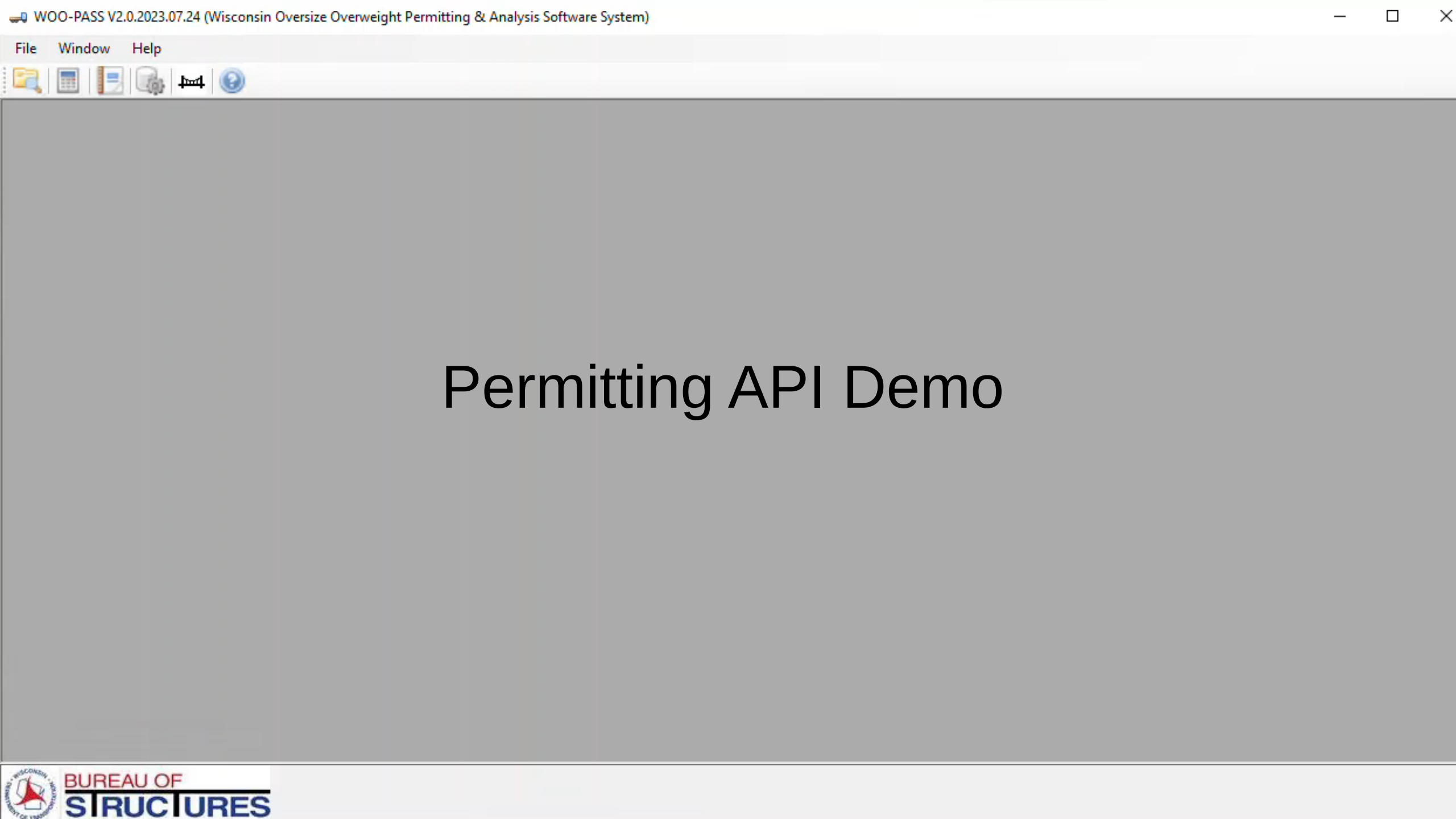
Trip Length (miles) : 150.09

Number of Restrictions impacting the trip : 8

Failures	
Closed	: 0
Attribute	: 1
Information	: 0
Acceptable	: 7

***** Failure Restrictions *****

Route ID : US-18
Restriction Type : ROADWAY RANGE
Reason : POSTED BRIDGE
Comment : B120028 AND B120028 AT IA LINE PRAIRIE DU CHIEN. IF GREATER THAN 170,000 LBS YOUR APPLICATION WILL NEED TO BE REVIEWED BY STRUCTURES DEPARTMENT.
From : US-18 CRAWFORD County Log 0.00
To : US-18 CRAWFORD County Log 1.14
Scheduled Date : SCHEDULED FROM 3/24/2021 UNTIL FURTHER NOTICE
Attribute Restricted Values
EWeight : 170000
WWeight : 170000


WOO-PASS V2.0.2023.07.24 (Wisconsin Oversize Overweight Permitting & Analysis Software System)
File
Window
Help
Permitting API Demo
BUREAU OF
STRUCTURES

Permitting with Load Rating Tool API

- BrDR Example 2-4
- SUPERLOAD ← → Permitting API Call
- LRT API
  - Generate precomputed data
  - Run analysis
    - RtApiEvent
    - RtApiRatingTool
    - RtApiToolResults
  - Process Results

```
RtApiToolResults rtApiToolResults = rtApiRatingTool.DoRating(currentRtApiEvent);
foreach (RtApiBridgeResult result in rtApiToolResults.BridgeResults)
{
    if (result.Code != null)
    {
        PermitResult permitResult = new PermitResult(permit.PermitName, result.BridgeId)
        {
            RtApiBridgeResult = result,
            StructureId = result.BridgeId,
            AnalysisEngine = Enums.AnalysisEngine.BRR,
            Analyzed = true,
        };
        switch (result.Code)
        {
            case "X":
                permitResult.Decision = Enums.PermitResultDecision.Deny;
                break;
            case "1":
                permitResult.Decision = Enums.PermitResultDecision.Pass;
                break;
            case "2":
                permitResult.Decision = Enums.PermitResultDecision.PassWithCondition;
                permitResult.PassCondition = result.PassConditions;
                break;
        }
        if (analysisEvent.Equals(Enums.AnalysisEvent.Permit))
        {
            if (result.ControllingImpact == 1)
            {
                permitResult.OperatingSingleLaneCapacityWithImpact = Convert.ToSingle(result.OperatingRatingFactor * permit.TotalLoad);
            }
            else if (result.ControllingImpact == 0)
            {
                permitResult.OperatingSingleLaneCapacityWithoutImpact = Convert.ToSingle(result.OperatingRatingFactor * permit.TotalLoad);
            }
        }
```

OSOW Permitting: API Success

- Fewer bridges tagged as “Evaluate Manually” or “Not in Database”
  - These require review by rating engineers
  - Prestressed Box Girders
  - Steel Girders w/ Longitudinal Stiffeners, Plastic Analysis
  - Future: more bridge types
- Streamlined routing and applications for carriers
- More Automation → Less Multi-Tasking for WisDOT Staff

OSOW Permitting: API Success

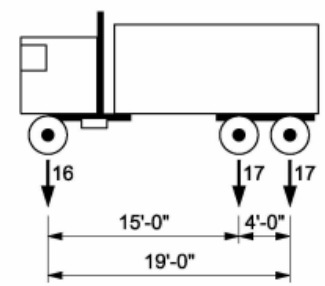
- Estimate of over 200 hours per year saved by WisDOT Staff
- Additional Time Savings by Carriers
  - Self-Routing to Avoid Waiting for WisDOT Review
  - Additional Time and Miles

Batch Analysis Reporting for Emergency & Posting Vehicles

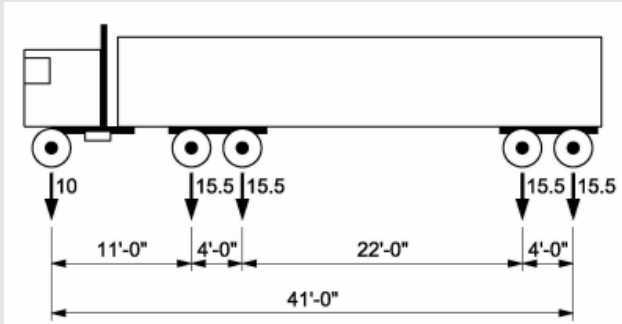
Batch Analysis Report: Background

- Wisconsin Bridge Postings
- Emergency Vehicle Evaluations
- Metric 13/14 & Future SNBI Requirements
- QA/QC Backlog
- Anticipated Future Reporting Needs (MBE Changes, Truck Configurations)

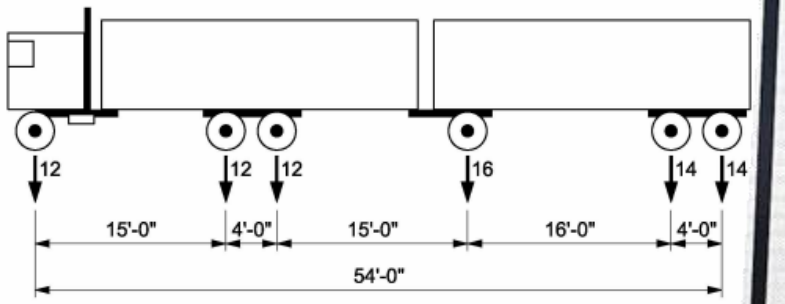
Wisconsin Bridge Postings



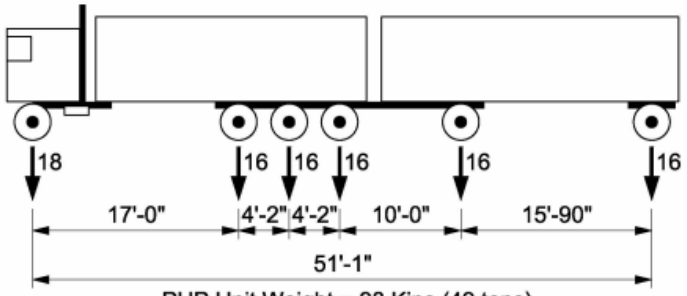
Type 3 Unit Weight = 50 Kips (25 tons)



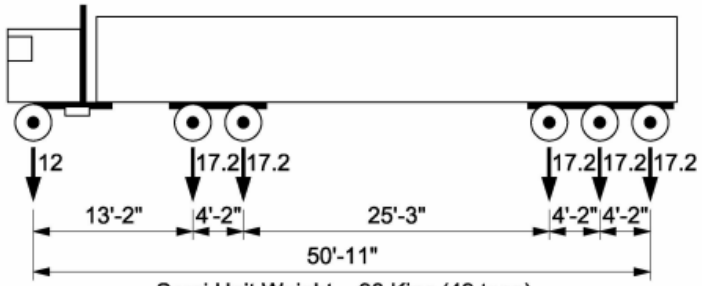
Type 3S2 Unit Weight = 72 Kips (36 tons)



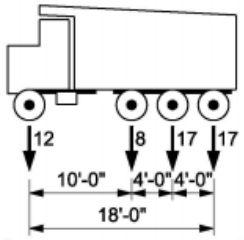
Type 3-3 Unit Weight = 80 Kips (40 tons)



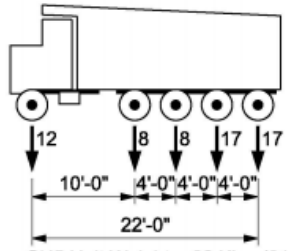
PUP Unit Weight = 98 Kips (49 tons)



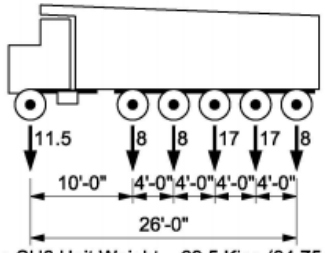
Semi Unit Weight = 98 Kips (49 tons)



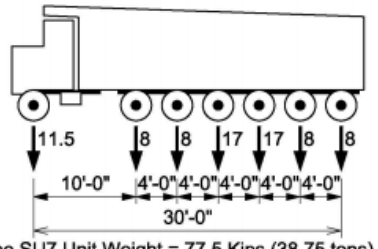
Type SU4 Unit Weight = 54 Kips (27 tons)



Type SU5 Unit Weight = 62 Kips (31 tons)



Type SU6 Unit Weight = 69.5 Kips (34.75 tons)



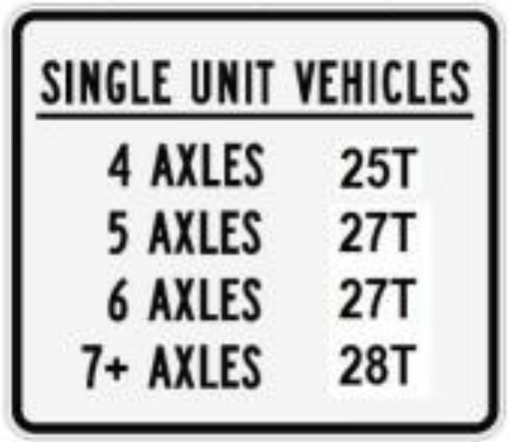
Type SU7 Unit Weight = 77.5 Kips (38.75 tons)

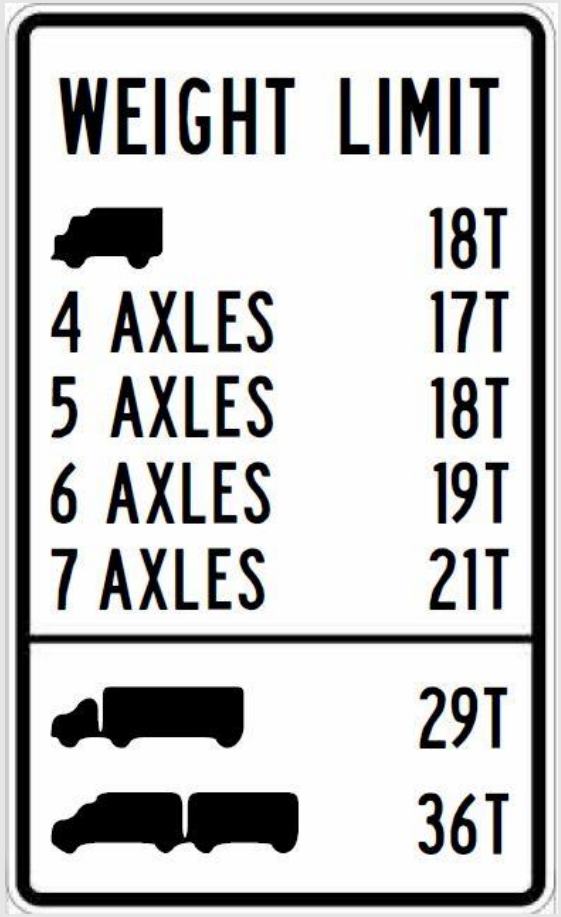
Wisconsin uses **single tonnage** signs

WISCONSIN DEPARTMENT OF TRANSPORTATION

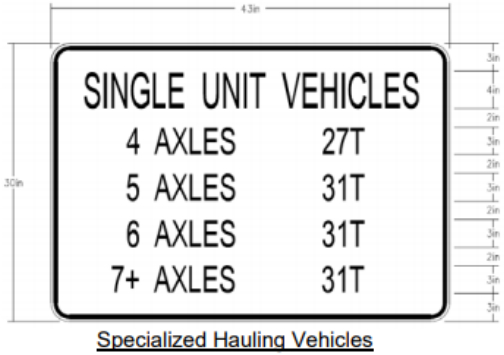
BUREAU OF STRUCTURES

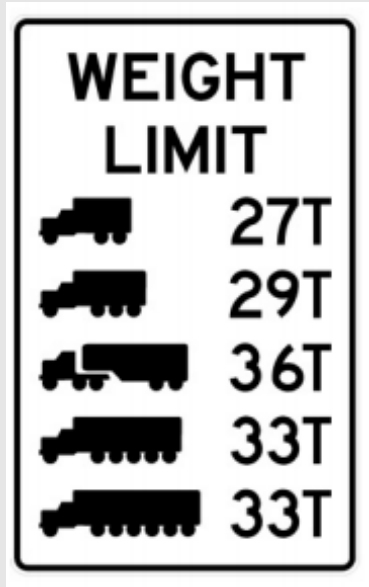

WEIGHT
LIMIT
23T
29T
32T

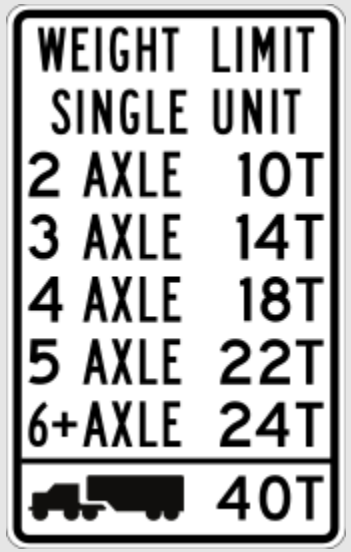

SINGLE UNIT VEHICLES
4 AXLES 25T
5 AXLES 27T
6 AXLES 27T
7+ AXLES 28T


WEIGHT LIMIT
18T
4 AXLES 17T
5 AXLES 18T
6 AXLES 19T
7 AXLES 21T
29T
36T


BRIDGE WEIGHT
LIMITS - TONS
SINGLE VEHICLE
3 OR LESS AXLES 22
4 TO 7 AXLES 25
COMBINATIONS
3 OR 4 AXLES 21
5 OR MORE 23


SINGLE UNIT VEHICLES
4 AXLES 27T
5 AXLES 31T
6 AXLES 31T
7+ AXLES 31T
Specialized Hauling Vehicles
EMERGENCY VEHICLES
SINGLE REAR AXLE 28T
TANDEM REAR AXLE 43T
Emergency Vehicles

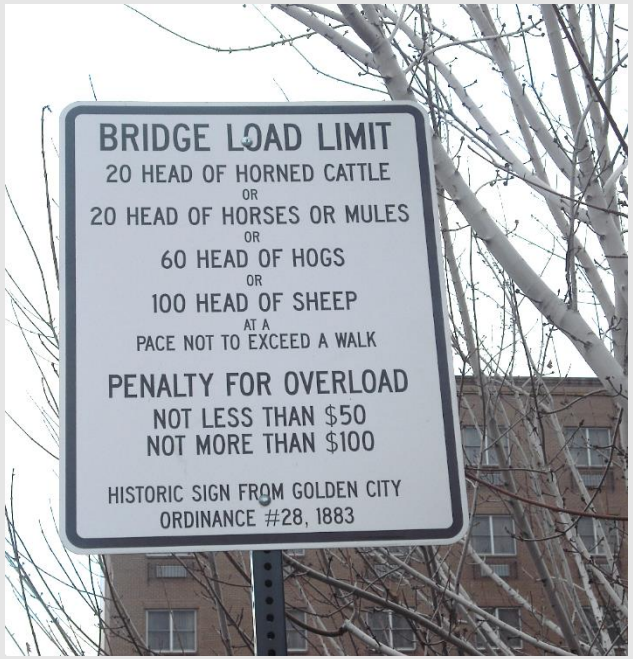

WEIGHT
LIMIT
27T
29T
36T
33T
33T


WEIGHT LIMIT
SINGLE UNIT
2 AXLE 10T
3 AXLE 14T
4 AXLE 18T
5 AXLE 22T
6+AXLE 24T
40T

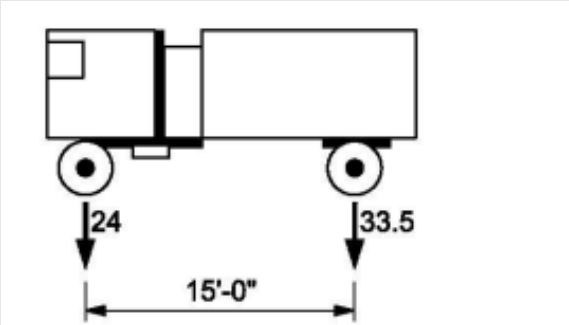

EMERGENCY VEHICLE WEIGHT LIMITS
SINGLE AXLE 15 T
TANDEM 20T
GROSS 25T
BRIDGE WEIGHT LIMIT - TONS
SINGLE VEHICLE
2 OR 3 AXLES 26 T
4 OR MORE 27 T
COMBINATIONS 45 T


TRUCKS OVER 15 TON 15 M P H ON BRIDGE
EXCEPT MAX WEIGHT LIMIT SINGLE UNIT 20 TON OTHERS 36 TON

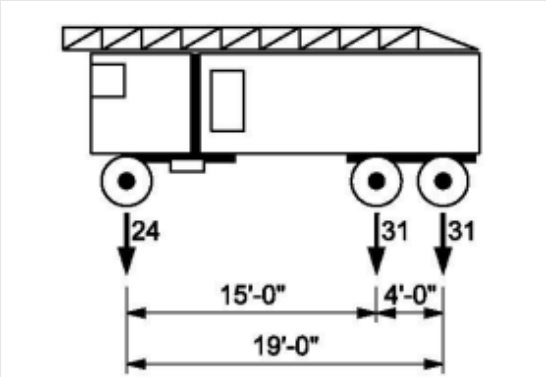

ALL VEHICLES OVER 8 TONS MUST STOP BEFORE CROSSING BRIDGE


BRIDGE LOAD LIMIT
20 HEAD OF HORNED CATTLE
OR
20 HEAD OF HORSES OR MULES
OR
60 HEAD OF HOGS
OR
100 HEAD OF SHEEP
AT A
PACE NOT TO EXCEED A WALK
PENALTY FOR OVERLOAD
NOT LESS THAN $50
NOT MORE THAN $100
HISTORIC SIGN FROM GOLDEN CITY
ORDINANCE #28, 1883

Emergency Vehicles



EV2 Unit Weight = 57.5 Kips (28.75 tons)



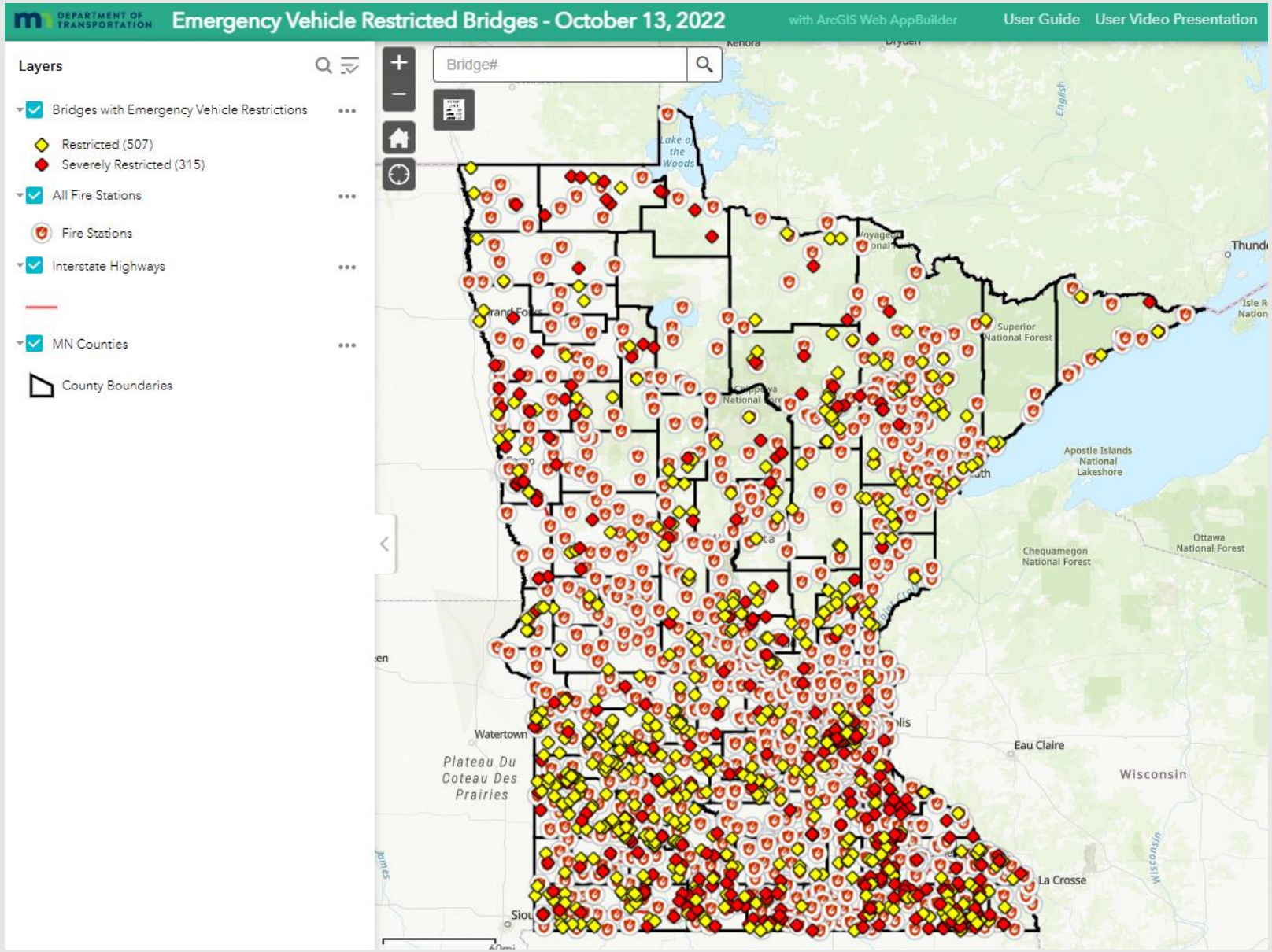
EV3 Unit Weight = 86 Kips (43 tons)

- Signs required on Interstate bridges or within reasonable access (one mile)
  - Completed Sept. 2021
  - Outreach through Firefighter Associations
- All other bridges
  - EVs exempt from FBF Limits in ALL of Wisconsin
  - Online List: Fall 2023

Emergency Vehicles

Beyond Reasonable Access:

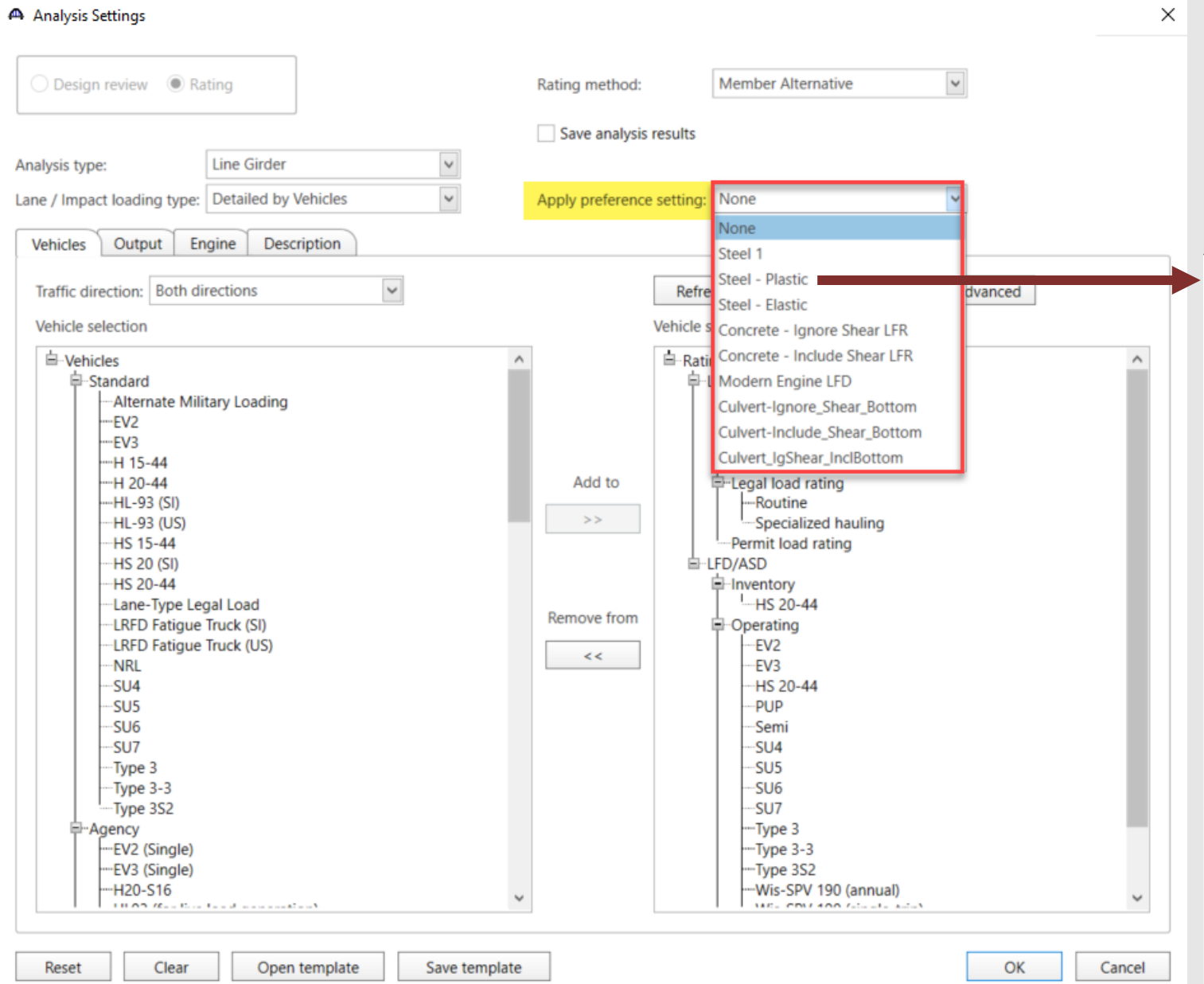
Weight Restriction Map
(MnDOT Example)

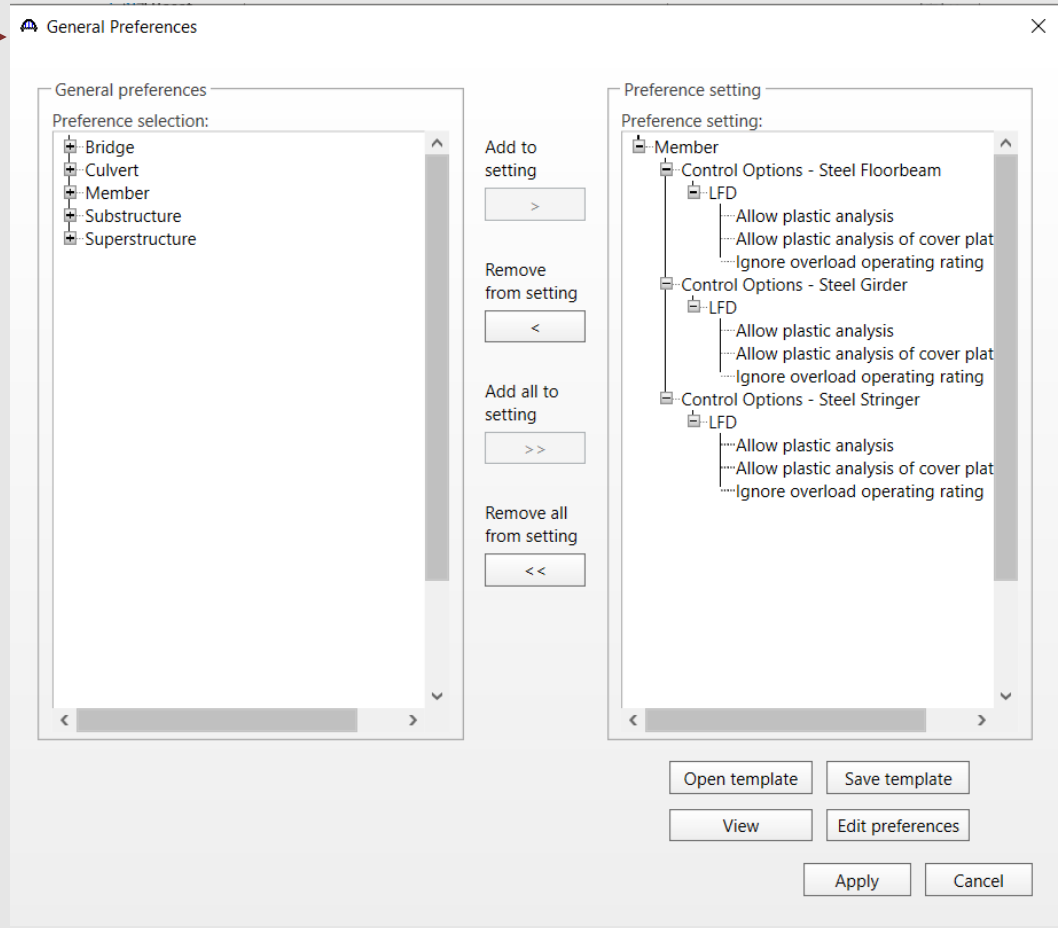


Posting Refinement Considerations

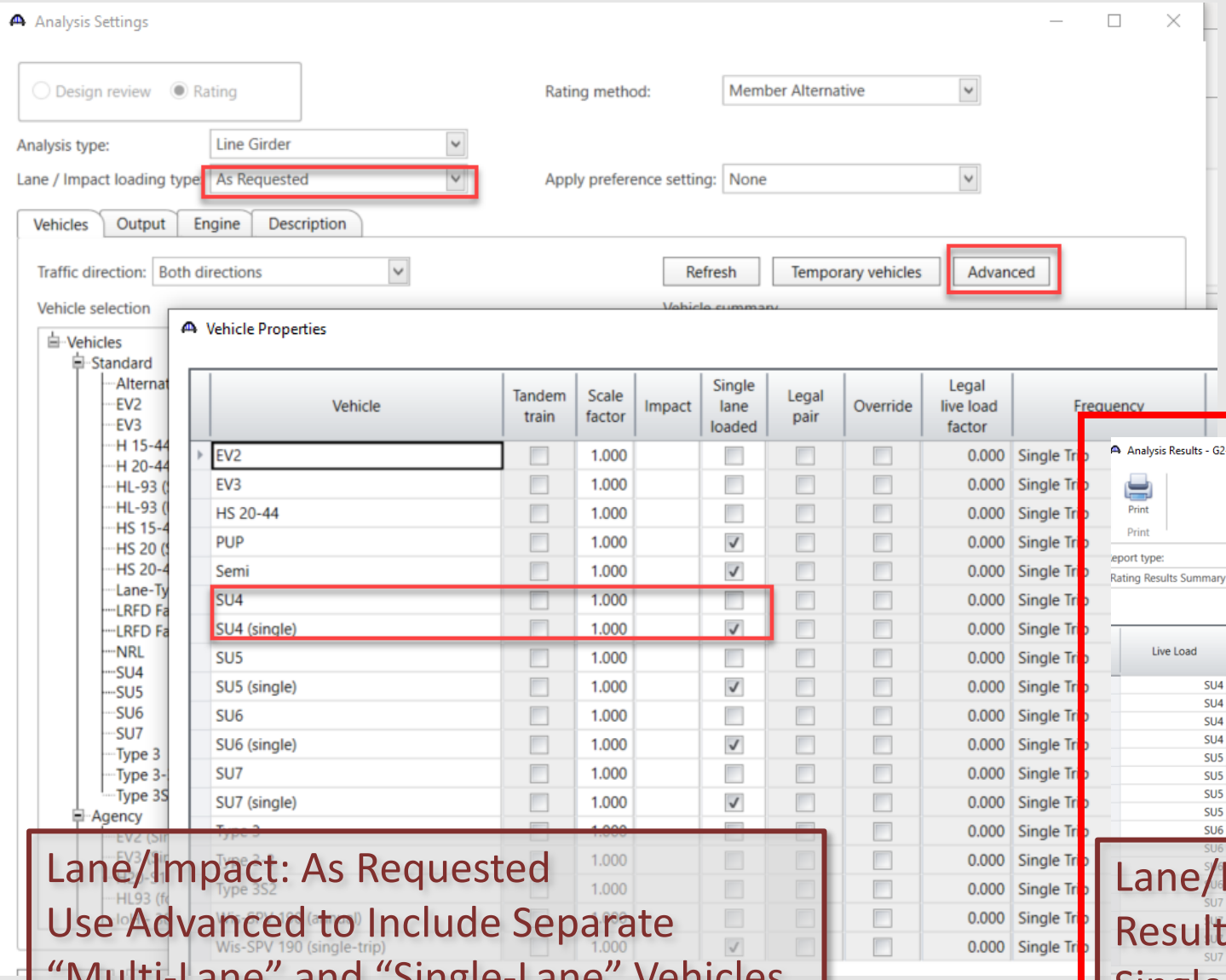
- Unknown Construction Details
- Refined Analysis (LLDF Adjustments)
- Lane Striping / Curbs and Sidewalks
- Dynamic Load Allowance Modification
- Limit State Options
  - Steel Elastic/Plastic, Concrete Shear, Moment Redistribution, Culvert Bottom Slabs
- Single-Lane Loading
- Live Load Factor Modification for EVs (NCHRP 20-07 / Task 410)

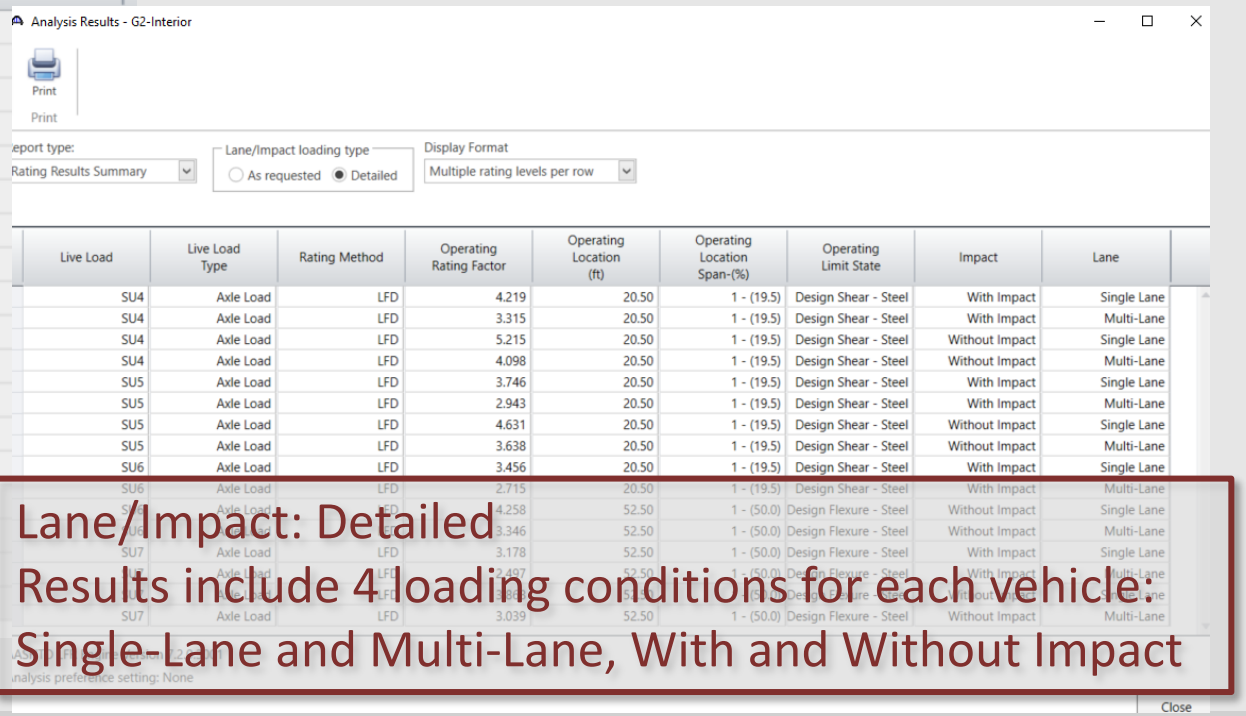
Limit State Options: Use Preference Settings





Multi/Single-Lane Loading: Two Options





Lane/Impact: As Requested
Use Advanced to Include Separate "Multi-Lane" and "Single-Lane" Vehicles

Lane/Impact: Detailed
Results include 4 loading conditions for each vehicle:
Single-Lane and Multi-Lane, With and Without Impact

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Live Load Factor Modifications for EVs

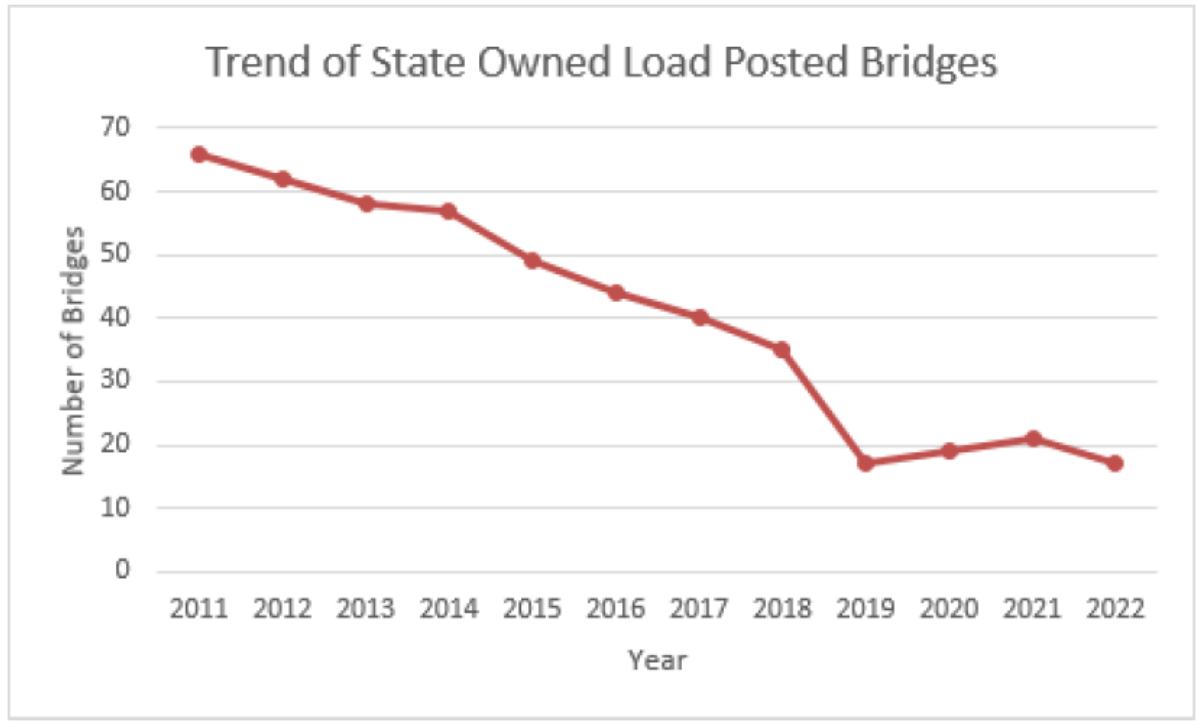
- NCHRP 20-07 / Task 410
- Adjusted BrR-Calculated Rating Factors in Post-Processing (Excel)

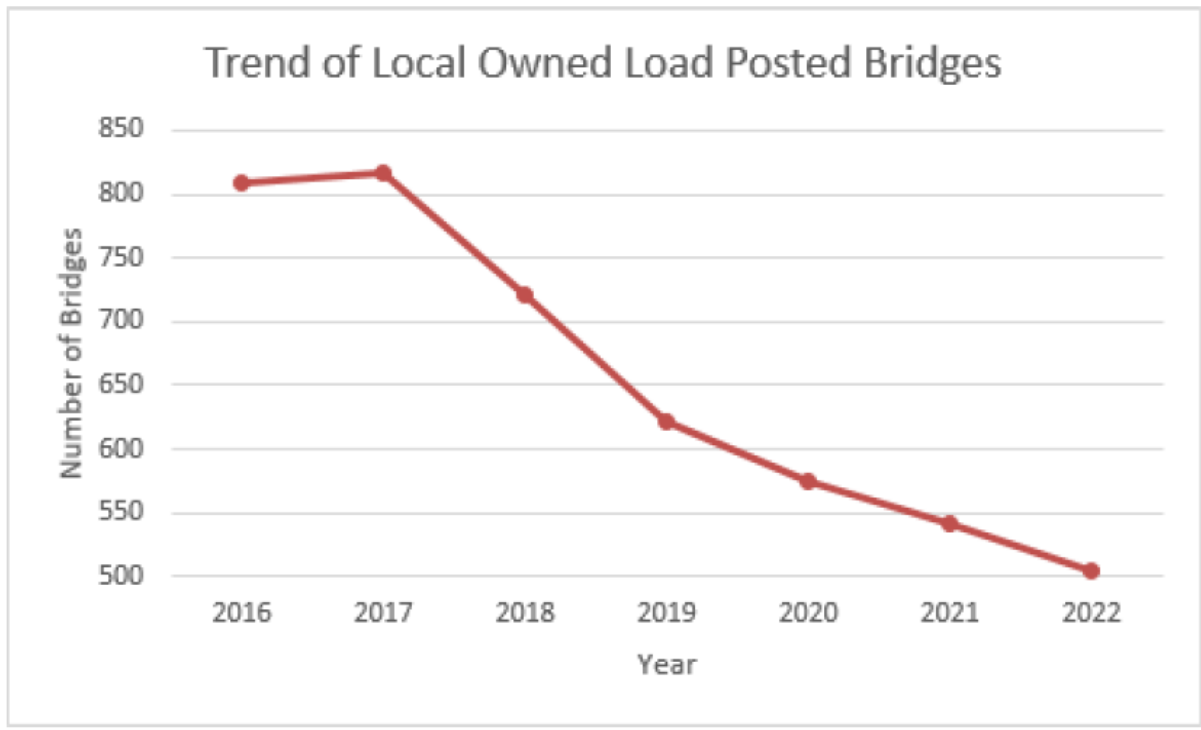
	A	AA	AB	AC	AD	AP	BW	BX
1							NCHRP 20-07/Task 410 LL Factors	
2	BRIDGE ID	ADT	ADT YEAR	TRAFFIC PATTERN ON	FUNCTIONAL CLASS	ADTT One Direct	EV2 LLF	EV3 LLF
12747	P100173	116	2015	TWO WAY TRAFFIC	LOCAL-RURAL	9.57	1.10	1.10

7	Bridge ID	EV2 ALT LLF	EV3 ALT LLF	Use Alt EV LLF	EV3 RF ORIG	EV3 LLF ORIG	EV3 RATING FACTOR
13	P100173	1.1	1.1	Y	0.643	1.3	0.76

Example:
BrR-Calculated RF = 0.643
Adjusted RF = 0.643 * 1.3 / 1.1 = 0.760

Wisconsin Bridge Postings





Wisconsin will have around 450-500 EV Restrictions in addition to ~500 Std. Weight Limit Postings (approx. 7% of bridge inventory)

Metric 13/14 & Future SNBI Compliance

- WisDOT Metric 13 IP & Metric 14 PCA
  - Better Documentation
    - Load Rating Summary Sheets
    - Internal Ratings → Bridge Mgmt System
  - SHV Evaluations
  - Culvert Load Ratings
- Future SNBI Requirements
  - Report Rating Factors for Each Vehicle


U.S. Department of Transportation
Federal Highway Administration

HIBS-30

NBIPOT

NBIS Oversight Program

Metrics for the Oversight of the National Bridge Inspection Program

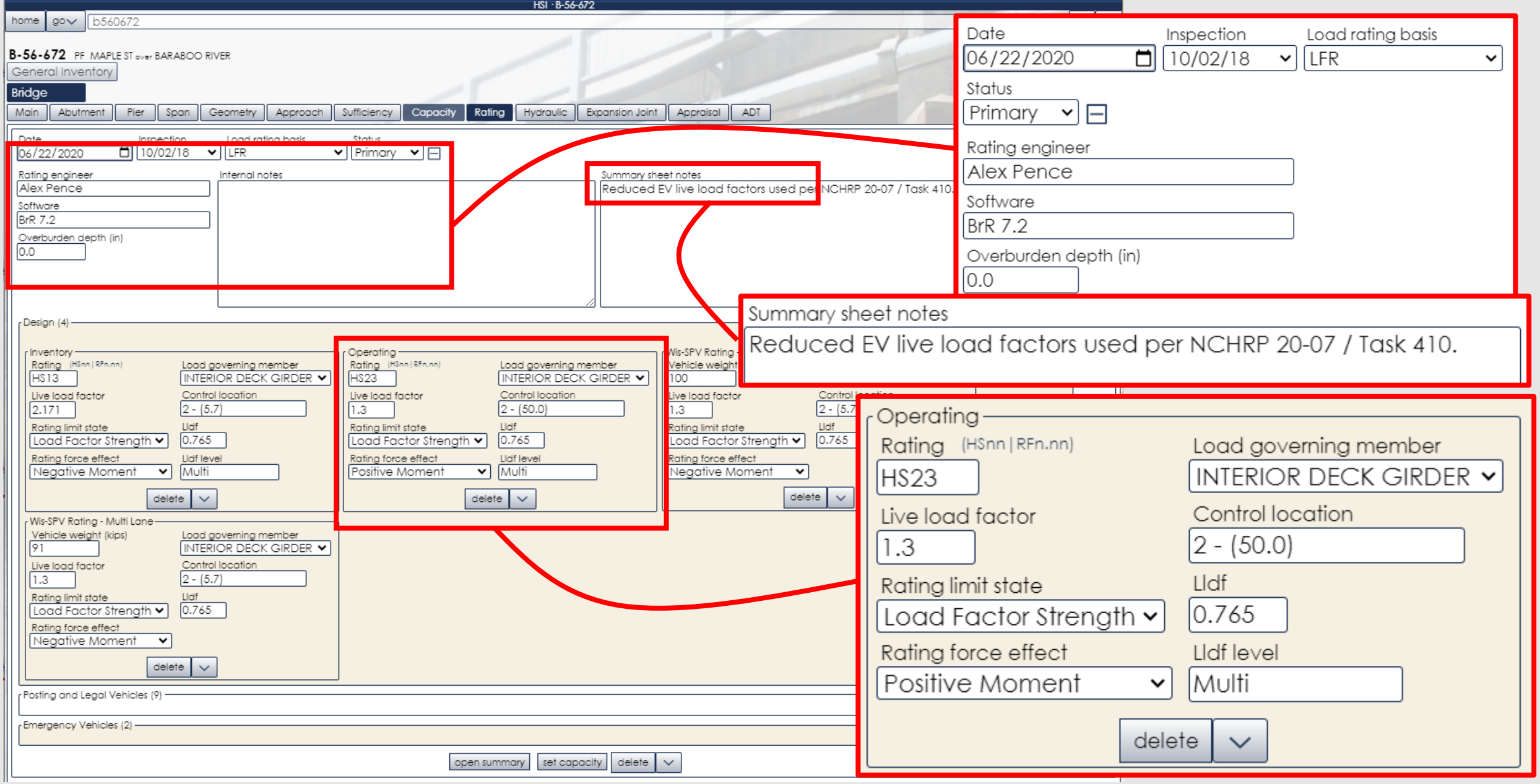
5.1 – LOADS AND LOAD RATING

Example Loads and Load Rating Data for Bridge Number 15558X

The bridge was designed for the HS-20 load using Allowable Stress Design. The bridge was rerated on February 14, 2016 using the load factor rating method to assess Specialized Hauling Vehicles. The calculated inventory rating factor was 0.30 and the operating rating factor was 0.50. The controlling legal load rating factor was 0.44 for the SU7 truck. Routine permit vehicles are not permitted to cross the bridge.

Table 14. Loads and Load Rating data items in the Primary Data Set for Bridge Number 15558X.

Item ID	Data Item	Value
B.LR.01	*Design Load*	HS20
B.LR.02	*Design Method*	ASD
B.LR.03	*Load Rating Date*	20160214
B.LR.04	*Load Rating Method*	LFR
B.LR.05	*Inventory Load Rating Factor*	0.30
B.LR.06	*Operating Load Rating Factor*	0.50
B.LR.07	*Controlling Legal Load Rating Factor*	0.44
B.LR.08	*Routine Permit Loads*	C



Date 06/22/2020
Inspection 10/02/18
Load rating basis LFR
Status Primary
Rating engineer Alex Pence
Software BrR 7.2
Overburden depth (in) 0.0
Summary sheet notes
Reduced EV live load factors used per NCHRP 20-07 / Task 410.
Operating
Rating (HSnn | RFn.nn) HS23
Load governing member INTERIOR DECK GIRDER
Live load factor 1.3
Control location 2 - (50.0)
Rating limit state Load Factor Strength
Lldf 0.765
Rating force effect Positive Moment
Lldf level Multi
delete

Wisconsin Department of Transportation
Bridge Load Rating Summary

v.07-2020h

Bridge Data

Structure Id: B-56-672	Traffic Count: 292 / Truck Traffic %: 0
Owner: COUNTY	Overburden Depth (in): 0 / Design Load Rating: H20
Municipality: V-North Freedom(56161)	Inspection Date: 02-Oct-2018
Feature On: PF MAPLE ST	
Feature Under: BARABOO RIVER	

NBI Condition Ratings

Deck:	Superstructure:	Substructure:	Culvert:
5	5	5	N

Spans

#:	Material:	Configuration:	Length (ft)
1	CONT STEEL	DECK GIRDER	38
2	CONT STEEL	DECK GIRDER	48
3	CONT STEEL	DECK GIRDER	38

Construction History:

Year:	Work Performed:
1940	NEW STRUCTURE

Load Rating Summary

Load Rating Basis: LFR

	Value:	Load Governing Member:	Rating Force Effect:	LLDF:
Inventory:	HS13	INTERIOR DECK GIRDER	Negative Moment	0.765
Operating:	HS23	INTERIOR DECK GIRDER	Positive Moment	0.765

Wisconsin Special Permit Vehicles	MVW (kips)	Load Governing Member:	Rating Force Effect:	LLDF
Single lane (w/o FWS):	100	EXTERIOR DECK GIRDER	Negative Moment	0.765
Multi lane (w/o FWS):	91	INTERIOR DECK GIRDER	Negative Moment	0.765

Load Posting Analysis (when required per Wisconsin Bridge Manual, Chapter 45)

Posting Vehicle		GVW (kips):	Rating Factor:	Weight Limit (T):	Load Governing Member:	Rating Force Effect:	LLDF
AASHTO Legal Vehicles	Type 3	50.0	1.61	N/A	INTERIOR DECK GIRDER	Positive Moment	0.985
	Type 3S2	72.0	1.75	N/A	INTERIOR DECK GIRDER	Positive Moment	0.985
	Type 3-3	80.0	2.02	N/A	INTERIOR DECK GIRDER	Positive Moment	0.985
	SU4	54.0	1.4	N/A	INTERIOR DECK GIRDER	Positive Moment	0.985
	SU5	62.0	1.29	N/A	INTERIOR DECK GIRDER	Positive Moment	0.985
	SU6	69.5	1.18	N/A	INTERIOR DECK GIRDER	Positive Moment	0.985
	SU7	77.5	1.12	N/A	INTERIOR DECK GIRDER	Positive Moment	0.985
WisDOT Spec.	PUP	98.0	1.41	N/A	EXTERIOR DECK GIRDER		
	Semi	98.0	1.53	N/A	EXTERIOR DECK GIRDER		
FAST Act EVs	EV2	57.5	1.62	N/A	INTERIOR DECK GIRDER		
	EV3	86.0	1.0	N/A	INTERIOR DECK GIRDER		

Posting for Legal/Specialized Permit Vehicles:

Weight Limits for Emergency Vehicles:

Software and version used: BrR 7.2

Rating Engineer: Alex Pence

Additional Remarks: Reduced EV live load factors used per NCHRP 20-07 / Task 410.

Date: 22-Jun-2020

Traffic Count: 292

Truck Traffic %: 0

Overburden Depth (in): 0

Design Load Rating: H20

Inspection Date: 02-Oct-2018

NBI Condition Ratings

Deck:	Superstructure:	Substructure:	Culvert:
5	5	5	N

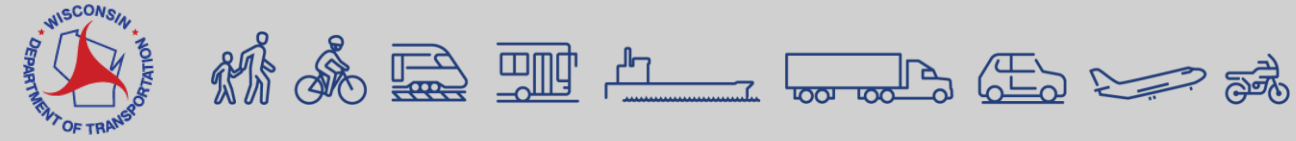
Construction History:

Year:	Work Performed:
1940	NEW STRUCTURE

Load Posting Analysis (when required per Wisconsin Bridge Manual, Chapter 45)

Posting Vehicle		GVW (kips):	Rating Factor:	Weight Limit (T):	Load Governing Member:	Rating Force Effect:	LLDF
	Type 3	50.0	1.61	N/A	INTERIOR DECK GIRDER	Positive Moment	0.985

Additional Remarks:
Reduced EV live load factors used per NCHRP 20-07 / Task 410.



BUREAU OF STRUCTURES

QA/QC Backlog

- Intern Load Rating Models
- Migration from Old Programs to BrR
- Discrepancies between Consultant Ratings & Internal Ratings
- Tabular Output → Compare Results vs. Prior Data, Identify Outliers

Anticipated Future Needs for Re-Evaluation

- Platoon Loading
- Annual Permit Configurations
- Inclusion of Additional Elements (e.g. Gusset Plates, Pier Caps)
- MBE Changes (e.g. Shear, Culverts, LRFR)

BrR Batch Analysis Custom Report

- Batch Analysis + Additional Output
- Analyze and Save Data from Multiple Analysis Settings
  - For example, Elastic vs. Plastic or Single vs. Multi Lane Loading
- Tabular Reporting for Post-Processing in Excel
- Potential Integration with Bridge Data Management System

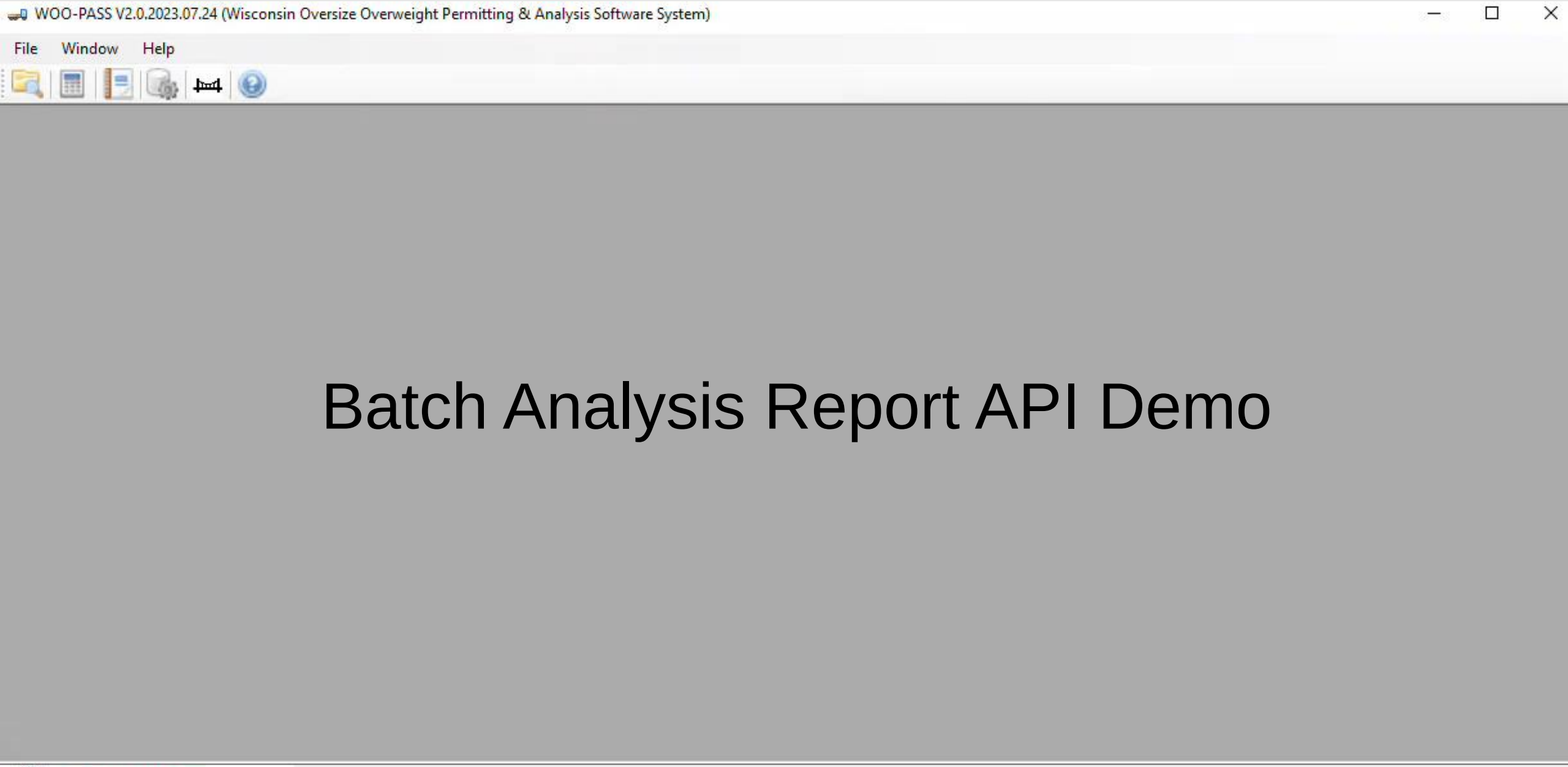
ProMiles + WisDOT Collaboration

- BrDR Service Unit
- Defined the Scope and Roles
- ProMiles provided sample code
- WisDOT further developed the API code and UI
- ProMiles assisted with some troubleshooting

Desired Report Output

- Some we could get from BWS
- Some from BE Batch Results
- Some from ARC Tool
- Some by clicking through individual bridge models

Data	Bridge Workspace Rating Results	Bridge Explorer Batch Results	ARC Tool Results
BID			
Bridge ID			
Description			
Date Modified			
Analysis Date		✓	Can manually record date of ARC Tool Dataset creation
Method	✓	✓	X
Overburden Depth	X	X	X
Inventory/Operating RF	✓	✓	✓
Inv/Oper Governing Member	X	Can be derived by drilling down to Member Rating Results	Level 2
Inv/Oper Controlling Location	Both (ft) and Span-(%)	Member Rating Results -- only as (ft), not Span-(%)	Member Rating Results -- only as (ft), not Span-(%)
Inv/Oper Rating Limit State	✓	X	✓
Inv/Oper Rating Pos/Neg LL Effect	X	X	X
Inv/Oper LLDF	X	X	X
Inv/Oper LL Factor	Derive from Method	Derive from Method	X
Inv/Oper LL Level (Single/Multi)	X	X	X

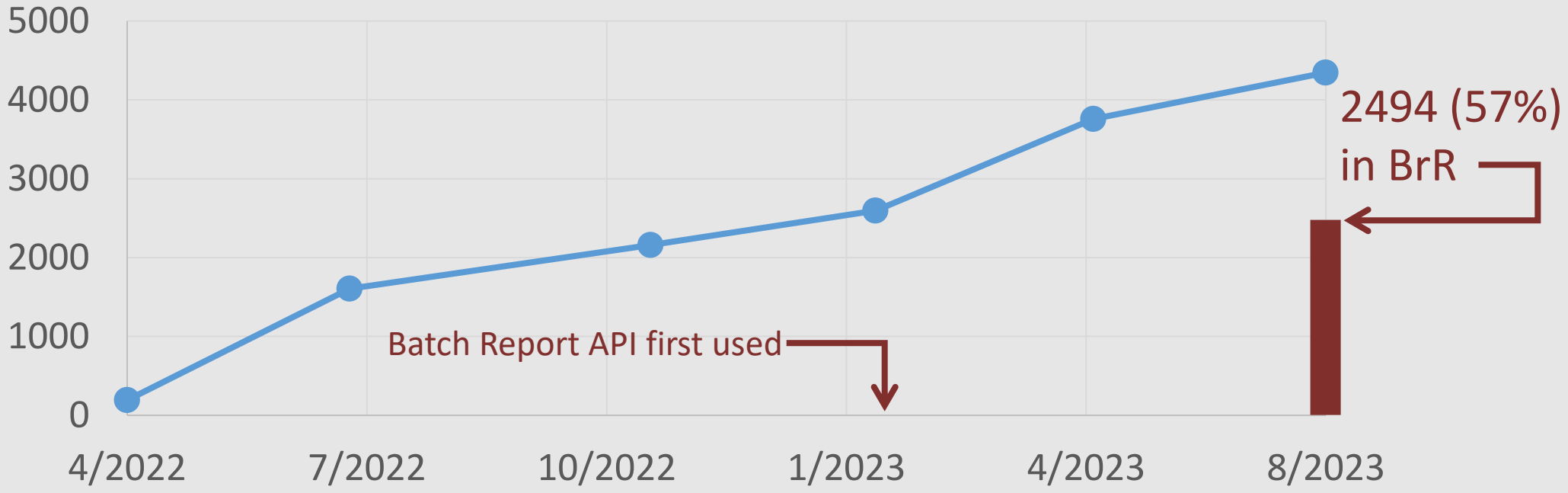

WOO-PASS V2.0.2023.07.24 (Wisconsin Oversize Overweight Permitting & Analysis Software System)
File
Window
Help
Batch Analysis Report API Demo
BUREAU OF
STRUCTURES

Post-Processing

	A	O	P	BO	BP	BR	BS	CE	CF
7	Bridge ID	Preference Setting - INV/OP/MVW	Preference Setting - Posting	SHV Single/Multi	EV Single/Multi	Use Alt EV LLF	Posting Calc (Tons)	INV	INV RF
12	B490164	Concrete - Include Shear LFR	Concrete - Ignore Shear LFR	Multi	Multi		---	HS19	0.95
13	P100173	Steel - Elastic	Steel - Elastic	Multi	Multi	Y	22	HS09	0.49
26									
27									
28									
29									
30									
31									
32									
33									
34									
35									
36									
37									

Batch Analysis Report: API Success

Progress completing documentation (Rating Tab Data Upload) for bridges requiring posting and emergency vehicle evaluation



Batch Analysis & Reporting with BrDR Analysis API

- BrDR Example 2-1
- WOO-PASS ← → Batch Analysis API Call
- Analysis API
  - Connect to the BrDR DB
  - Create the Analysis Event and Results objects
  - Retrieve Bridge Object and Run Analysis
  - Process Results

```
if (bIsSessionStarted)
{
    // Create the analysis event and results
    DoEventManager doEventManager = BRIDGEWare.GetManager<DoEventManager>();
    DoBridgeResultsManager doBridgeResultsManager = BRIDGEWare.GetManager<DoBridgeResultsManager>();
    DoAnalysisEvent doAnalysisEvent = doEventManager.Create<DoAnalysisEvent>();
    DoBridgeResults doBridgeResults = doBridgeResultsManager.Create(doAnalysisEvent);
    // Set needed values
    doAnalysisEvent.StartingPath = SysSecurity.GetUserAnalysisOutputFolder(); ; // Note: This is just an example
    //doAnalysisEvent.AnalysisEventType.SetValue(ANALEVNT.RATE); // Rating
    //doAnalysisEvent.AnalysisMethodType.SetValue(EVNTANALMET.EVNTLFD); // LFD
    doAnalysisEvent.EventTimestamp.SetValue(DateTime.Now.ToUniversalTime()); // Setting up timestamp
    doAnalysisEvent.AnalysisCachePath = SysSecurity.GetAnalysisCacheFolder();
    doAnalysisEvent.ReportXslFolderPath = SysSecurity.GetReportXslFolder();
    if (analysisEventTemplates.Count == 0)...
    DoAnalysisEventTemplate analysisEventTemplateSelection = null;
    foreach (DoAnalysisEventTemplate doAnalysisEventTemplate in analysisEventTemplates)...
    if (!string.IsNullOrEmpty(preferenceTemplateName))...
    DoBridgeManager doBridgeManager = BRIDGEWare.BridgeManager;
    DoBridge doBridge = doBridgeManager.RetrieveByBridgeId(structureId);
    if (doBridge != null)
    {
        AnalysisApiFeedback brAnalysisFeedback = new AnalysisApiFeedback();
        AnalysisApi analysisApi = new AnalysisApi();
        //brAnalysisFeedback.MessageAdded += (o, e) => { Console.WriteLine($"Message Type: {e.MessageType.ToString()} - {e.Message}"); };
        //brAnalysisFeedback.ProgressUpdated += (o, e) => { Console.WriteLine($"Progress updated: {e.NewProgressPercentage}"); };
        //Debug.WriteLine($"Message Type: {e.MessageType.ToString()} - {e.Message}");
        string analysisFeedback = "";
        brAnalysisFeedback.MessageAdded += (o, e) => { analysisFeedback += String.Format("Message Type: {0} - {1}\r\n", e.MessageType.ToStr
        //brAnalysisFeedback.ProgressUpdated += (o, e) => { Debug.WriteLine($"Progress updated: {e.NewProgressPercentage}"); };
        // Create analysis components to be analyzed
        AnalysisApiComponents analysisApiComponents = new AnalysisApiComponents
        {
            // Set the components
            Bridge = doBridge
        };
        if (doBridge.StructDefList != null && doBridge.StructDefList.Count > 0)
        {
            DoStructDef doStructDef = doBridge.StructDefList[0];
            //DoGirderSystemStructDef doGirderSystemStructDef = (DoGirderSystemStructDef)doStructDef;

            // Analyze the girder system struct def
            //analysisApiComponents.SuperStructDef = doGirderSystemStructDef;
        }
        analysisApiComponents.AnalysisFeedback = brAnalysisFeedback;
        analysisApiComponents.AnalysisEvent = doAnalysisEvent;
        // Run Analysis
        analysisApi.DoAnalysis(doBridge, analysisApiComponents);
        doBridgeResults = doAnalysisEvent.BridgeResults; // Unprocessed results
        List<WiResults> processedResults = ProcessAnalysisBridgeResults(doBridgeResults, doBridge, analysisEventTemplateSelection, preferenceTemplateName, brAnalysi
        List<WiDetailedResults> detailedResults = ProcessAnalysisDetailedResults(doBridgeResults);
        return new Tuple<string, DoBridge, List<WiResults>, AnalysisApiComponents, string, List<WiDetailedResults>>(structureId, doBridge, processedResults, analysi
    }
```

```
Template : string
Preference : string
BID : int
BridgeId : string
BridgeName : string
Description : string
DateModified : DateTime
AnalysisDate : DateTime
VehicleName : string
LiveLoadType : string
RatingLevel : string
RatingFactor : double
RatingLevelProperty : string
RatingMethodType : string
DesignMethodType : string
SuperstructureName : string
SuperstructureDefinition : string
SuperstructureDefinitionType : string
MemberName : string
WearingSurfaceThickness : double
CulvertComponent : string
Capacity : double
Location : double
Span : int
SpanPercent : double
LocationSpanPercent : string
LimitState : string
PositiveNegative : string
LLDF : double
Lanes : string
LIFactor : double
InvRf : double?
OprRf : double?
ElementName : string
Component : string
LocationPercentage : double
LfdSingleLIFactorMoment : double
LfdSingleLIFactorShear : double
LfdSingleLIFactorShearSupp : double
LfdSingleLIFactorDeflection : double
LfdMultiLIFactorMoment : double
LfdMultiLIFactorShear : double
LfdMultiLIFactorShearSupp : double
LfdMultiLIFactorDeflection : double
```

BrDR API Resources

- Developer License
- BrDR API Guide PDF
- API Examples packaged in a Visual Studio solution
- Example Projects Guide PDF
- API CHM files
- ProMiles

```
Examples:

 - 1 Basic API Operations

 - 1.1 Object retrieve examples
 - 1.2 Object CRUD examples
 - 1.3 Summary object examples
 - 1.4 Retrieving reinforced concrete cross sections
 - 1.5 Retrieving prestressed beam spans
 - 1.6 C++ Object retrieve example (a subset of Example 1.1) [Not in solution]
 - 1.7 Calculating Steel Cross-Sectional Area
 - 1.8 Create and save bridge example
 - 1.9 Import Utility example
 - 1.10 Licensing example
 - 1.11 IFC bridge import/export example


 - 2 Analysis Examples

 - 2.1 Analysis API
 - 2.2 Simplified Analysis API (LFD)
 - 2.3 XML-based Analysis API
 - 2.4 Rating Tool API
 - 2.5 Simplified Analysis API (LRFR)


 - 3 Engine

 - 3.1 Creating a 3rd-party engine
 - 3.2 Creating a 3rd-party engine properties UI window
 - 3.3 Retrieve Engine Properties from Bridge Object
```