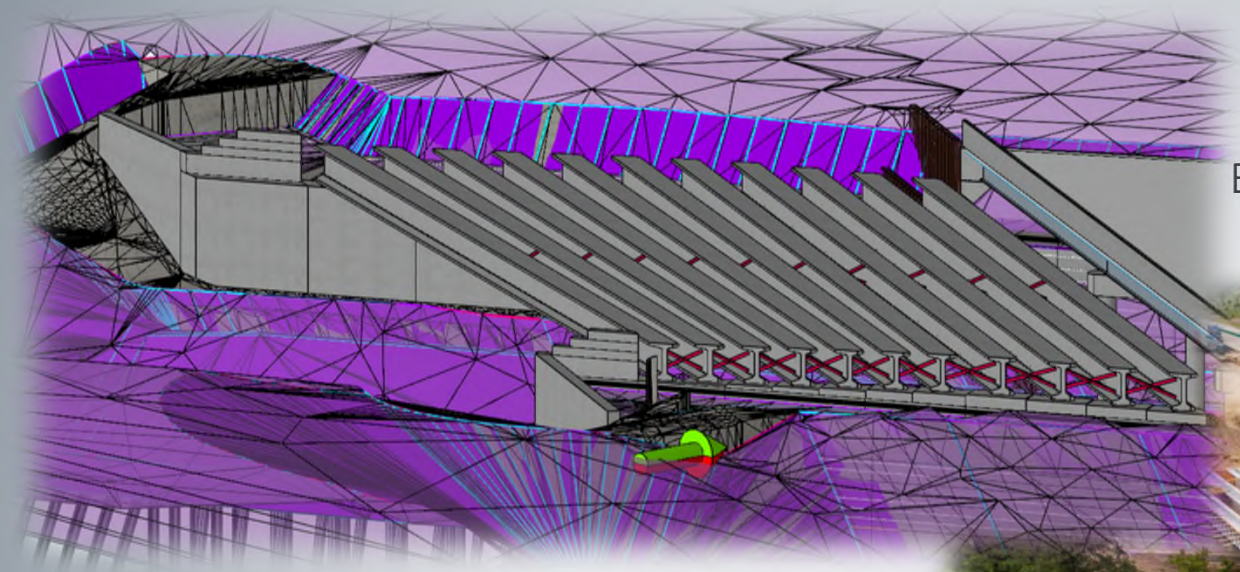
Bridge Model Delivery Pilot and MDOT Digital Vision

Brad Wagner

BOBS Structure Project Division Administrator

Digital Vision Core Team



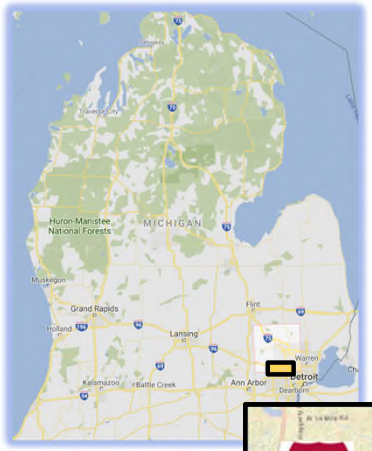
MDOT Michigan Department of Transportation

BUREAU of BRIDGES and STRUCTURES

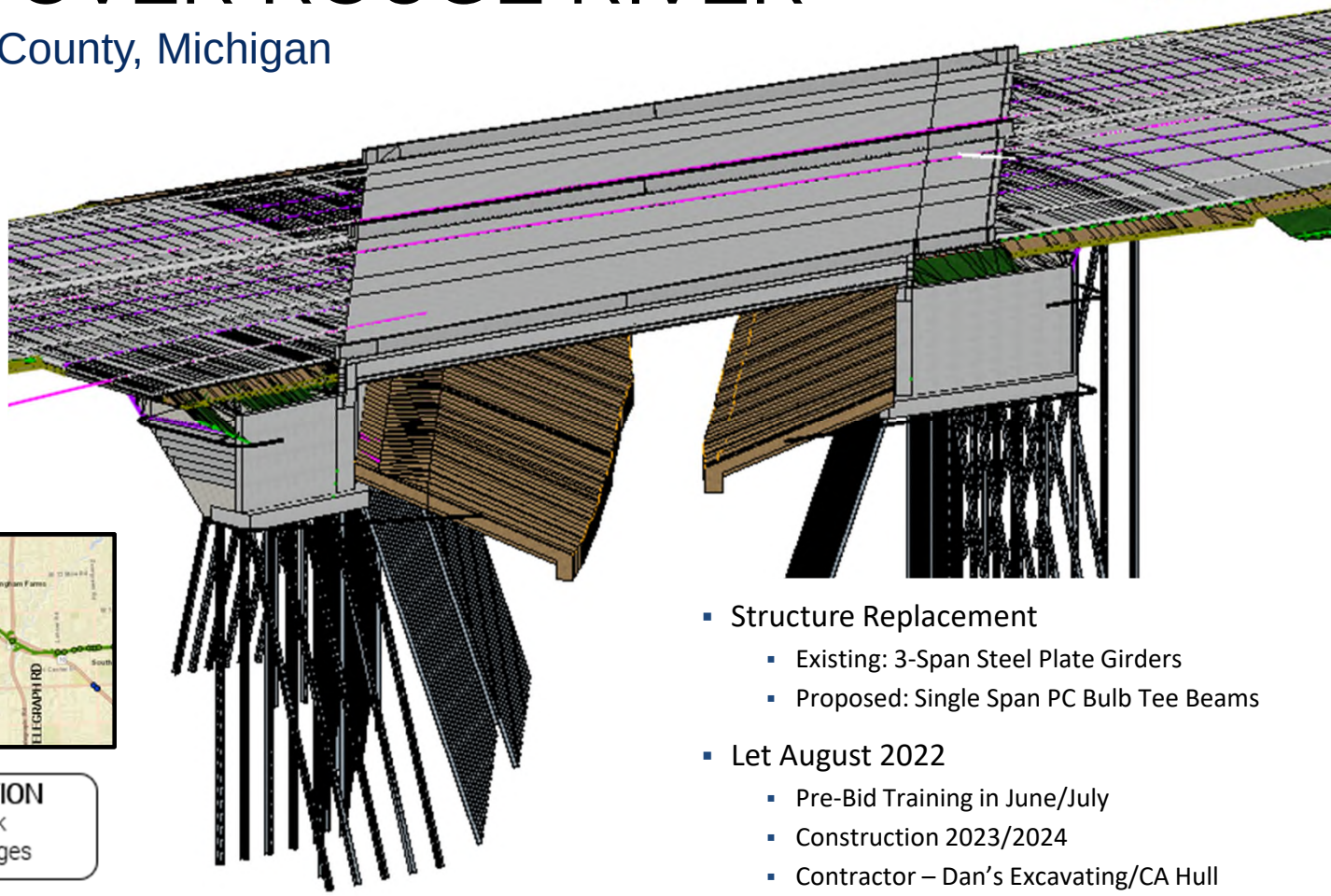
SPANNING CONNECTING SAFELY EFFICIENTLY

I-696 EB & WB OVER ROUGE RIVER

City of Southfield, Oakland County, Michigan



I-696 RECONSTRUCTION
8.5 miles of road work
Rehabilitation of 10 bridges



- Structure Replacement
  - Existing: 3-Span Steel Plate Girders
  - Proposed: Single Span PC Bulb Tee Beams
- Let August 2022
  - Pre-Bid Training in June/July
  - Construction 2023/2024
  - Contractor – Dan's Excavating/CA Hull

MODEL OVERVIEW

Model & Software Structure

Bridge Model Files

ProConcrete
Steel Reinforcement
Design & Quantities

OpenBridge Modeler
3D Structure Models
(Existing and Proposed)

Others

Other Discipline Files

OpenRoads Designer
3D Road Models
Survey and Earthwork Models
gINT Geotechnical Data

PDF
Reports (SP, etc.)

Excel
Tables (deck elevations, beam details, etc.

MicroStation
2D details

"Container" File

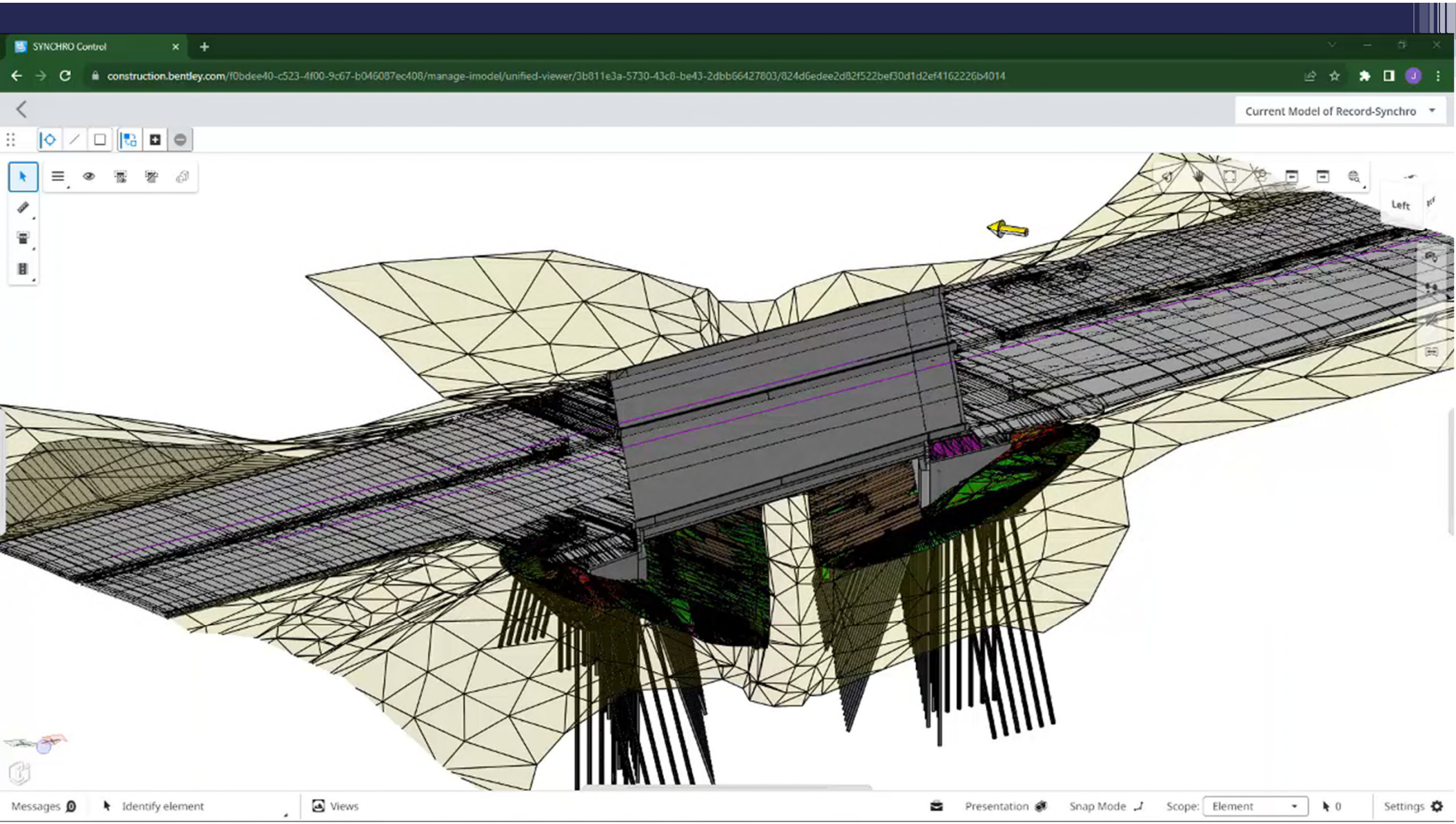
DGN (OpenRoads Designer)

Contract

Construction Software

SYNCHRO
Trimble
Leica Geosystems

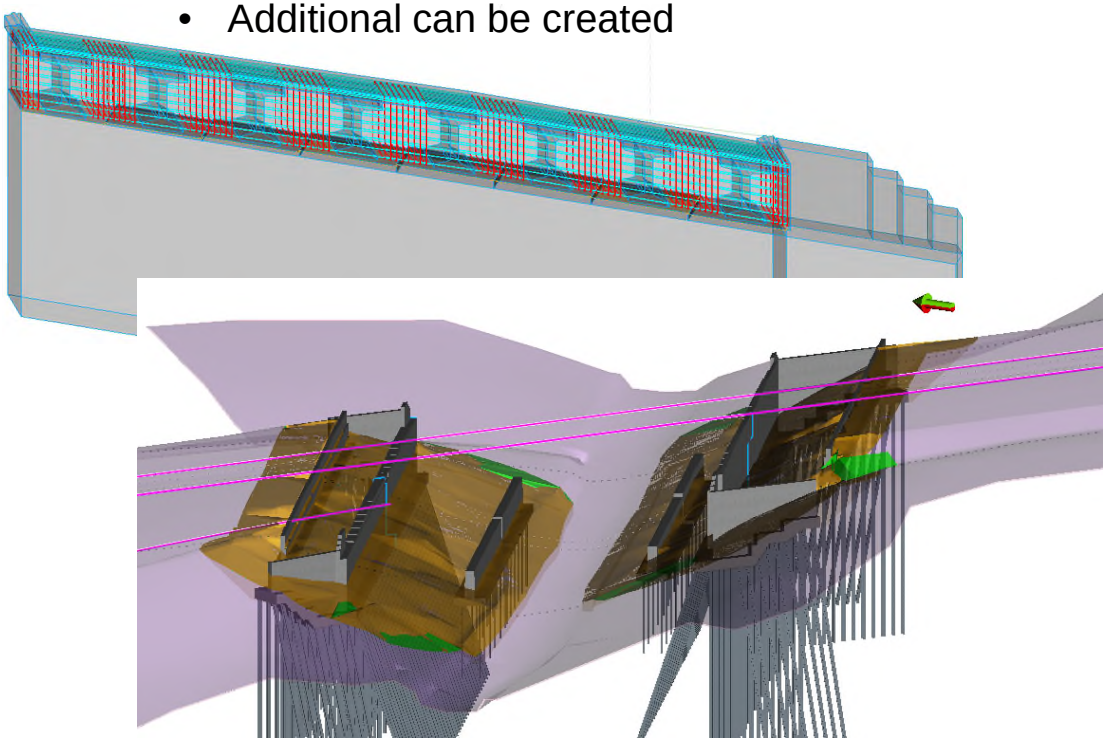
Others


SYNCHRO Control
construction.bentley.com/f0bdee40-c523-4f00-9c67-b046087ec408/manage-imodel/unified-viewer/3b811e3a-5730-43c8-be43-2dbb66427803/824d6edee2d82f522bef30d1d2ef4162226b4014
Current Model of Record-Synchro
Left
Messages
Identify element
Views
Presentation
Snap Mode
Scope:
Element
0
Settings

MODEL STRUCTURE & FORMAT

Saved Views

- Allows user to quickly access oriented information
- Additional can be created

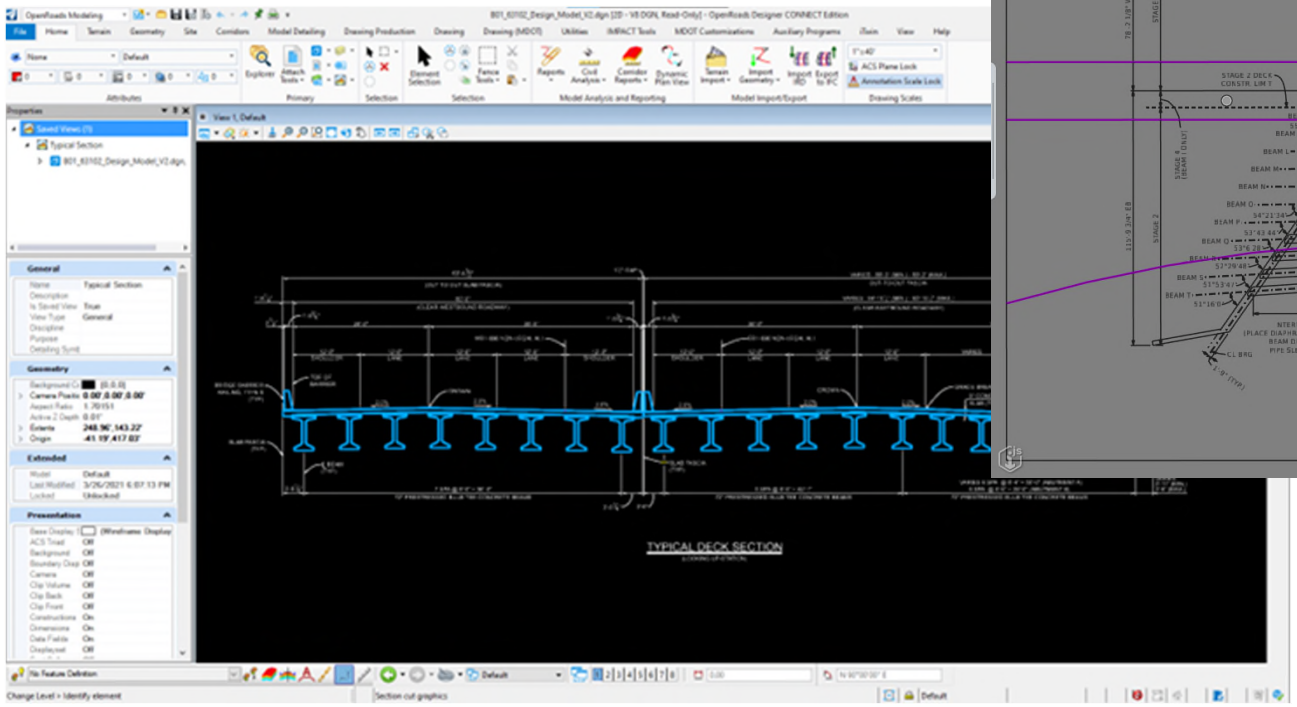


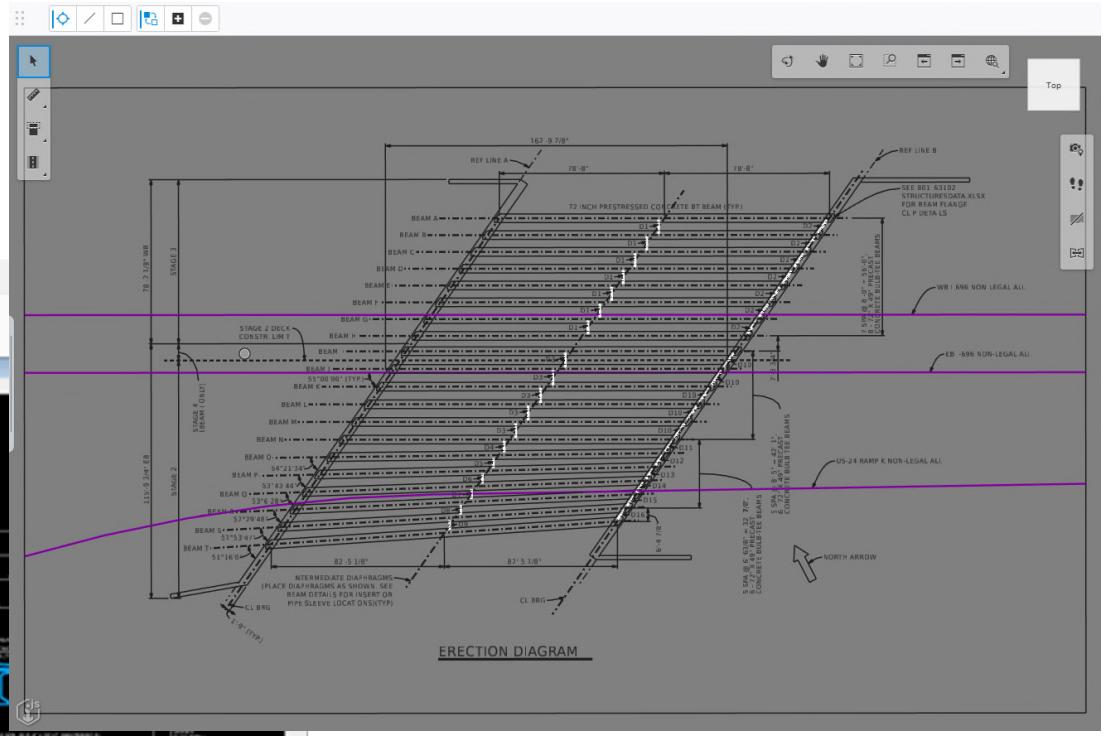
Saved Views - View 1

Name	Description
1.00 Plan Overview	Overall general plan of structure and approaches
1.04 Structure 3D View	Isometric view of the structures
1.05 Earthwork	Excavation and fill limits in 3D with only pertinent surfaces and subst
1.07 Pile Layout	Plan view of pile layout including location of test piles (red circles arc
1.08 Utilities Existing	Plan view of existing utilities near the structure
0.04 General Notes	General notes for overall bridge construction
0.05 Riprap Header Details	2D details and notes of the riprap header placement and limits at abu
0.06 Construction Joints - Superstructure	2D details of longitudinal construction joints for superstructure inclu
0.07 Joints - Substructure	2D details of construction and expansion joints (including expansion
0.09 Superstructure Coating Detail	2D detail and notes for barrier & deck fascia coating limits
0.13 Abutment pour diagram	Proposed pour locations and designations in 2D elevation views
0.10 Deck pour diagram	Proposed deck pour locations and designations in 2D plan view
0.11 EPS Block Lightweight Fill Details	2D details and notes for placement of EPS block lightweight fill
0.12 Slopewall Details	2D details and notes for placement of slopewall adjacent to abutmen
0.08 East Approach Section	2D details including at abutment, approach/sleeper slabs, and under
1.03 Typical Section_a	Annotated superstructure typical section
1.01 Elevation_a	Annotated general elevation views along the alignment and normal t
1.02 Erection Plan_a	Annotated erection plan with dimensions for setting beams along sk
WB_2.01 Abutment A Footing View	Combine traditional views into an isometric of the abutment footing
WB_2.01 Abutment B Footing View	Combine traditional views into an isometric of the abutment footing
WB_2.02 Abutment A View	Combine traditional plan and elevation views into an isometric of the
WB_2.02 Abutment B View	Combine traditional plan and elevation views into an isometric of the
WB_2.03 Abutment A Section	Traditional abutment section view with reinforcement (perpendicular
0.14 Project Title	View with Project Location and other information traditionally showr
0.00 Model Elements Included as Links	Extents of Model Elements Included as Links section (overview)
0.01 Contractual Model File Links	Links to project contractual model file links
0.02 Special Provision and NTB Links	Links to project Special Provisions and Notice to Bidders
0.03 RID File and Report Links	Link to the RID review checklist and index and other RID files and rep
1.09 Utilities Proposed	Plan view of proposed utilities near the structure
WB_3.02 Deck Plan	Traditional deck plan view with reinforcement
WB_3.02_1 Deck Plan_Top	Traditional deck plan view with reinforcement with only top mat of re
WB_3.02_2 Deck Plan_Bottom	Traditional deck plan view with reinforcement with only bottom mat
WB_3.04 Deck and Barrier View	Isometric view of deck and barriers with reinforcement
WB_3.03 Deck Section	Traditional deck section view with reinforcement (perpendicular to al
WB_3.05 Dependent Backwall View	Isometric view with only the backwall concrete and reinforcement sh
WB_4.01 Approach Slab View	Isometric view of approach slab with reinforcement
1.11 Phasing View-1	Phase 1 isometric view with shape element showing extents of EB str
1.10 Phasing Section-1	Phase 1 Section with shape element showing extents of EB structure
1.12 3D Boring Logs	3D soil boring logs with representative data from gINT export

Annotated Views

- Saved views with dimensions, tags, and notes
- To scale and model attributes are available





Model Properties/Attributes

- Added directly to model “solids”
- Includes customized Item Types
  - Design information and pay items/specs
- List per bridge element
- Pay Items

Element	*NBI#*	*Attribute 1*	*Attribute 2*	*Attribute 3*	*Attribute 4*	*Attribute 5*
Abutment Stem		Concrete Grade	f'c (psi)	Pour #	Fixity	
example data:	219	3500HP	3500	B	Exp	
Concrete Deck		Concrete Grade	f'c (psi)	Bevel dim. (in.)	Barrier Key/Water Stop	Drip Edge
example data:	12	4000HP	4000	0.75	6" x 4" Trap. Key (see model for detail)	3/4" triangle molding
Concrete Haunch		Concrete Grade	f'c (psi)	Slope		
example data:	13	4000HP	4000	Slope as required for form removal		
Concrete Parapet		Concrete Grade	f'c (psi)	Bevel dim. (in.)	Barrier Key/Water Stop	
example data:	331	4000HP	4000	0.75	6" x 4" Trap. Key (see model for detail)	
PS Concrete Beams		Type	f'c (psi)	f'ci (psi)		
example data:	109	72" Bulb Tee	8000	6500		

Links to Supplemental Documents

CONTRACTUAL ITEMS

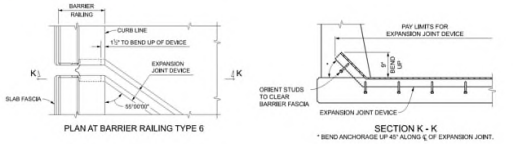
CONTRACTUAL MODEL FILES	FILE TYPE	DESCRIPTION
B01_63102_StructuresData.xlsx	EXCEL	SPREADSHEET WI
B01_63102_ReinforcementDetails.xlsx	EXCEL	SPREADSHEET WI
B01_63102_Quantities.xlsx	EXCEL	SPREADSHEET WI
B01_63102_ProjectSignature Sheet.xlsm	EXCEL	FILE LIST WITH DI

- Files linked to model space
- Can be any type of .pdf, excel or word file

EB BOTTOM OF DECK ELEVATIONS

Beam		CL Bmg, Abut A	1	2	3	4	5	6	7	8	9	10	11	12	13	14	CL Bmg, Abut. B
Dist. From CL Bmg, Abutment A (ft) *		0.00	10.49	20.98	31.47	41.95	52.44	62.93	73.42	83.91	94.40	104.89	115.38	125.86	136.35	146.84	157.33
I	Fascia	679.09	679.35	679.58	679.80	680.00	680.17	680.33	680.47	680.58	680.68	680.75	680.81	680.84	680.86	680.85	680.83
I	Right	679.64	679.89	680.13	680.35	680.54	680.72	680.88	681.01	681.13	681.22	681.30	681.35	681.39	681.40	681.40	681.37
J	Left	679.69	679.95	680.18	680.40	680.60	680.77	680.93	681.06	681.18	681.28	681.35	681.41	681.44	681.46	681.45	681.43
J	Right	679.74	680.00	680.23	680.45	680.65	680.82	680.98	681.11	681.23	681.33	681.40	681.46	681.49	681.51	681.50	681.48
K	Left	679.79	680.05	680.29	680.50	680.70	680.86	681.03	681.17	681.28	681.38	681.45	681.51	681.54	681.56	681.55	681.53
K	Right	679.84	680.10	680.34	680.55	680.75	680.93	681.08	681.22	681.33	681.43	681.50	681.56	681.59	681.61	681.60	681.58
L	Left	679.90	680.15	680.39	680.61	680.80	680.98	681.13	681.27	681.39	681.48	681.56	681.61	681.65	681.66	681.66	681.63
L	Right	679.95	680.20	680.44	680.66	680.85	681.03	681.18	681.32	681.44	681.53	681.61	681.66	681.70	681.71	681.71	681.68
M	Left	680.00	680.26	680.49	680.71	680.91	681.08	681.24	681.37	681.49	681.59	681.66	681.72	681.75	681.77	681.76	681.74
M	Right	679.99	680.25	680.48	680.70	680.89	681.07	681.23	681.36	681.48	681.57	681.65	681.70	681.74	681.76	681.75	681.72
N	Left	679.87	680.12	680.35	680.56	680.76	680.93	681.09	681.22	681.34	681.43	681.51	681.57	681.61	681.63	681.63	681.60
N	Right	679.76	680.01	680.24	680.45	680.65	680.82	680.97	681.11	681.23	681.32	681.40	681.46	681.49	681.51	681.51	681.49
O	Left	679.64	679.89	680.13	680.34	680.54	680.72	680.88	681.01	681.13	681.23	681.31	681.38	681.42	681.44	681.44	681.42
O	Right	679.44	679.70	679.93	680.15	680.35	680.53	680.69	680.83	680.95	681.06	681.14	681.20	681.25	681.27	681.27	681.26
P	Left	679.24	679.51	679.75	679.98	680.19	680.38	680.54	680.69	680.82	680.92	681.01	681.08	681.12	681.15	681.16	681.15
P	Right	679.04	679.31	679.56	679.78	679.99	680.18	680.34	680.49	680.62	680.73	680.81	680.88	680.93	680.95	680.96	680.95
Q	Left	678.84	679.12	679.38	679.62	679.83	680.03	680.20	680.35	680.49	680.60	680.69	680.76	680.81	680.84	680.85	680.84
Q	Right	678.64	678.92	679.18	679.42	679.63	679.83	680.00	680.16	680.29	680.40	680.49	680.56	680.61	680.64	680.65	680.64
R	Left	678.45	678.74	679.01	679.25	679.48	679.68	679.86	680.02	680.16	680.28	680.37	680.45	680.50	680.53	680.54	680.52
R	Right	678.25	678.54	678.80	679.05	679.28	679.48	679.66	679.82	679.96	680.08	680.17	680.24	680.30	680.33	680.34	680.32

EXPANSION JOINT DETAILS

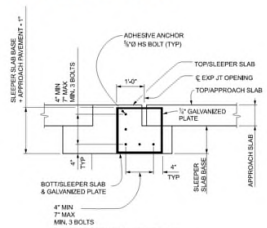


PLAN AT BARRIER RAILING TYPE 6

SECTION K - K

SECTION THROUGH EXPANSION JOINT

END PLATE DETAILS



END PLATE DETAIL
(SLEEPER SLAB WITH APPROACH SLAB/PAVEMENT)

EXPANSION JOINT TABLE

Structure Number	Angle of Crossing	Location of Joint	Min. Tot. Travel Along Centerline of Bridge	Required Length of Expansion Joint Device
B01-3 of 63102	55	E Sleeper Slab	1"	104'- 7 1/2"
B01-4 of 63102	55	E Sleeper Slab	1"	74'- 3 1/2"

Structure Number	Size
B01-3 of 63102	1'-9" X 1'-9"
B01-4 of 63102	1'-9" X 1'-9"

Model Element Breakdown (MEB)

Model Element/Entity	Project? Y/N	LOD	2D?	requirements to be further informed by the IDM being developed for TPF(5)-372	Required Reports	Engineer of Record	Applicable References	Authorized BIM Uses	Limitations	Includes reinforcement or other connection details	Required File Deliverables	Contractual or FIO?	Comments
Category: Decks and Slabs				Type (e.g. open grid), material (e.g. reinforced concrete, steel deck), location (e.g. station and offsets), geometry (e.g. spacing, skew angles, length, width, thickness, area, volumes), other information (e.g. pay item number, NBI number, specification, etc.)		Structural Engineer Name							
Deck	Yes	400	3D	See BI01_63102_ItemTypesList.xlsx for additional information requirements as Item Types included as attributes in the model		Parker Thompson, PE, SE			Construction joints and pour locations provided as 2D details	Yes	BI01_63102_EB_OBM.dgn; BI01_63102_VB_OBM.dgn; BI01_63102_StructuresData.xlsx; BI01_63102_Structures_Additional_Info.dgn	Contractual	Elevations and notes in BI01_63102_StructuresData.xlsx; construction joint information provided in 2D details and notes
Haunches	Yes	300	3D	See BI01_63102_ItemTypesList.xlsx for additional information requirements as Item Types included as attributes in the model		Parker Thompson, PE, SE			Slope as required, not shown in model	N/A	BI01_63102_EB_OBM.dgn; BI01_63102_VB_OBM.dgn; BI01_63102_StructuresData.xlsx	Contractual	Elevations and notes in BI01_63102_StructuresData.xlsx; construction joint information provided in 2D details and notes
Precast Deck Panel													
Approach Slab/Sleeper Slabs	Yes	400	3D	See BI01_63102_ItemTypesList.xlsx for additional information requirements as Item Types included as attributes in the model		Parker Thompson, PE, SE			Construction joints and pour locations provided as 2D details	Yes	BI01_63102_EB_OBM.dgn; BI01_63102_VB_OBM.dgn; BI01_63102_StructuresData.xlsx; BI01_63102_Structures_Additional_Info.dgn	Contractual	Elevations and notes in BI01_63102_StructuresData.xlsx
Deck Joints	Yes	200	3D	See BI01_63102_ItemTypesList.xlsx for additional information requirements as Item Types included as attributes in the model		Parker Thompson, PE, SE			Element set at 2.5" width for width at 70 degrees F	No	BI01_63102_EB_OBM.dgn; BI01_63102_VB_OBM.dgn; BI01_63102_StructuresData.xlsx; BI01_63102_Structures_Additional_Info.dgn	Contractual	Details, tables, and notes in BI01_63102_StructuresData.xlsx
Sidewalk													
Bridge Barrier/Railing	Yes	400	3D	See BI01_63102_ItemTypesList.xlsx for additional information requirements as Item Types included as attributes in the model		Parker Thompson, PE, SE			Transitions to curb not shown in model	Yes	BI01_63102_EB_OBM.dgn; BI01_63102_VB_OBM.dgn	Contractual	
Viewing Surfaces and Protective System													
Category: Superstructure						Structural Engineer Name							
Steel Girder													
Prestressed Beam	Yes	200	3D	See BI01_63102_ItemTypesList.xlsx for additional information requirements as Item Types included as attributes in the model		Parker Thompson, PE, SE			models is approximate; work with BI01_63102_ItemTypesList.xlsx	No	BI01_63102_EB_OBM.dgn; BI01_63102_VB_OBM.dgn; BI01_63102_StructuresData.xlsx	Contractual	Details, tables, reinforcement, and notes in BI01_63102_StructuresData.xlsx
Closed Web/Box Girder													
Stringer													
Truss													
Arch													
Floor Beam													
Cable-Primary													
Cable-Secondary													
Gusset Plate													
Pin, Pin and Hanger Assembly, or Both													
Steel Shear Studs													
Steel Stiffeners/Connection Plates													
Steel Field Splice													
Steel Cross Frame and Diaphragm	Yes	100	2D	See BI01_63102_ItemTypesList.xlsx for additional information requirements as Item Types included as attributes in the model		Parker Thompson, PE, SE			Not shown in 3D in model, 2D details and information provided	No	BI01_63102_StructuresData.xlsx; BI01_63102_ElevationPlan.dgn; BI01_63102_StructuresData.xlsx	Contractual	Details, tables, reinforcement, and notes in BI01_63102_StructuresData.xlsx
Concrete Diaphragm (End and Intermediate)													
Beam Seats/Pedestals	Yes	400	3D	See BI01_63102_ItemTypesList.xlsx for additional information requirements as Item Types included as attributes in the model		Parker Thompson, PE, SE			Construction joints, pour locations, and details provided as 2D details	Yes	BI01_63102_EB_OBM.dgn; BI01_63102_VB_OBM.dgn; BI01_63102_Structures_Additional_Info.dgn	Contractual	
Bearing assembly	Yes	400	3D	See BI01_63102_ItemTypesList.xlsx for additional information requirements as Item Types included as attributes in the model		Parker Thompson, PE, SE			Details and notes provided in 2D details	No	BI01_63102_EB_OBM.dgn; BI01_63102_VB_OBM.dgn;	Contractual	

Unique Special Provisions

Spec Book Modifications

- Add definition of Model
- Expand the definition of Plans
- Incorporate “Model” language
- Order of precedence for model elements

Model Coordination & Training Special Provision

- Create Model Coordinator role
- Training after award
- Model coordination meetings
- Contractor Develop BIM Execution Plan
- Lessons Learned

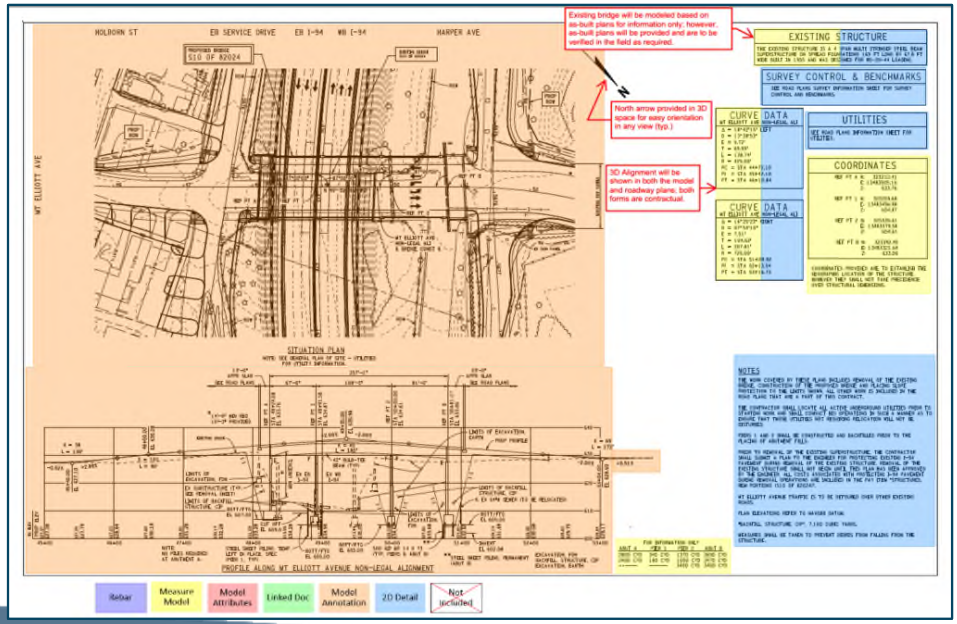
INDUSTRY ENGAGEMENT

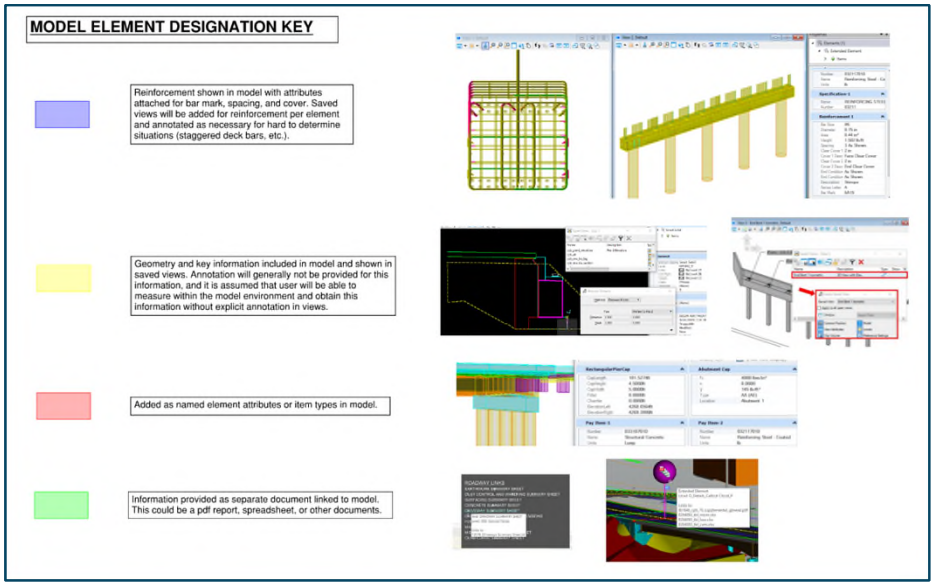
Design Deliverable Working Group (DDWG)

Bridge Pilot Sub-team

Industry Engagement – Cross Walk

- Where to find the information in model files
- Sample 2D plan set






"It's in there..."

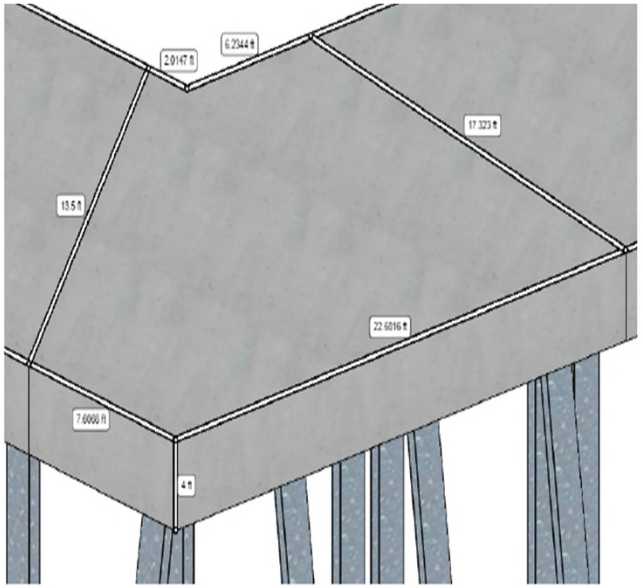
BUILDING A BRIDGE USING BIM

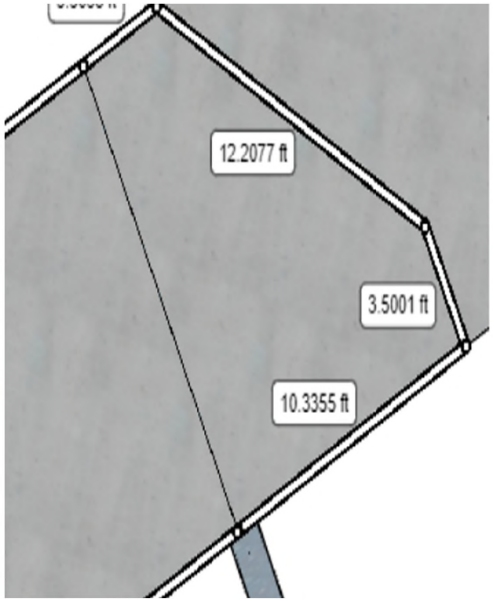
Construction Oversight

- Existing three span steel to single span concrete
- GLEG + QA survey ⟺ CA Hull + QC Survey
- Weekly Model Coordination Meetings

Construction Oversight

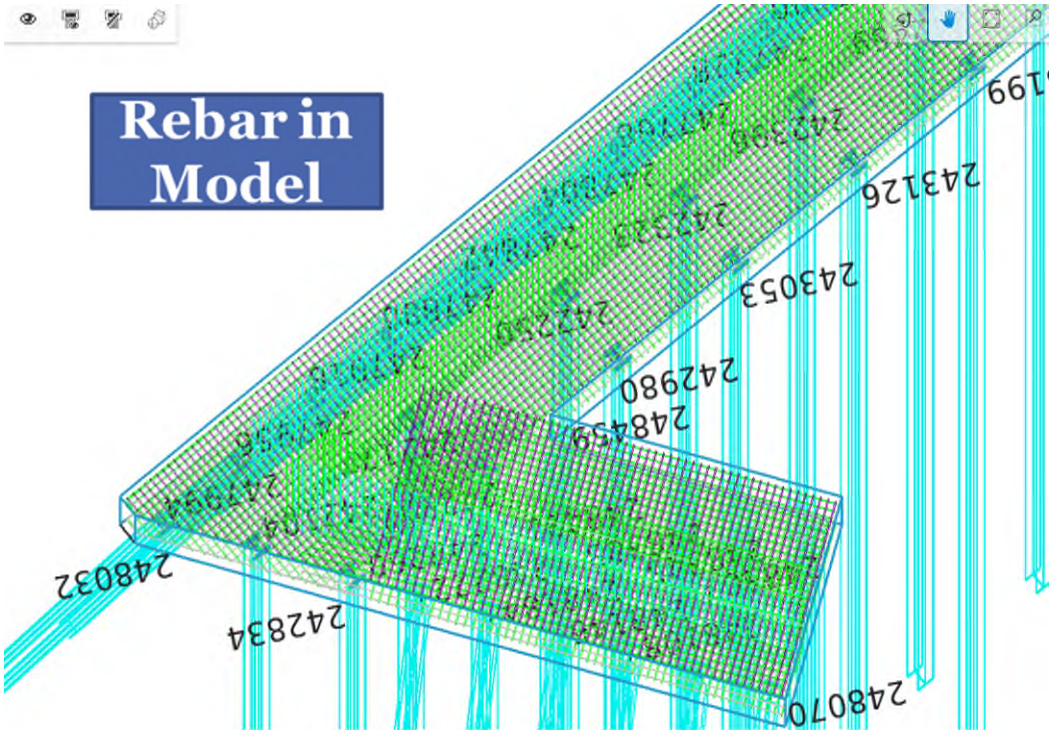
- Utilize Synchro field with I-pad for model viewing
- Created Marked up “2-D plan sheets” for field and IDR use



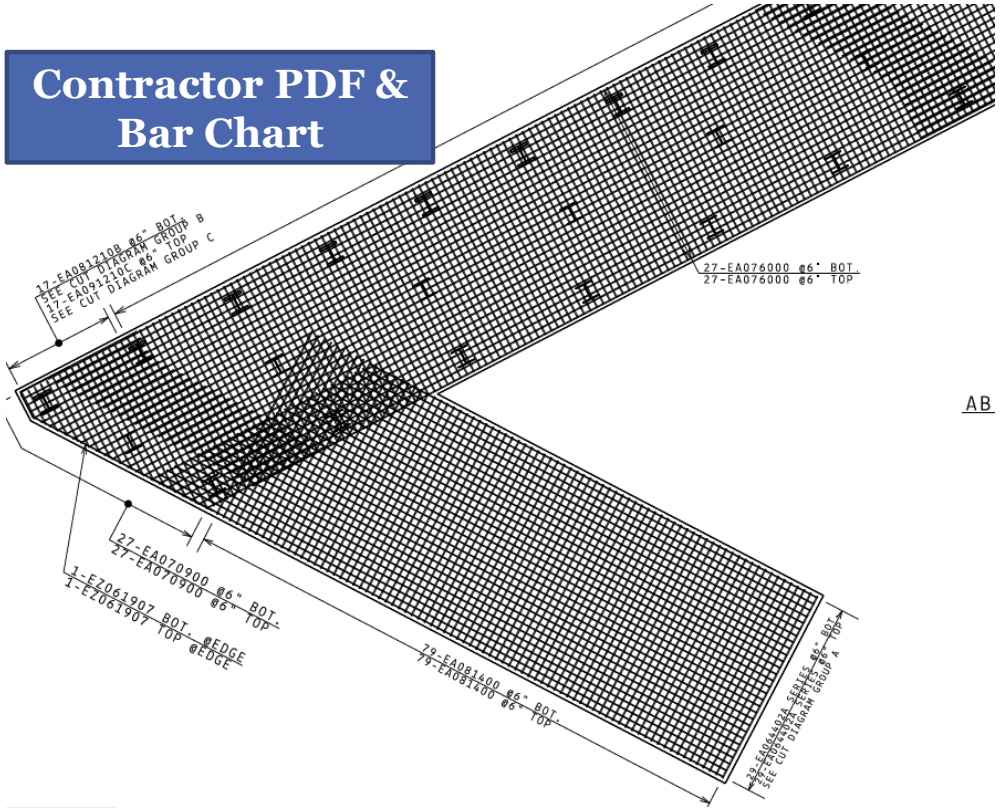


Model to Construction

Rebar in Model



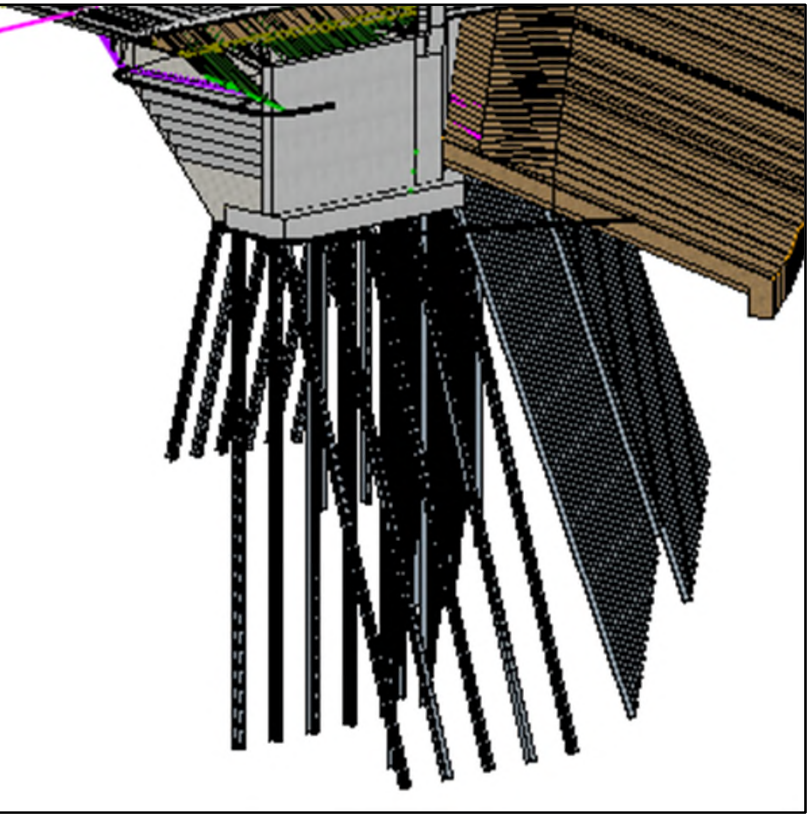
Contractor PDF & Bar Chart

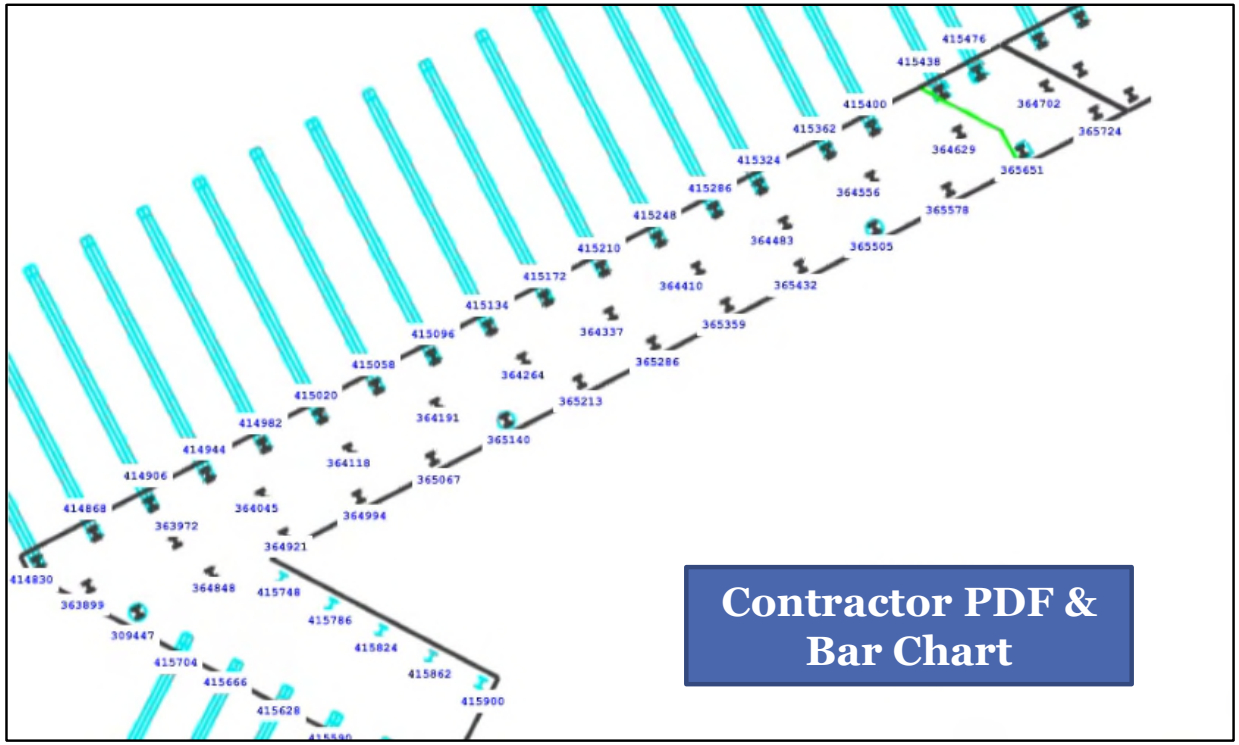


BAR	DIMENSIONS a	b	c	d	e	f	g	h	j	NO. REQ'D.	TOTAL WT. (lb)
ABUTMENT - STAGE 2											
Epoxy Coated Reinforcement											
EA054405	44'-5"									36	1668
EA054505	45'-5"									5	237
EA054606	46'-6"									31	1503
EA060611	6'-11"									92	956
EA060708	7'-8"									16	184
EA060810	8'-10"									4	53
EA060910	9'-10"									16	236
EA061002	10'-2"									2	31
EA061302	13'-2"									2	40
EA061508	15'-8"									2	47

Model to Construction

Piles in Model

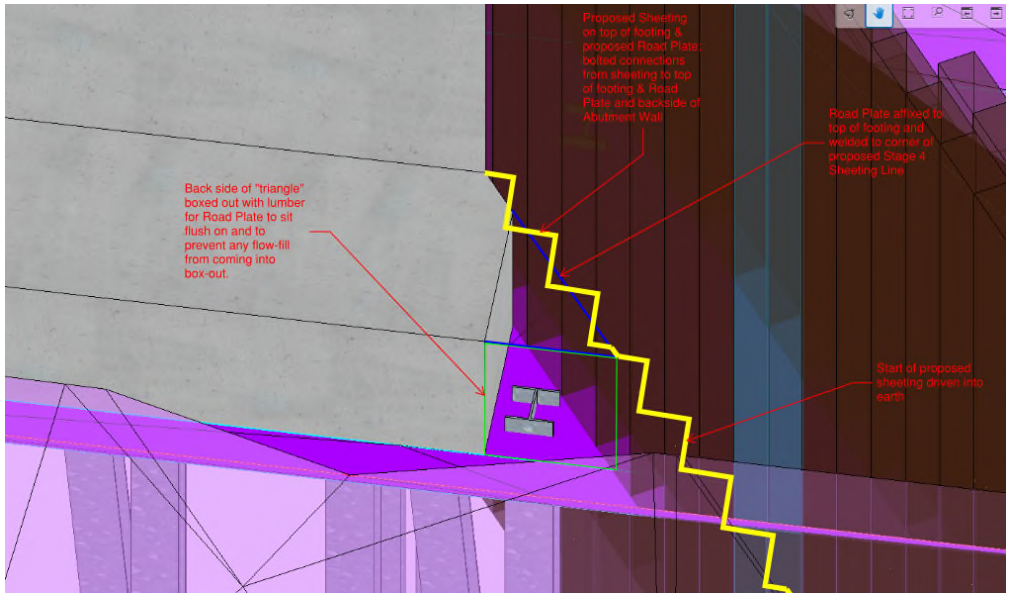


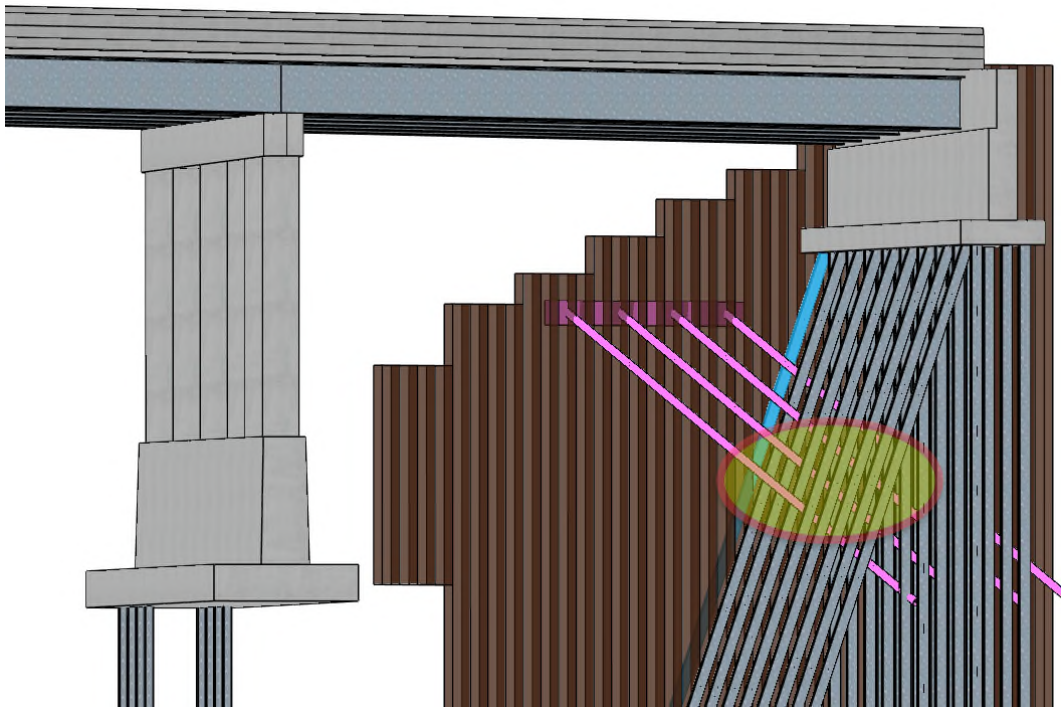


Contractor PDF & Bar Chart

Visualization

- Visualization of temporary works
- Sharing content between design and field

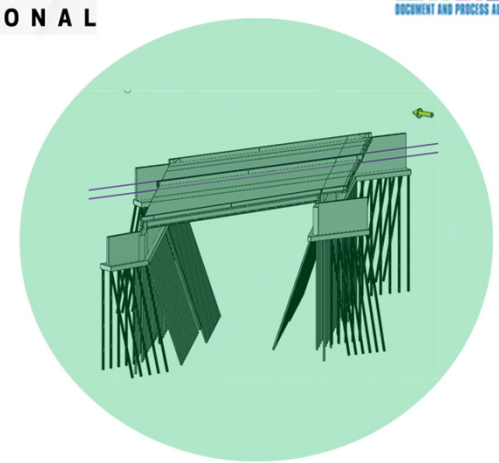




Takeaways

Takeaways – the Good

- Exceptional partnership
- Saved views were crucial
- Visualization of risk areas
- Urgency and availability of key staff



Takeaways – Challenges

- Communicating model changes
- Learning curve/ software limitations
- Tablets in a field environment
- Model use limited to prime
- Conveying info to laborers

What's next?

<u>2025 Model Delivery Pilot</u>

M-53 over Greenman Creek

Bay Region, near Cass City

Box Culvert

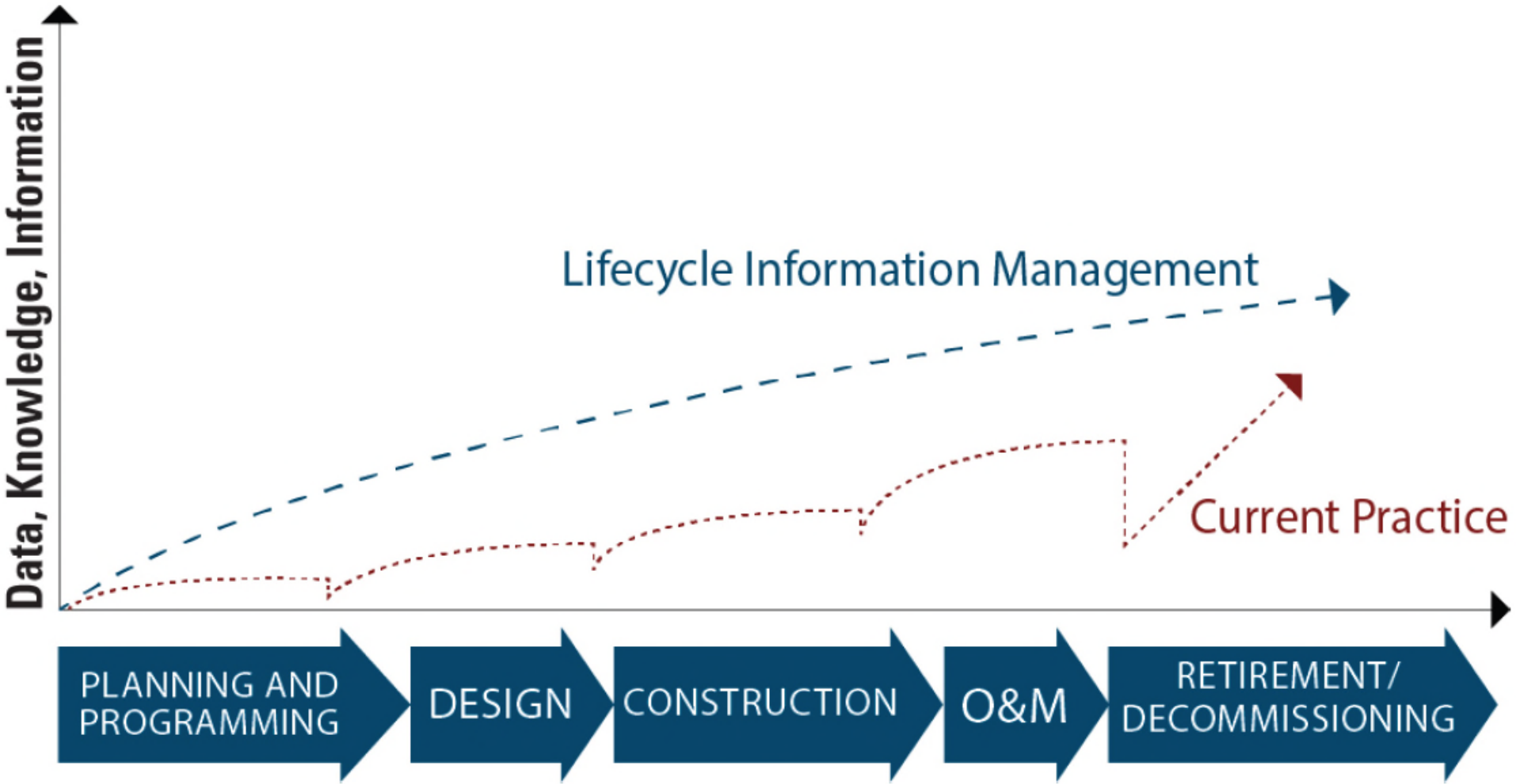
Goals:

- Build upon previous pilot
- Deliver culvert, approach work, staging digitally
- Emphasis on digital workflows with fabricator and rebar supplier

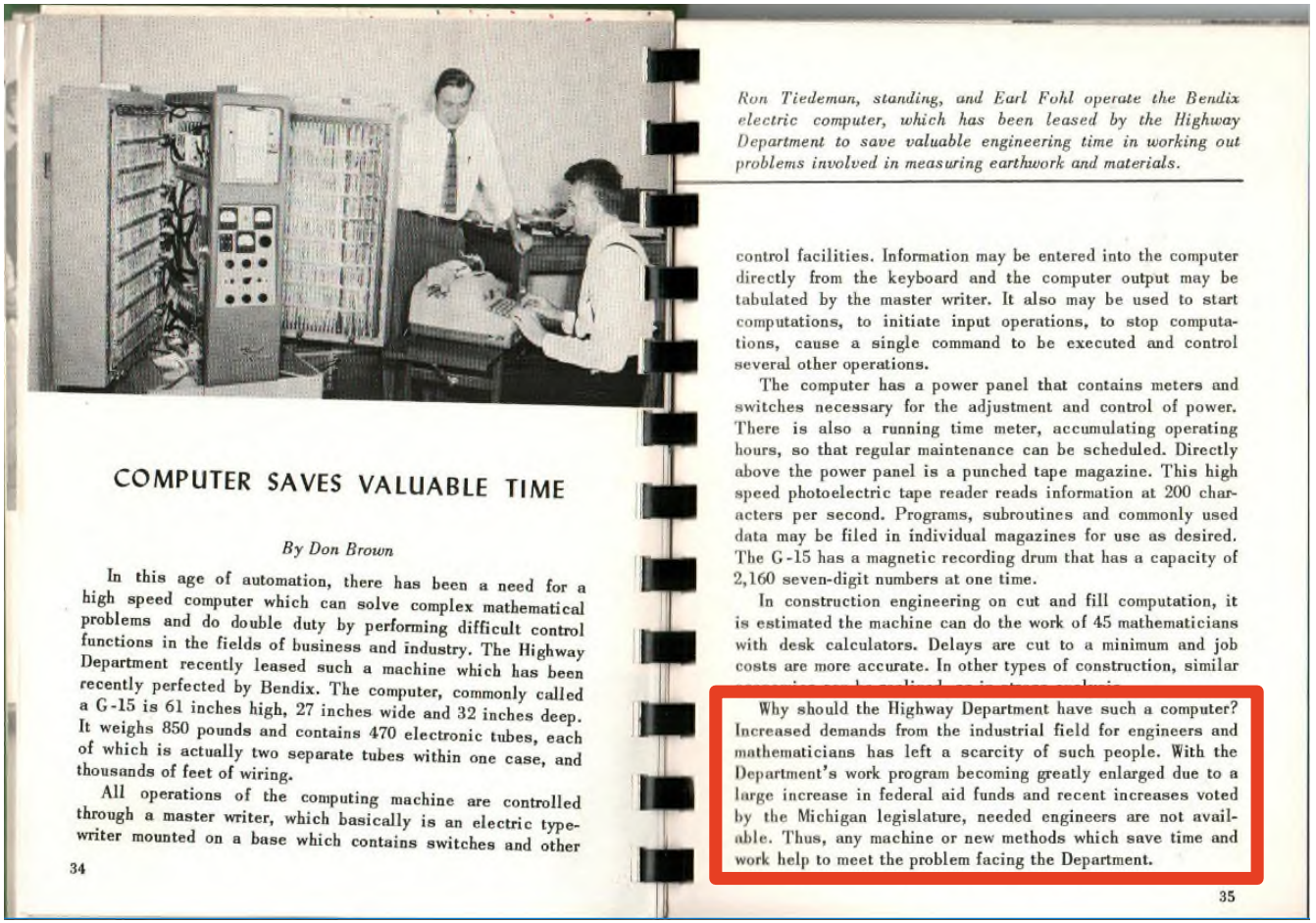
Developing MDOT's Digital Vision

We’ve got to think differently

about how we integrate technology into how we do business


Data, Knowledge, Information
Lifecycle Information Management
Current Practice
PLANNING AND PROGRAMMING
DESIGN
CONSTRUCTION
O&M
RETIREMENT/ DECOMMISSIONING

Michigan State Highway Department – 1956



Ron Tiedeman, standing, and Earl Fohl operate the Bendix electric computer, which has been leased by the Highway Department to save valuable engineering time in working out problems involved in measuring earthwork and materials.

COMPUTER SAVES VALUABLE TIME

By Don Brown

In this age of automation, there has been a need for a high speed computer which can solve complex mathematical problems and do double duty by performing difficult control functions in the fields of business and industry. The Highway Department recently leased such a machine which has been recently perfected by Bendix. The computer, commonly called a G-15 is 61 inches high, 27 inches wide and 32 inches deep. It weighs 850 pounds and contains 470 electronic tubes, each of which is actually two separate tubes within one case, and thousands of feet of wiring.

All operations of the computing machine are controlled through a master writer, which basically is an electric typewriter mounted on a base which contains switches and other

control facilities. Information may be entered into the computer directly from the keyboard and the computer output may be tabulated by the master writer. It also may be used to start computations, to initiate input operations, to stop computations, cause a single command to be executed and control several other operations.

The computer has a power panel that contains meters and switches necessary for the adjustment and control of power. There is also a running time meter, accumulating operating hours, so that regular maintenance can be scheduled. Directly above the power panel is a punched tape magazine. This high speed photoelectric tape reader reads information at 200 characters per second. Programs, subroutines and commonly used data may be filed in individual magazines for use as desired. The G-15 has a magnetic recording drum that has a capacity of 2,160 seven-digit numbers at one time.

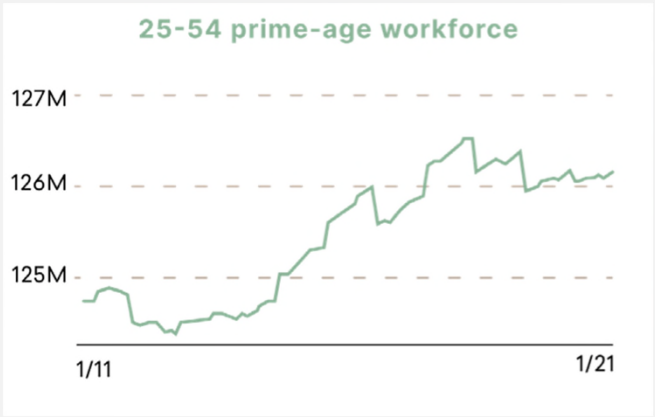
In construction engineering on cut and fill computation, it is estimated the machine can do the work of 45 mathematicians with desk calculators. Delays are cut to a minimum and job costs are more accurate. In other types of construction, similar

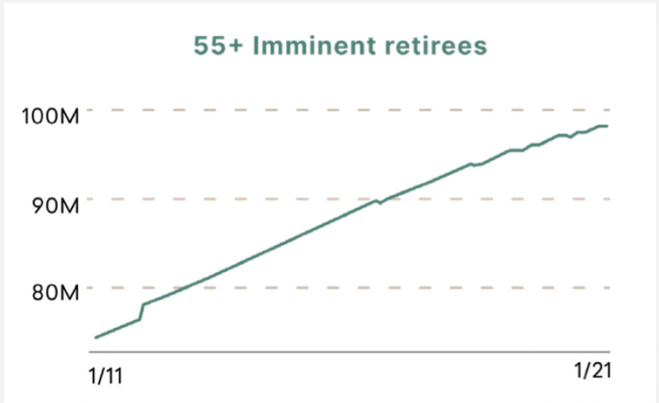
Why should the Highway Department have such a computer? Increased demands from the industrial field for engineers and mathematicians has left a scarcity of such people. With the Department's work program becoming greatly enlarged due to a large increase in federal aid funds and recent increases voted by the Michigan legislature, needed engineers are not available. Thus, any machine or new methods which save time and work help to meet the problem facing the Department.

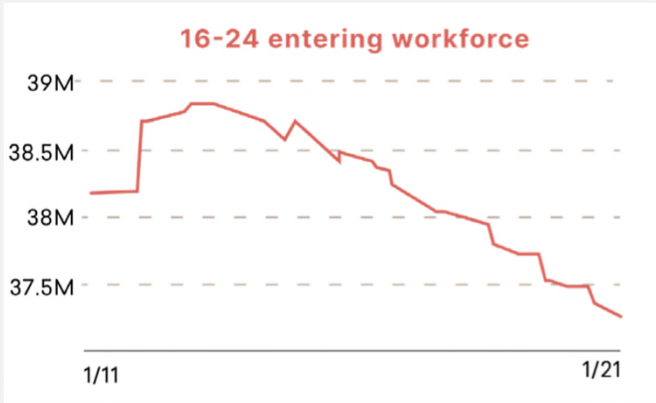
Why should the Highway Department have such a computer? Increased demands from the industrial field for engineers and mathematicians has left a scarcity of such people. With the Department's work program becoming greatly enlarged due to a large increase in federal aid funds and recent increases voted by the Michigan legislature, needed engineers are not available. Thus, any machine or new methods which save time and work help to meet the problem facing the Department.

More Americans Are Nearing Retirement Age Than Entering Working Age

This trend is not projected to turn around any time this century.







Civilian non-institutional population

Source: Bureau of Labor Statistics

How are we trying to Solve the Problem?

Our Approach

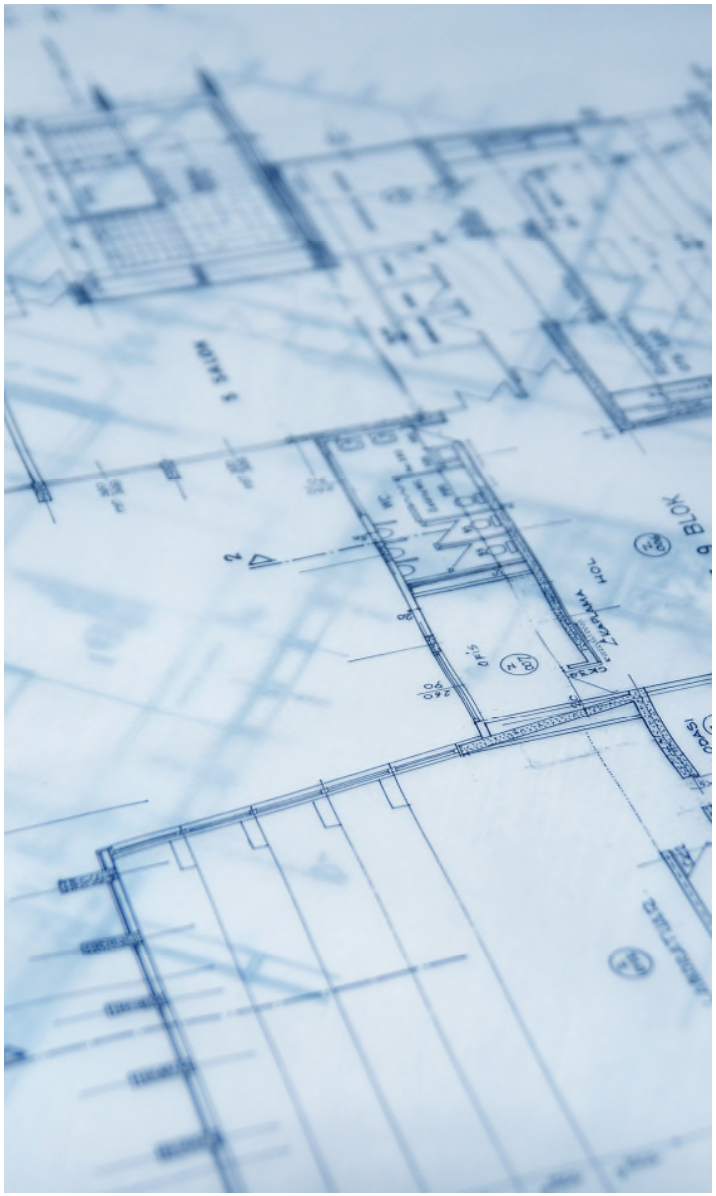
Why do we have:

- **Construction Plans?**
- **Contractual Models?**
- **GIS Asset Management Systems?**

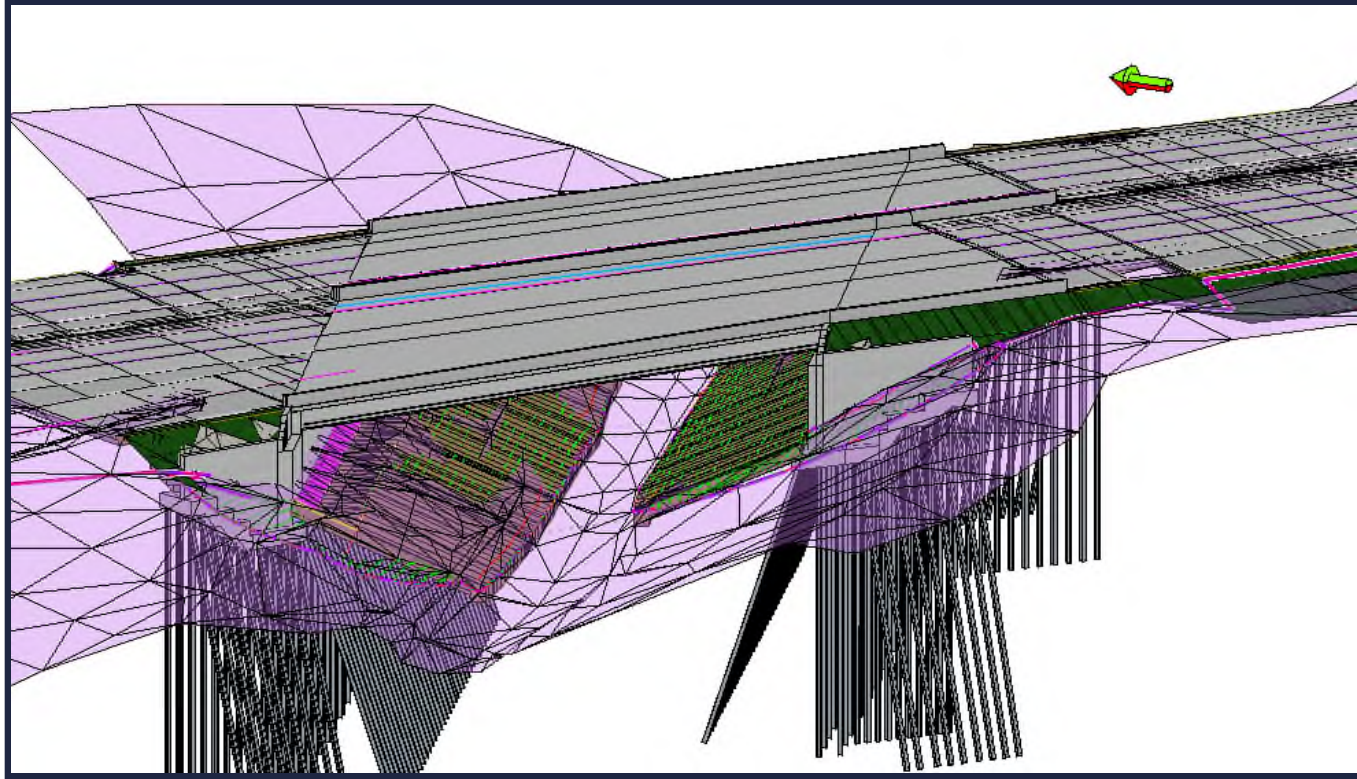
To Share Information

To Visualize Information

To Record Information



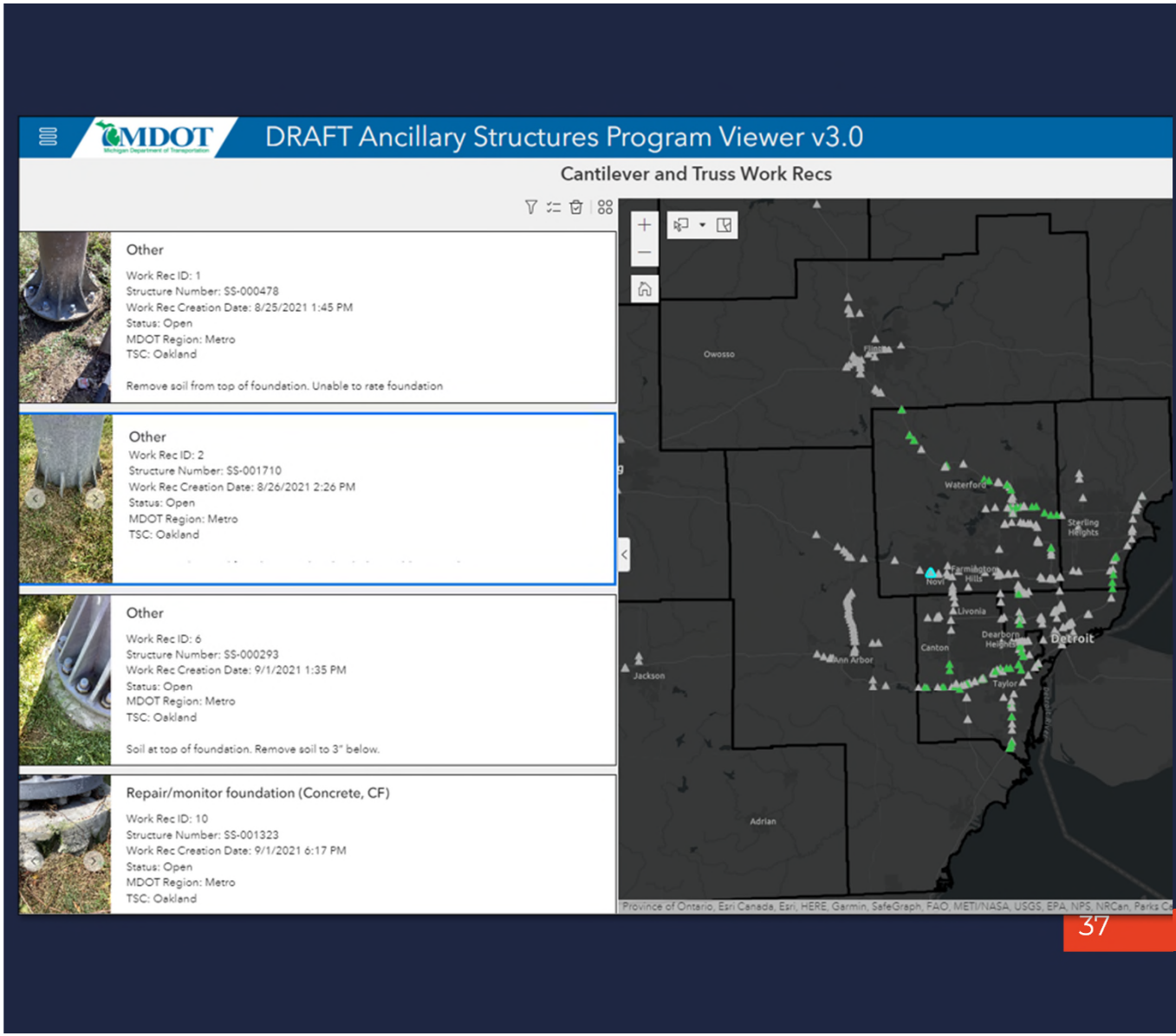
Digital Delivery Pilot



Blue Water Bridge

Immersive Technology Study

Ancillary Asset Management

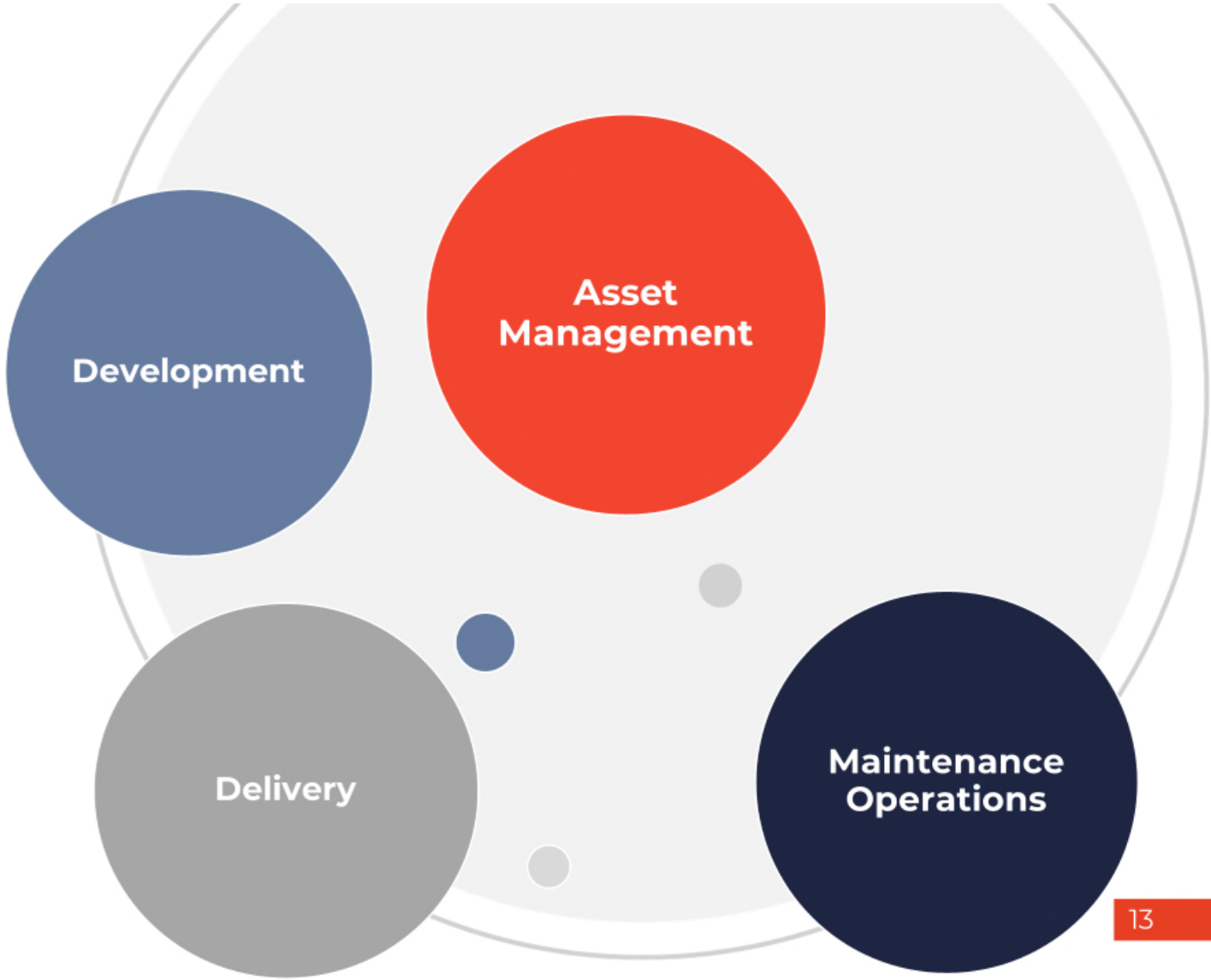


ROW to GIS Conversion

Hand-Drafted ROW Maps → **Scanned Maps to TIFF and inserted into .DGN** → **Hybrid DGN linework file and TIFF images** → **Modernized implementation GIS (current)**

Our Current Path

Operating in separate orbits.



MDOT's Digital Vision

Operating together in one orbit.

Digital Vision & Roadmap Project

Project Sponsors

Demetrius Parker
– Bureau of Development Director

Jason Gutting
– Bureau of Field Services Director

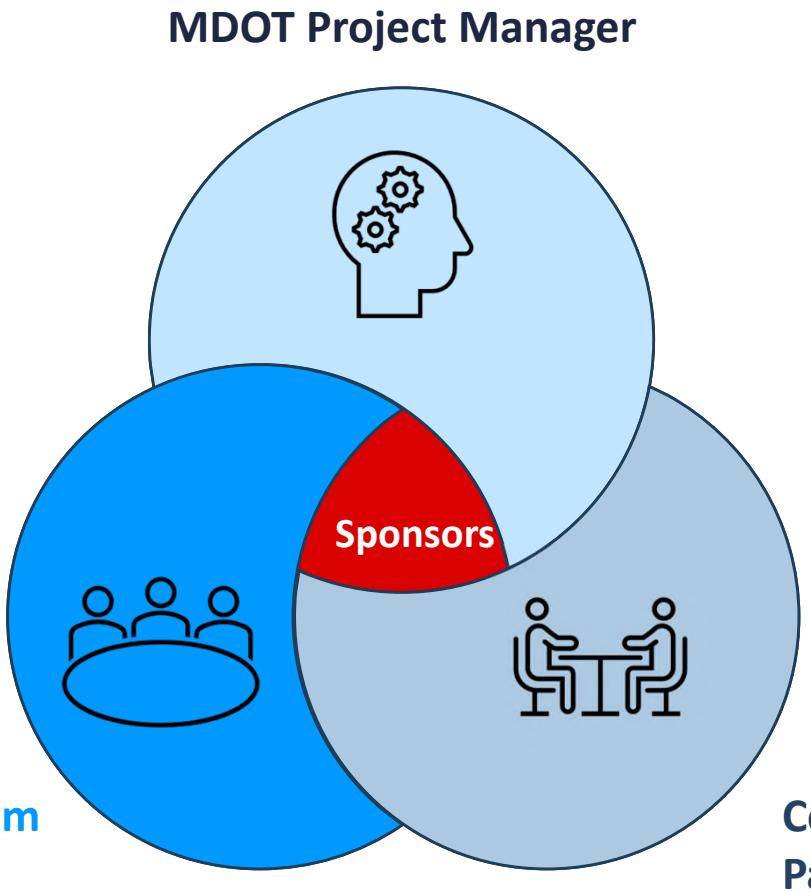
Rebecca Curtis
– Bureau of Bridges & Structures Director

Todd White
- Bureau of Transportation Planning Director

Andy Esch
- Enterprise Information Management Officer

Aaron Johnson
- Superior Region Engineer

Project Resources



Project Strategy

Drive alignment by collaborating and engaging with internal and external stakeholders to define MDOT's digital vision.

Understand the current state of practice and potential challenges/ opportunities for all stakeholders which will inform development of the implementation roadmap for digital workflows.

Use a people-first approach throughout development of the vision and roadmap for digital workflows that considers the unique challenges, opportunities, and needs for individual stakeholders.

Phased Project Approach

(1) Prepare Approach

- Clearly define why a vision & roadmap is need
- Work with internal & external stakeholders
- Research, peer-exchange, surveys, and focus groups

Ongoing – February 2024

(2) Current State of Practice

- Understand current initiatives & processes relating to digital workflows throughout the Department.
- Stakeholder mapping, interviews, field observations.
- Identify key attributes, goals, pain points, and motivators

March 2024 – March 2025

(3) Vision & Roadmap Development

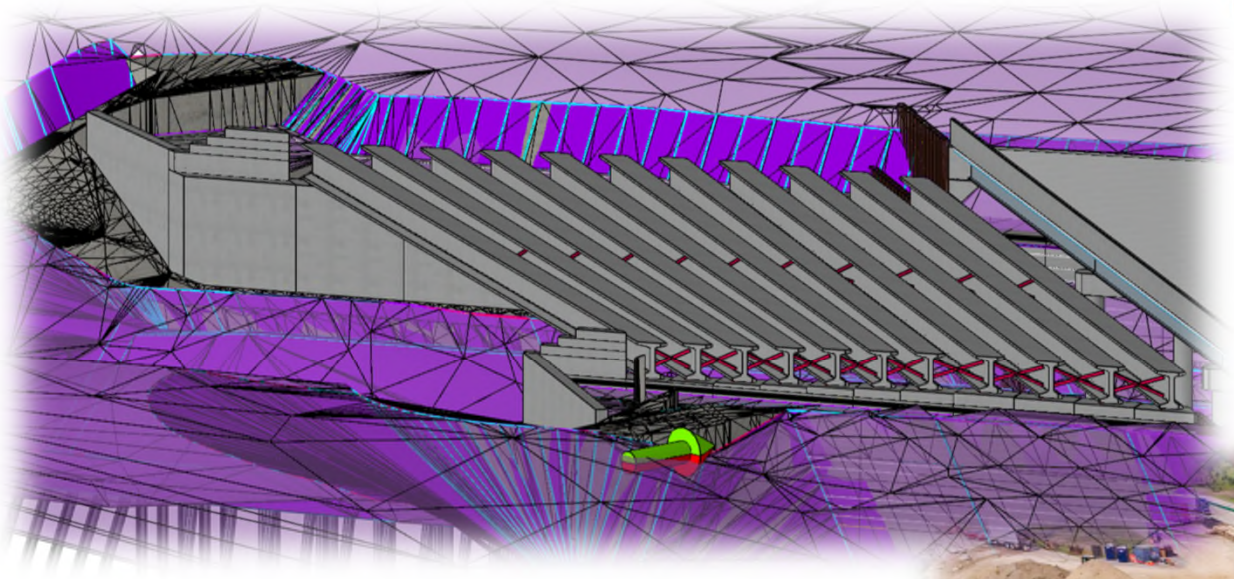
- Collaboratively develop the Vision for MDOT's digital future and how to get there.
- Investigate IT infrastructure needed to support a future transition.
- Develop clear metrics to assess the progress and effectiveness of implementations.

April 2025 – December 2025

(4) Implementation

- Present a people-first approach to change and integrate the vision and roadmap into business processes.

January 2026 - Ongoing



Thank you!

Brad Wagner
wagnerb@michigan.gov

MDOT
Michigan Department of Transportation