

Cedar Prairie Trail Bridge Replacement





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Agenda



PROJECT SCOPE



PRELIMINARY
DESIGN SOLUTIONS



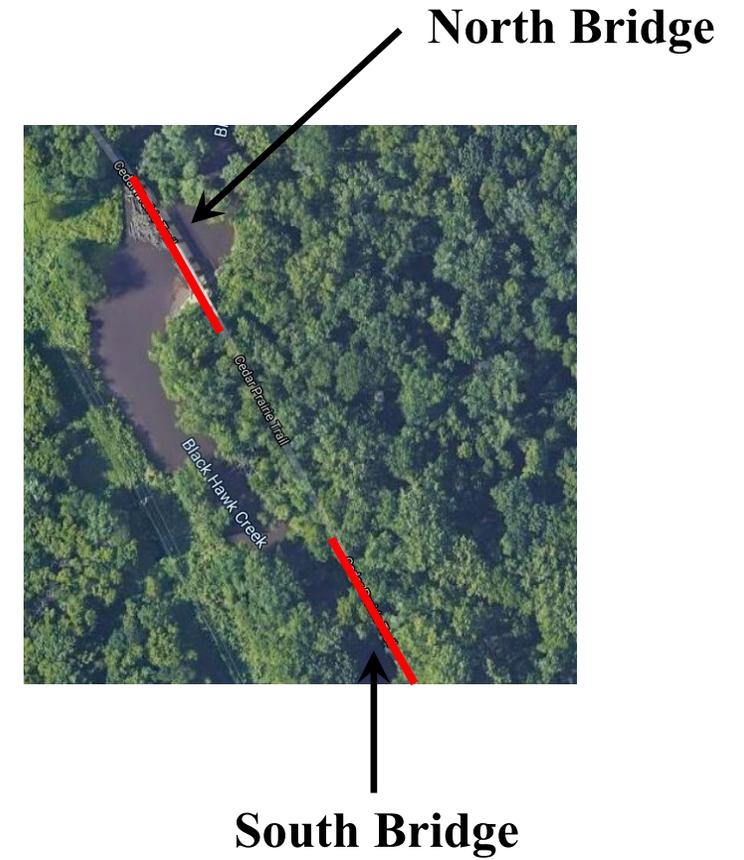
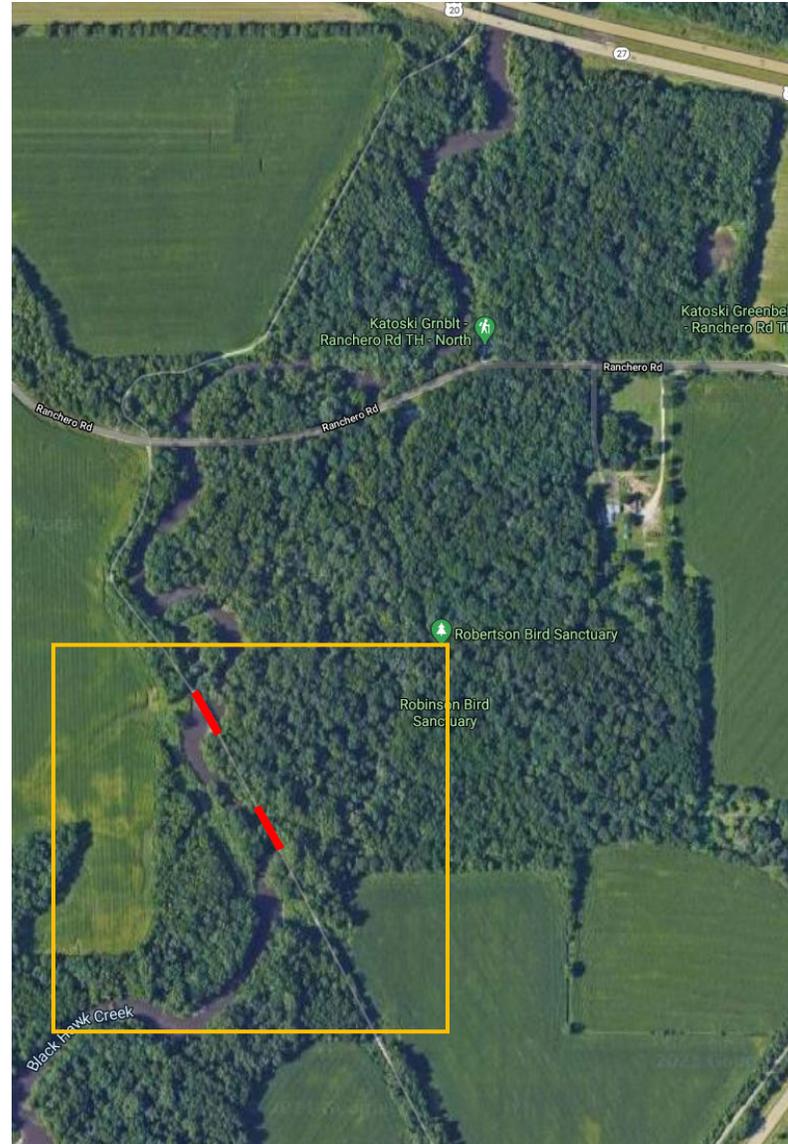
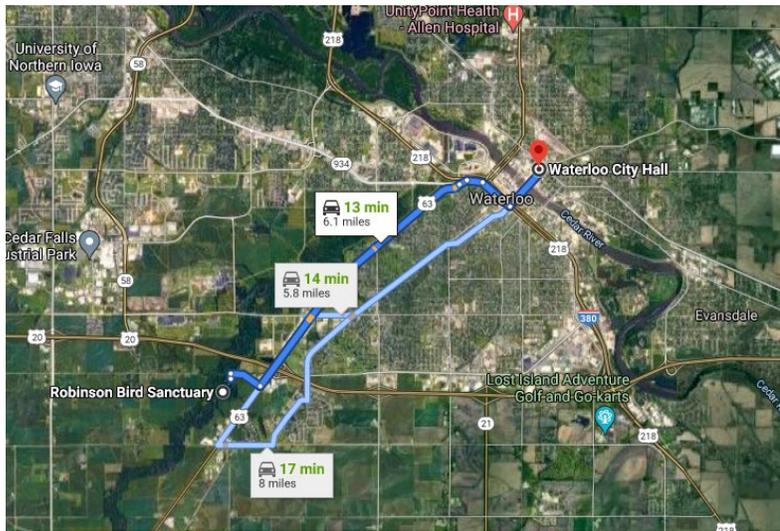
RECOMMENDED
DESIGN



CONCLUSION

Site Location and Client

City of Waterloo
Jamie Knutson, P.E.
Wayne Castle, P.E.



Project Scope: Existing Conditions



North Bridge

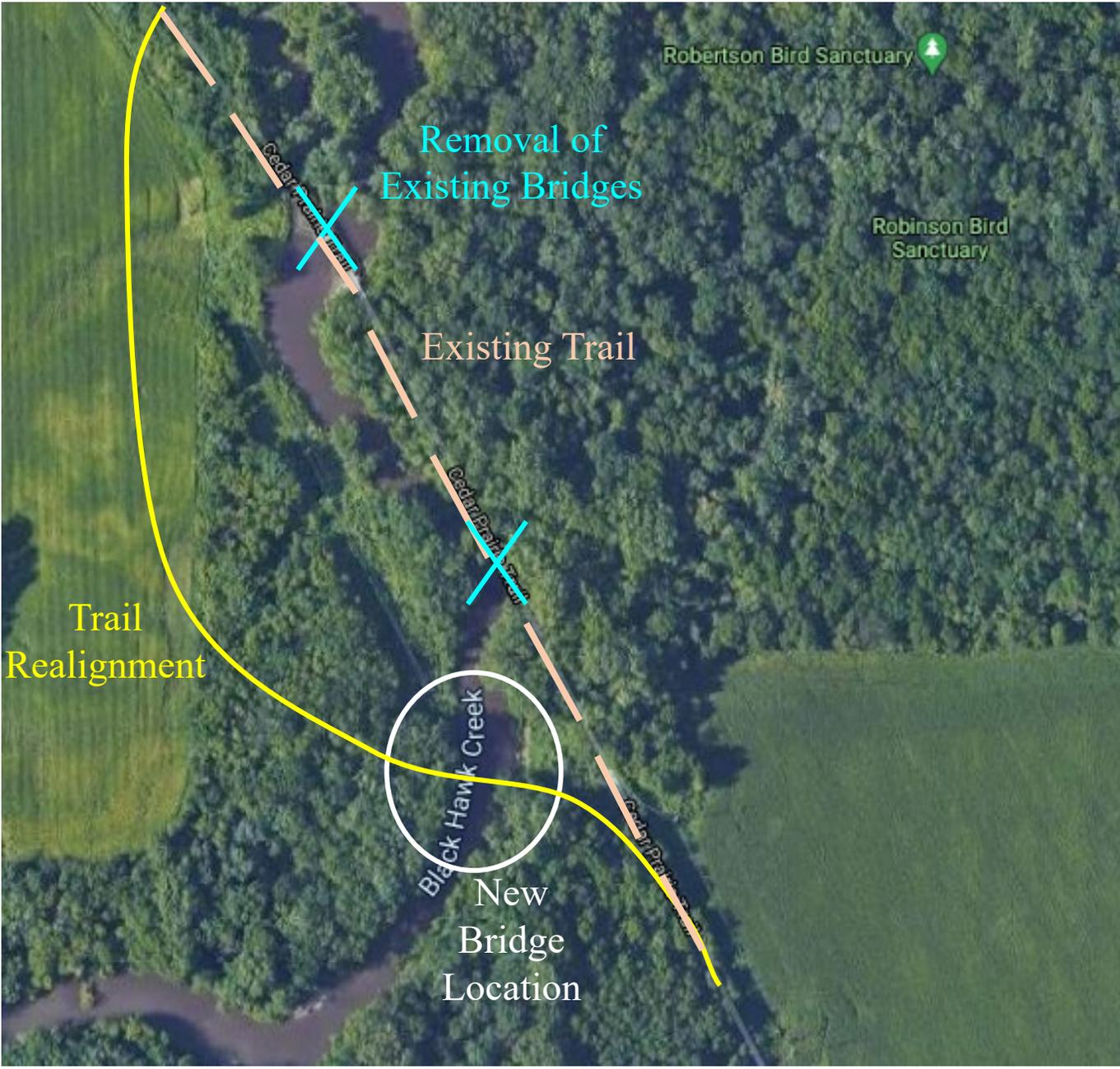


South Bridge

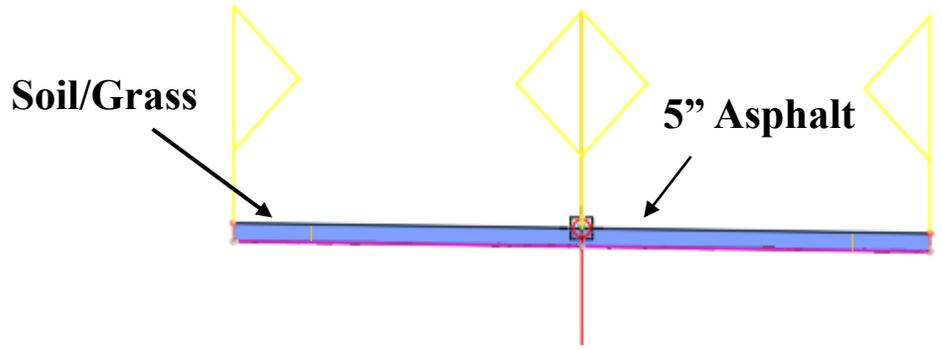
Project Scope: Client Goals



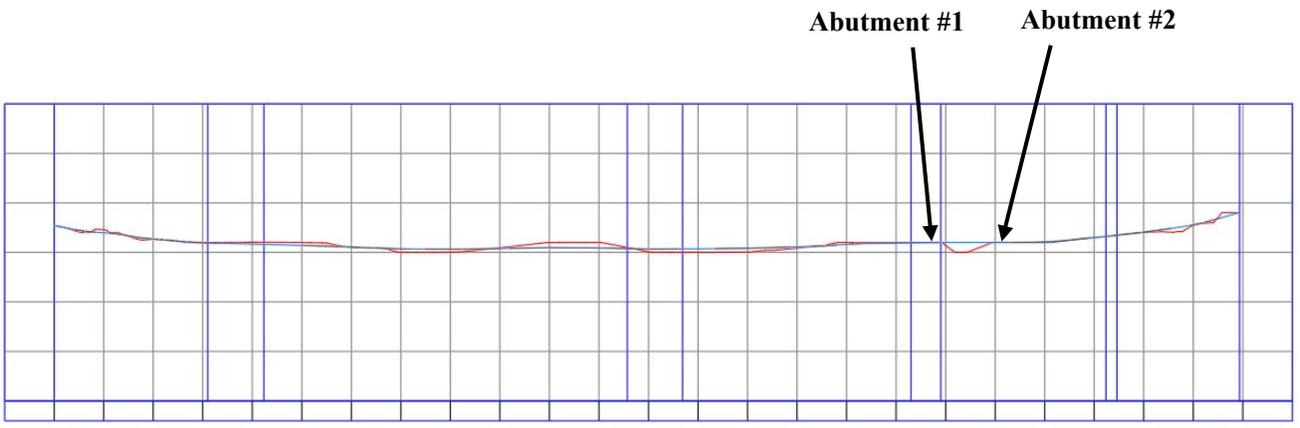
Western Trail Alignment



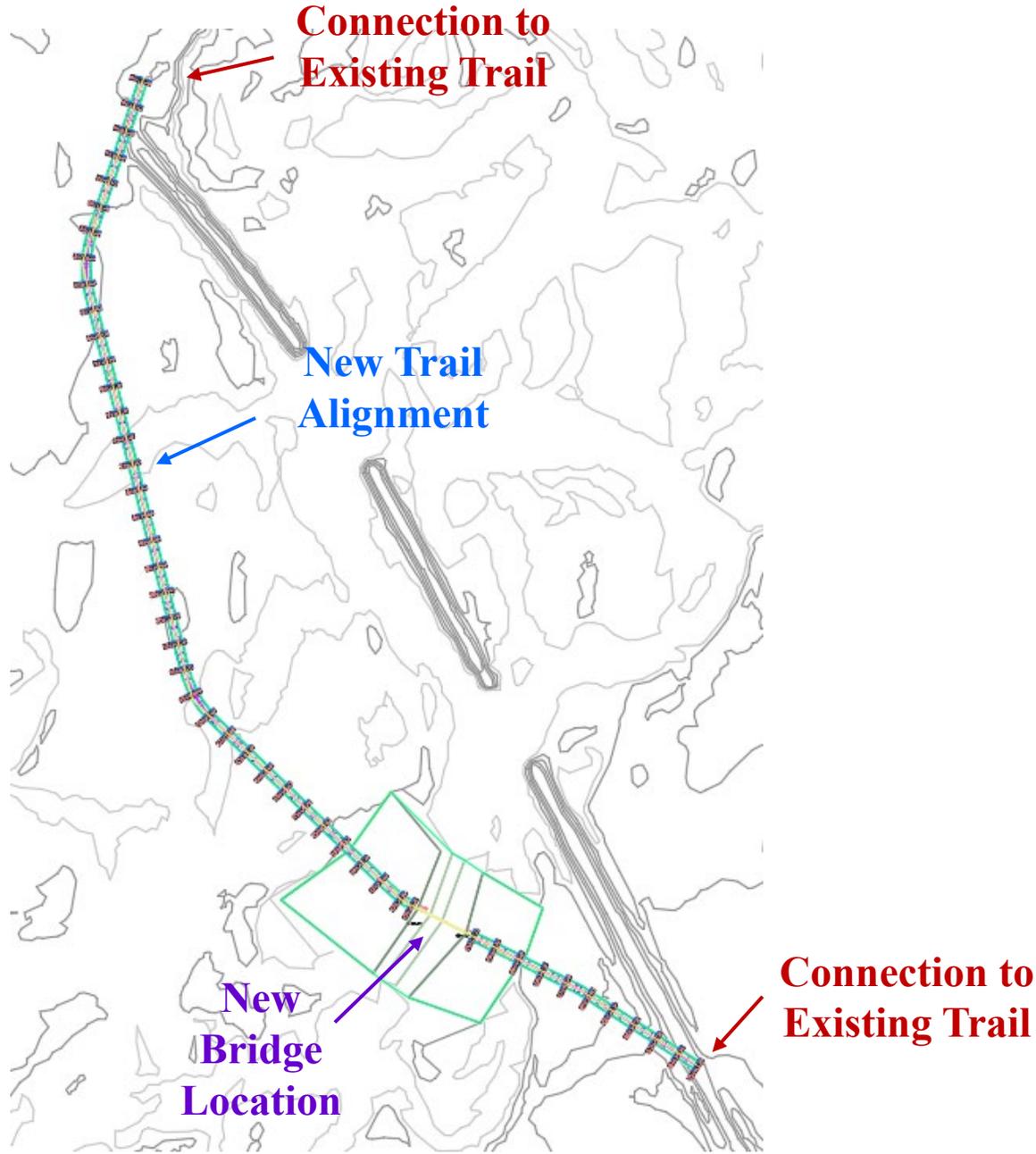
Western Trail Alignment



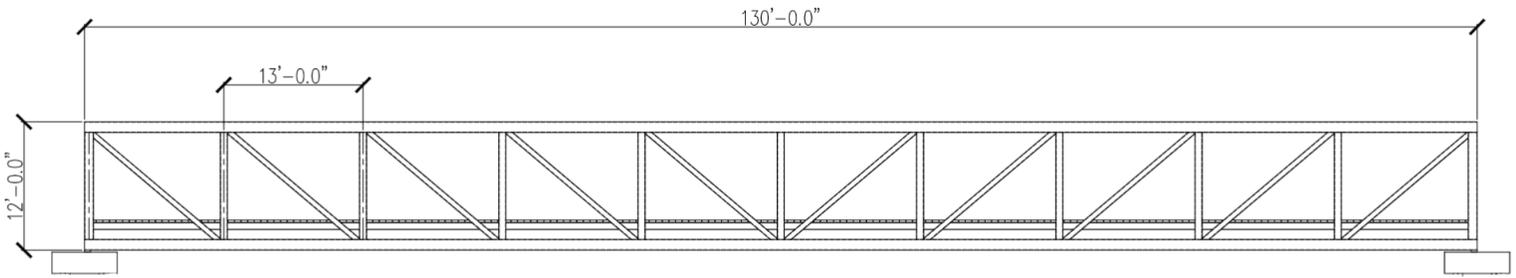
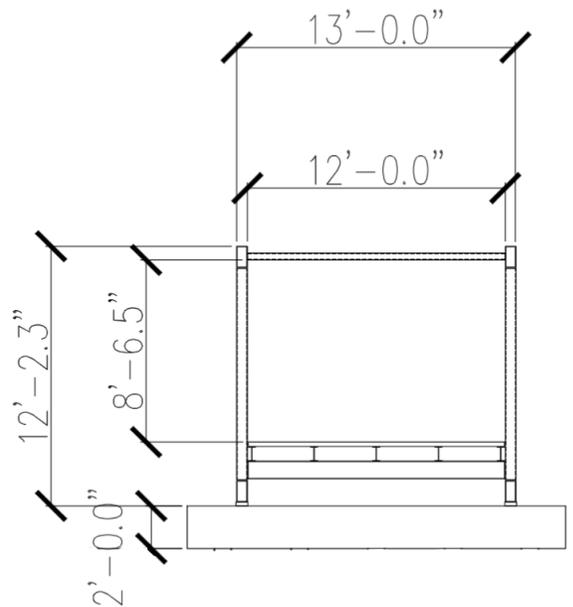
Pavement Cross Section



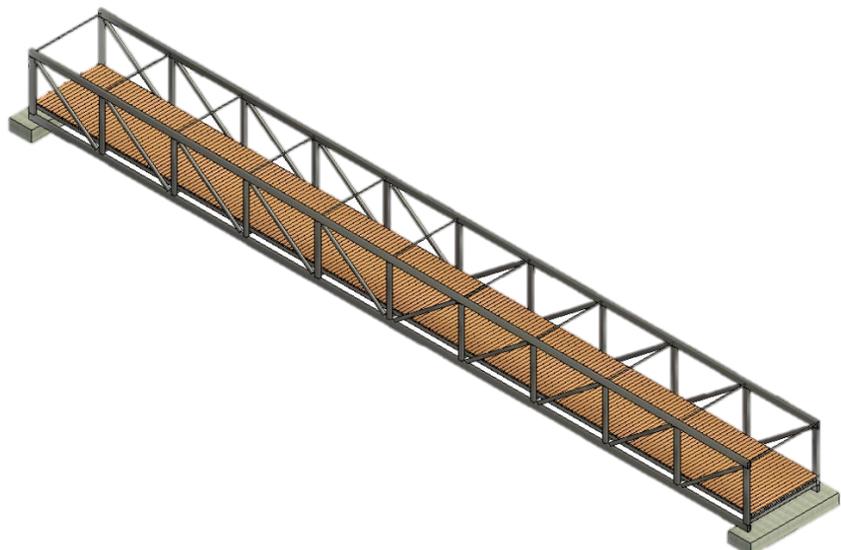
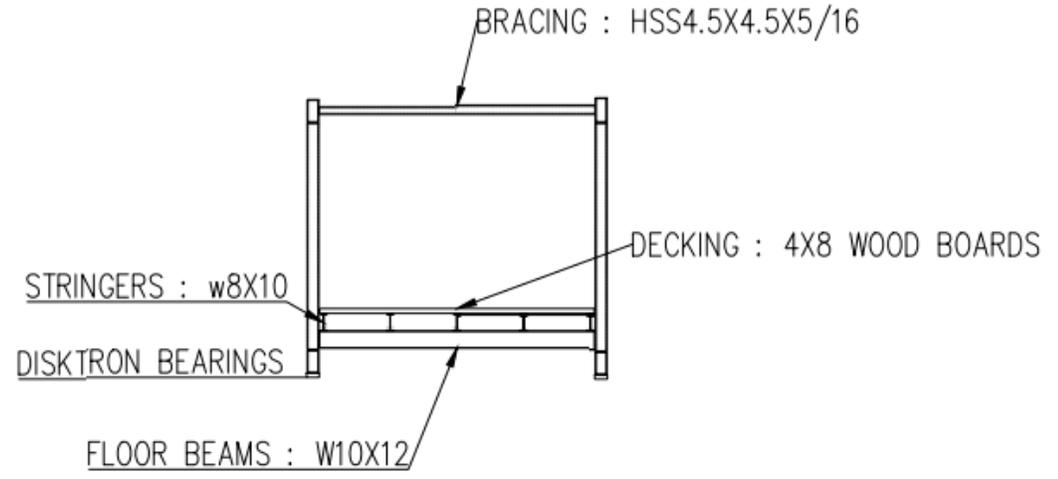
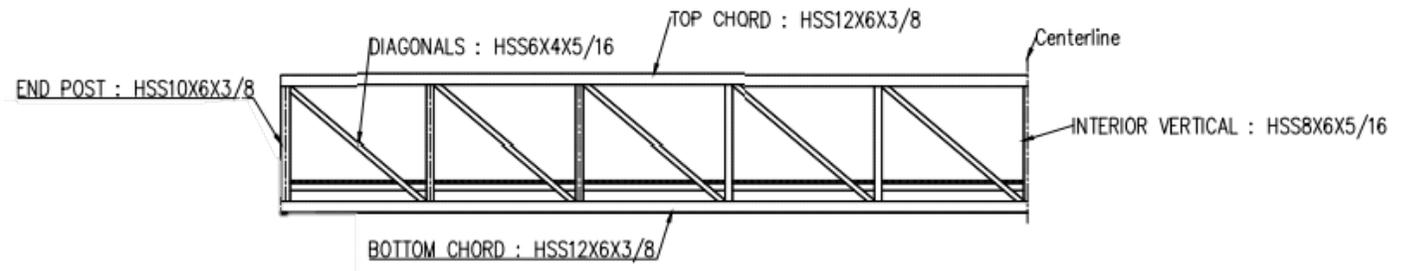
Trail Alignment Profile



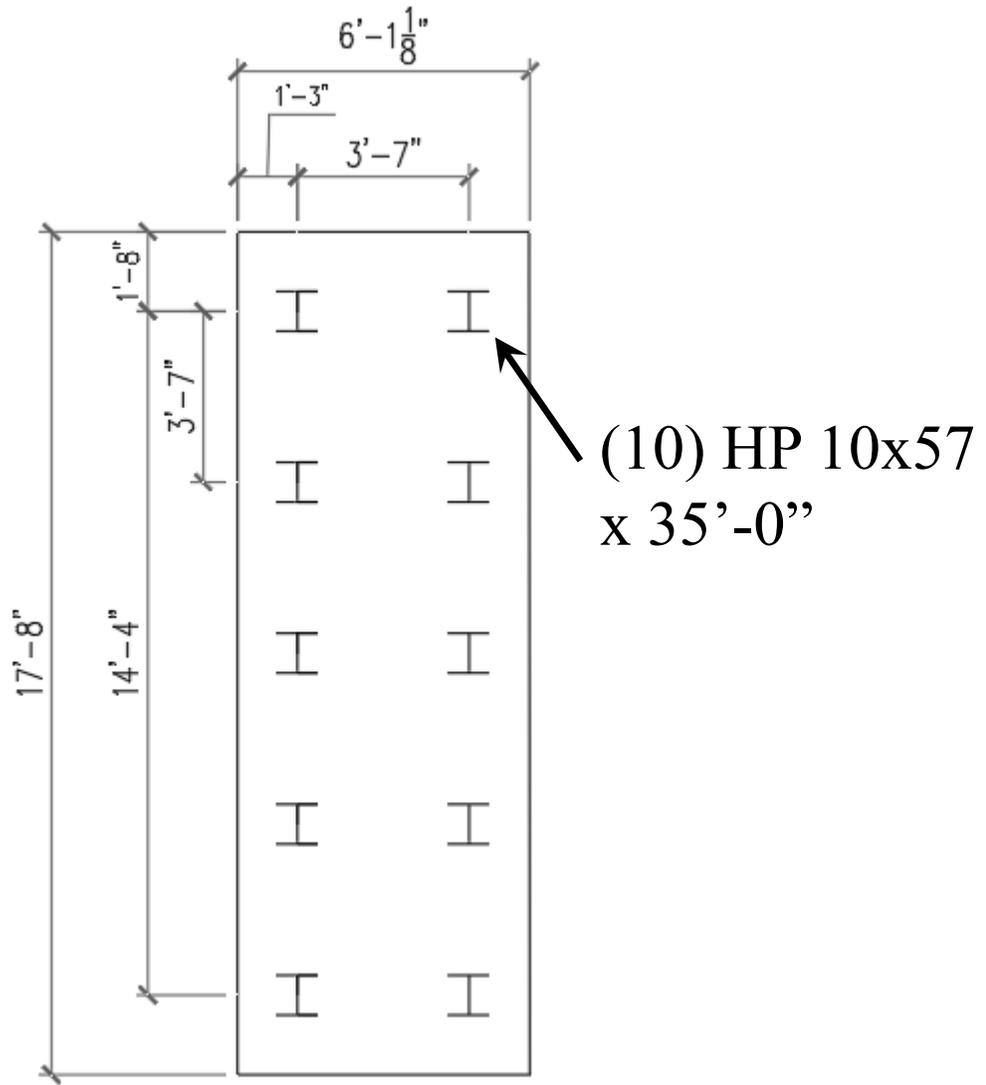
Western Trail Alignment: Bridge Design



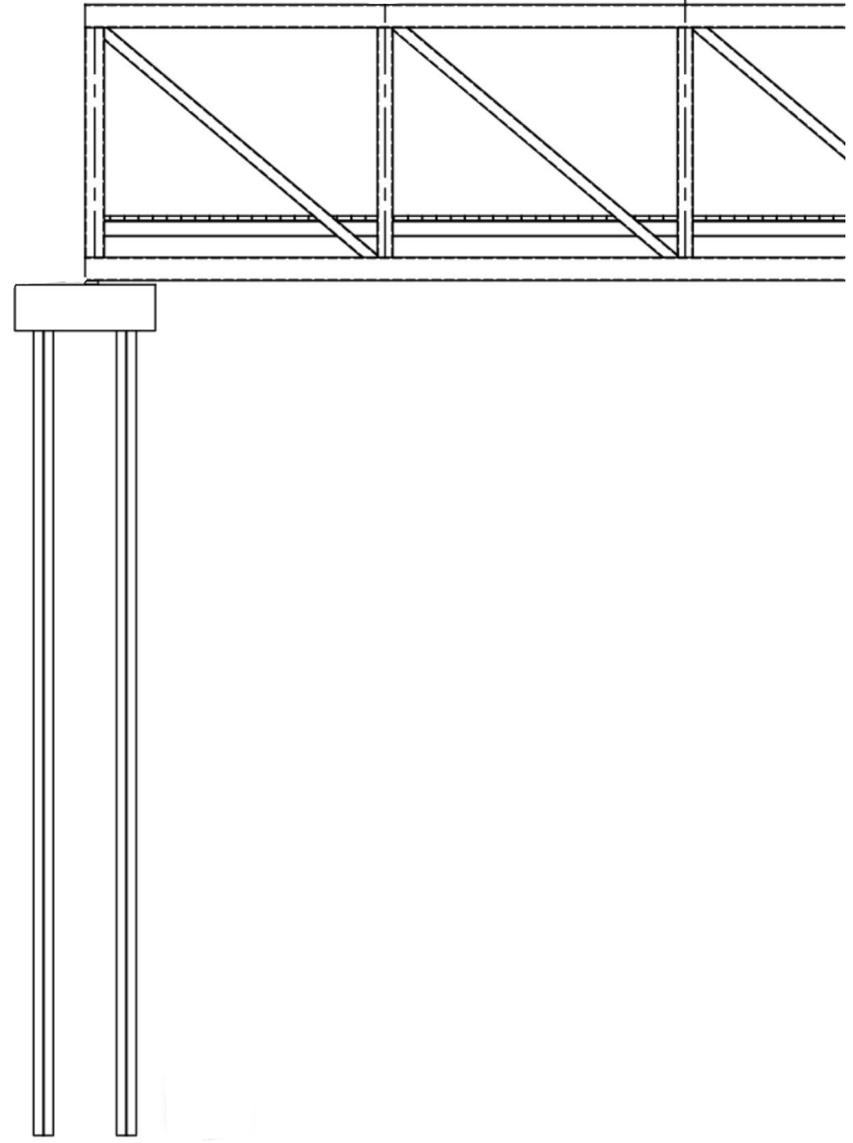
TRUSS IS SYMMETRIC ABOUT CENTERLINE



Western Trail Alignment: Foundation Design



(10) HP 10x57
x 35'-0"

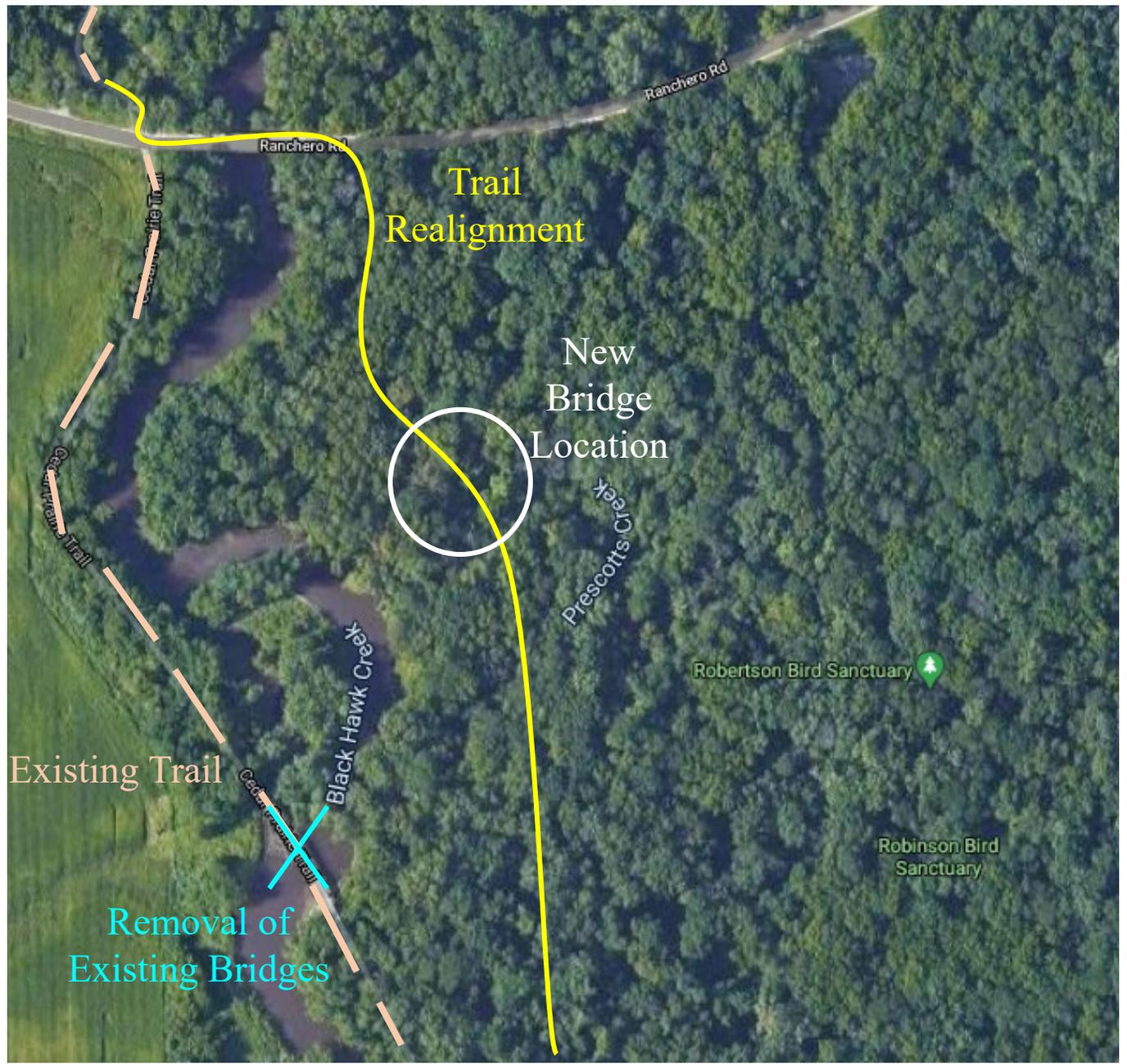


Pile Group Design

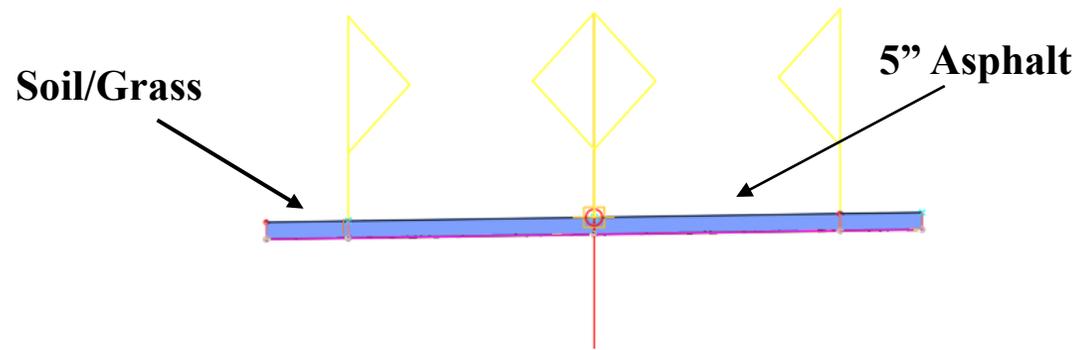
Eastern Trail Alignment



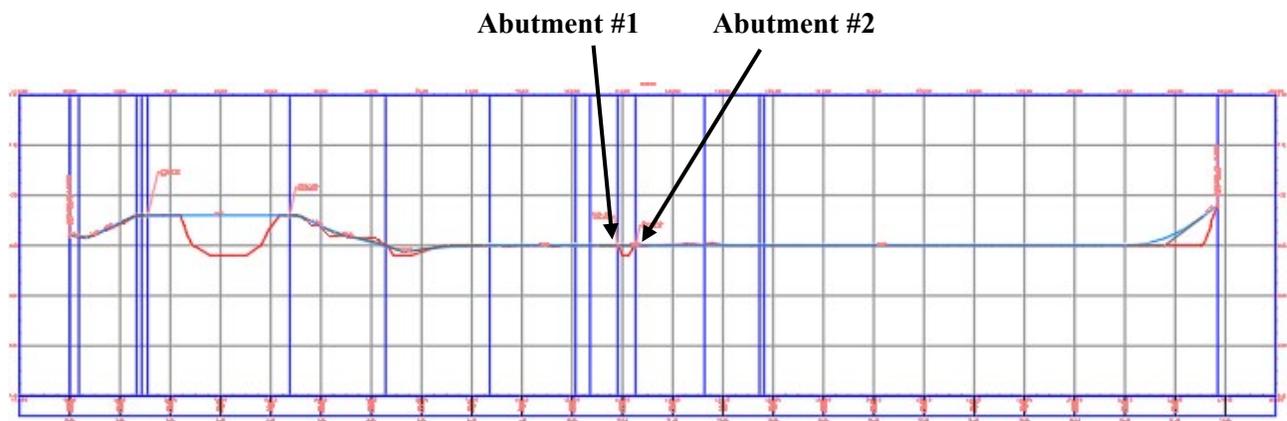
Prescotts Creek



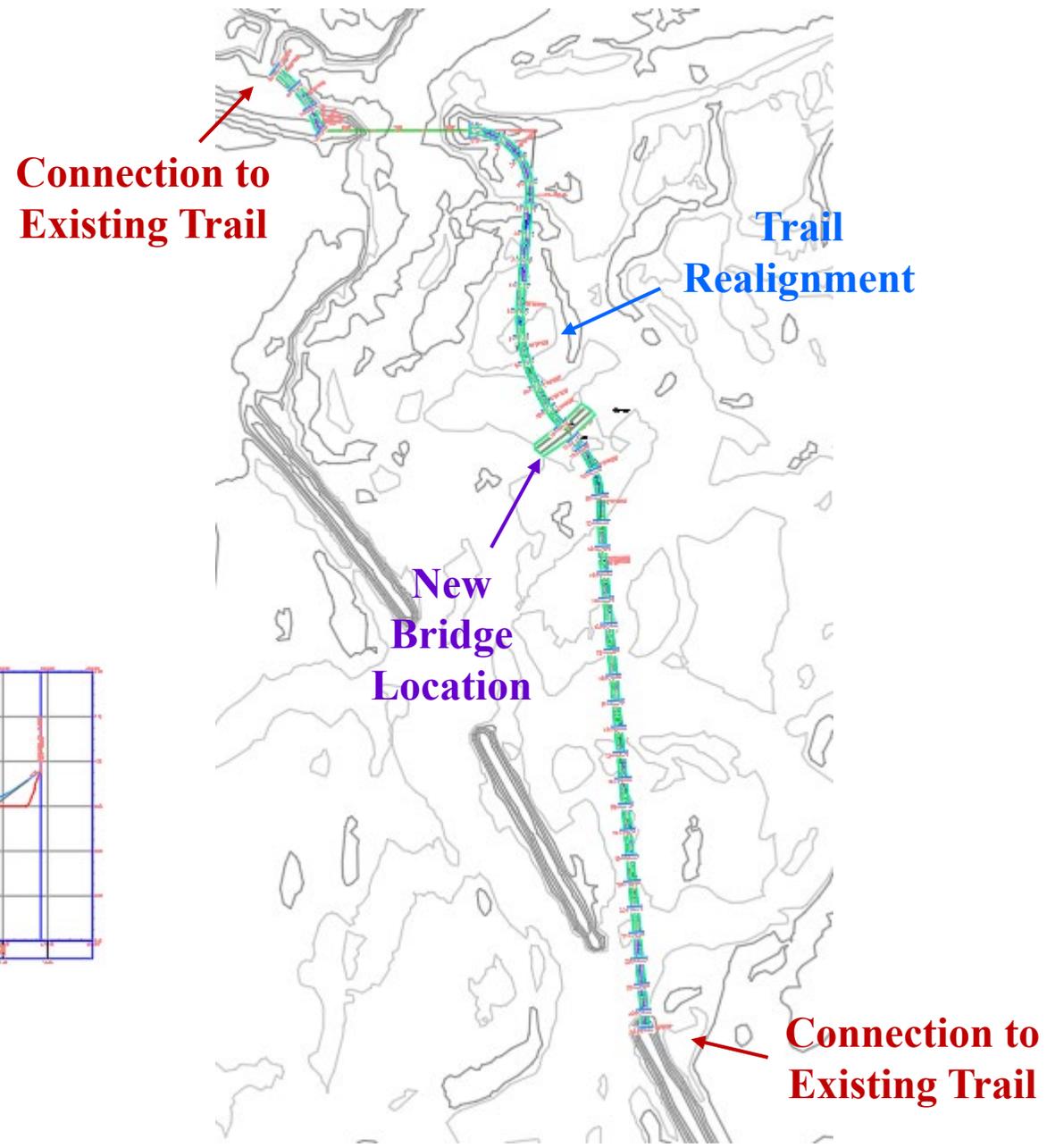
Eastern Trail Alignment



Pavement Cross Section



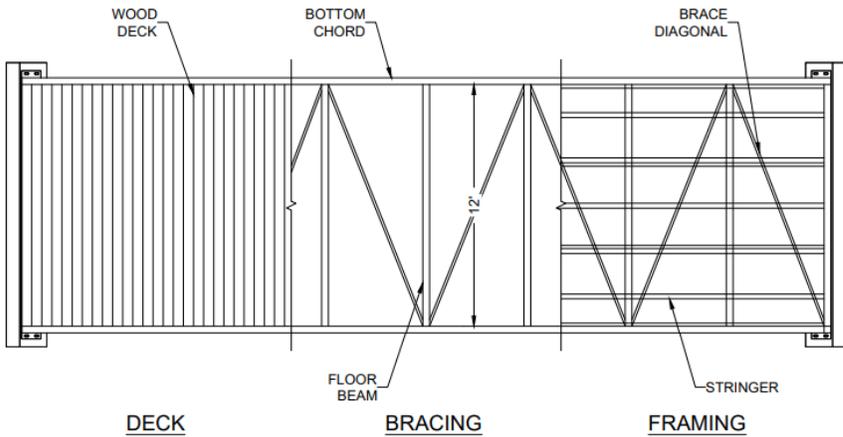
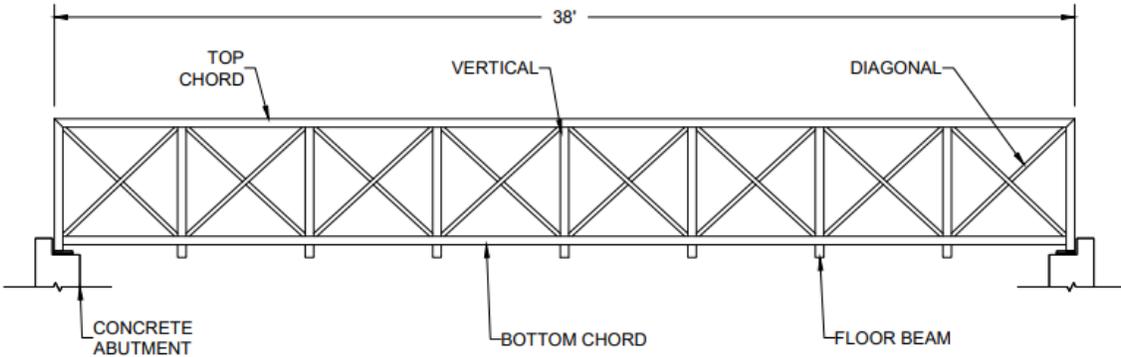
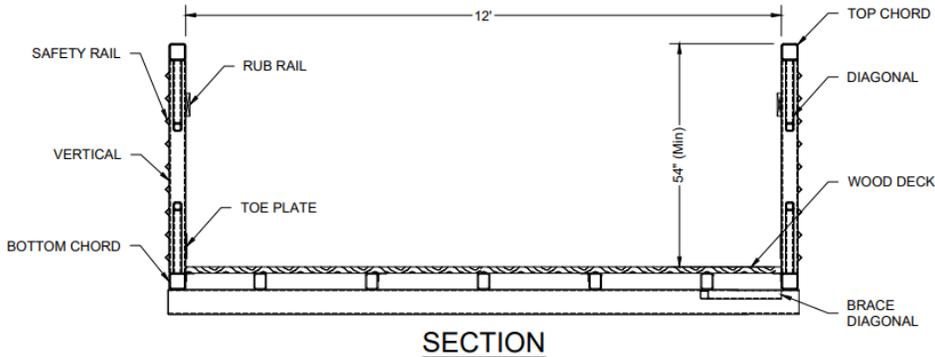
Trail Alignment Profile



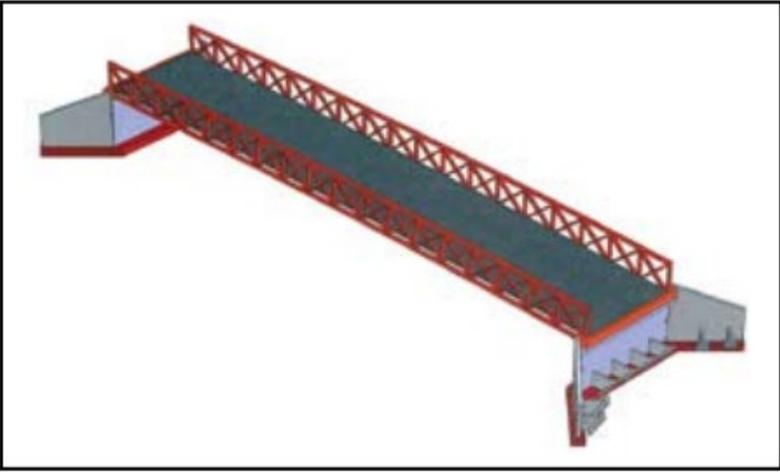
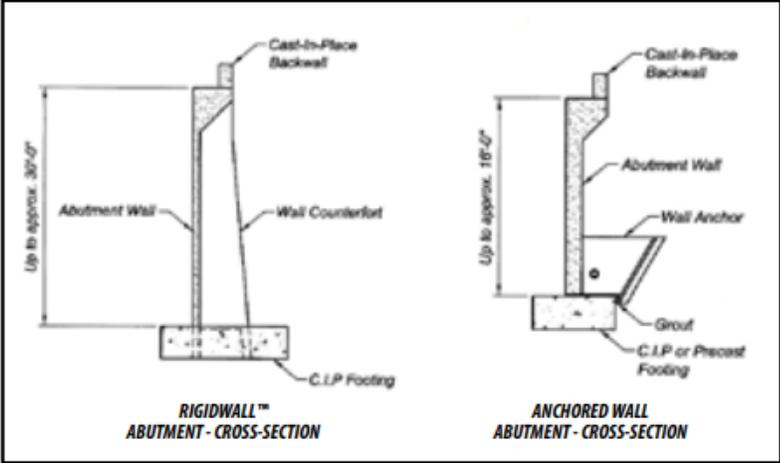
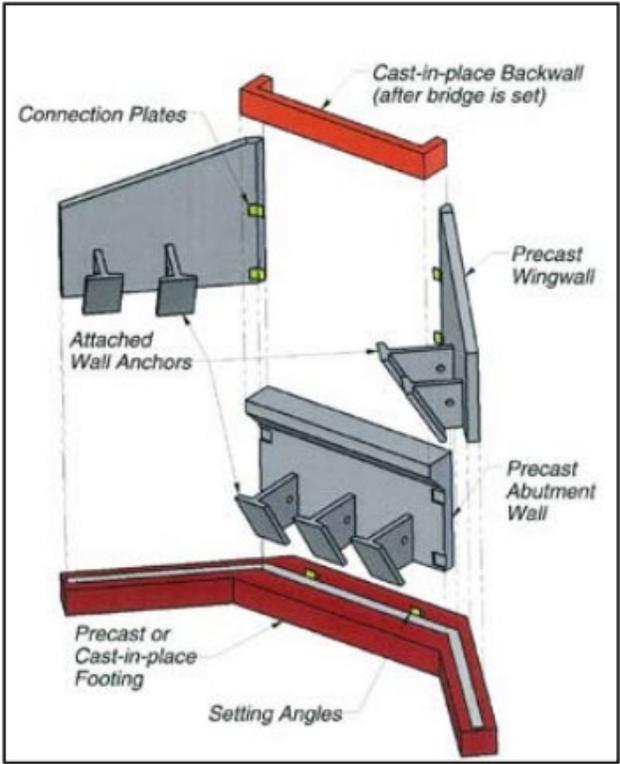
Eastern Trail Alignment: Bridge Design



Design Live Load = 85 psf



Eastern Trail Alignment: Foundation Design



Hydraulic Analysis

2D HEC-RAS Model

Assumptions:

Trapezoidal channel shape

Steady-state flow

Uniform soil type in overbanks with

$D_{50} = 0.00087$ in

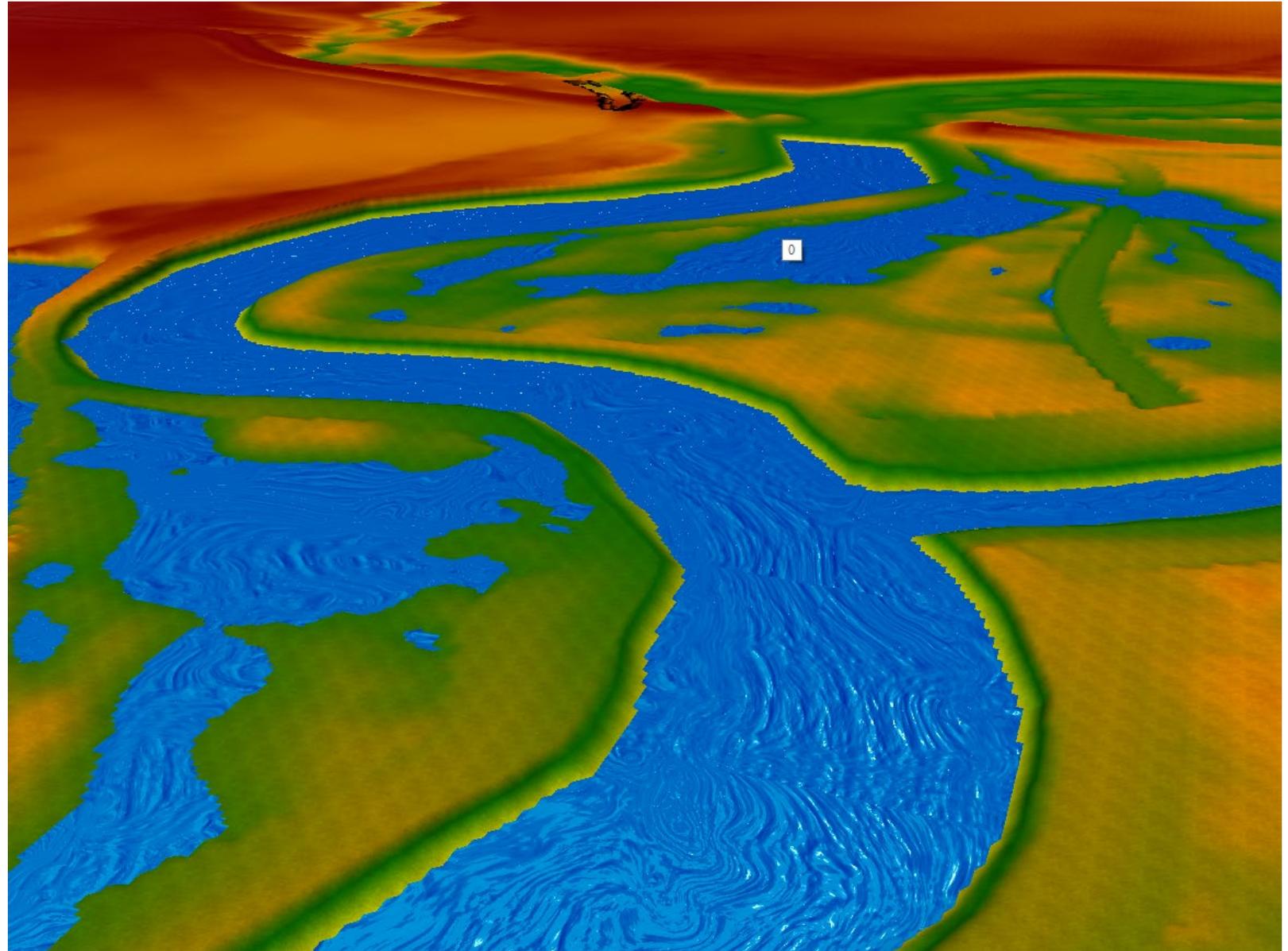
Stiff clay stream bed

Contraction scour only

Limitations:

< 1 mile upstream and downstream

Bridge at Ranchero Rd. not considered



Hydraulic Analysis Results

West Alternative

Event	Depth, Upstream, ft	Velocity US, ft/s	Velocity DS, ft/s	Scour Depth, y_s , ft
2 year	11.7	3.64	3.86	-1.17
10 year	13.3	4.04	4.33	-2.50
100 year	15.6	4.4	4.3	-5.37
500 year	15.7	4.78	5.3	-4.30

East Alternative

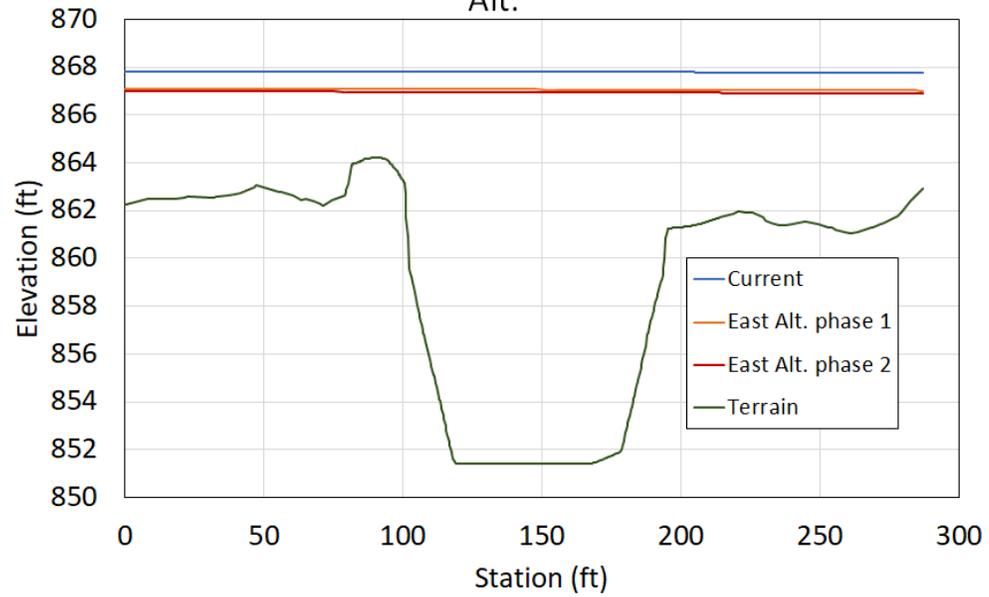
Event	Depth, Upstream, ft	Velocity US, ft/s	Velocity DS, ft/s	Scour Depth, y_s , ft
2 year	11.1	0.65	0.49	-4.68
10 year	12.2	2.23	1.99	-4.68
100 year	14.2	4.4	4.3	-5.90
500 year	14.4	3.96	3.88	-6.06

$$\frac{y_2}{y_1} = \left(\frac{Q_2}{Q_1} \right)^{6/7} \left(\frac{W_1}{W_2} \right)^{k_1}$$

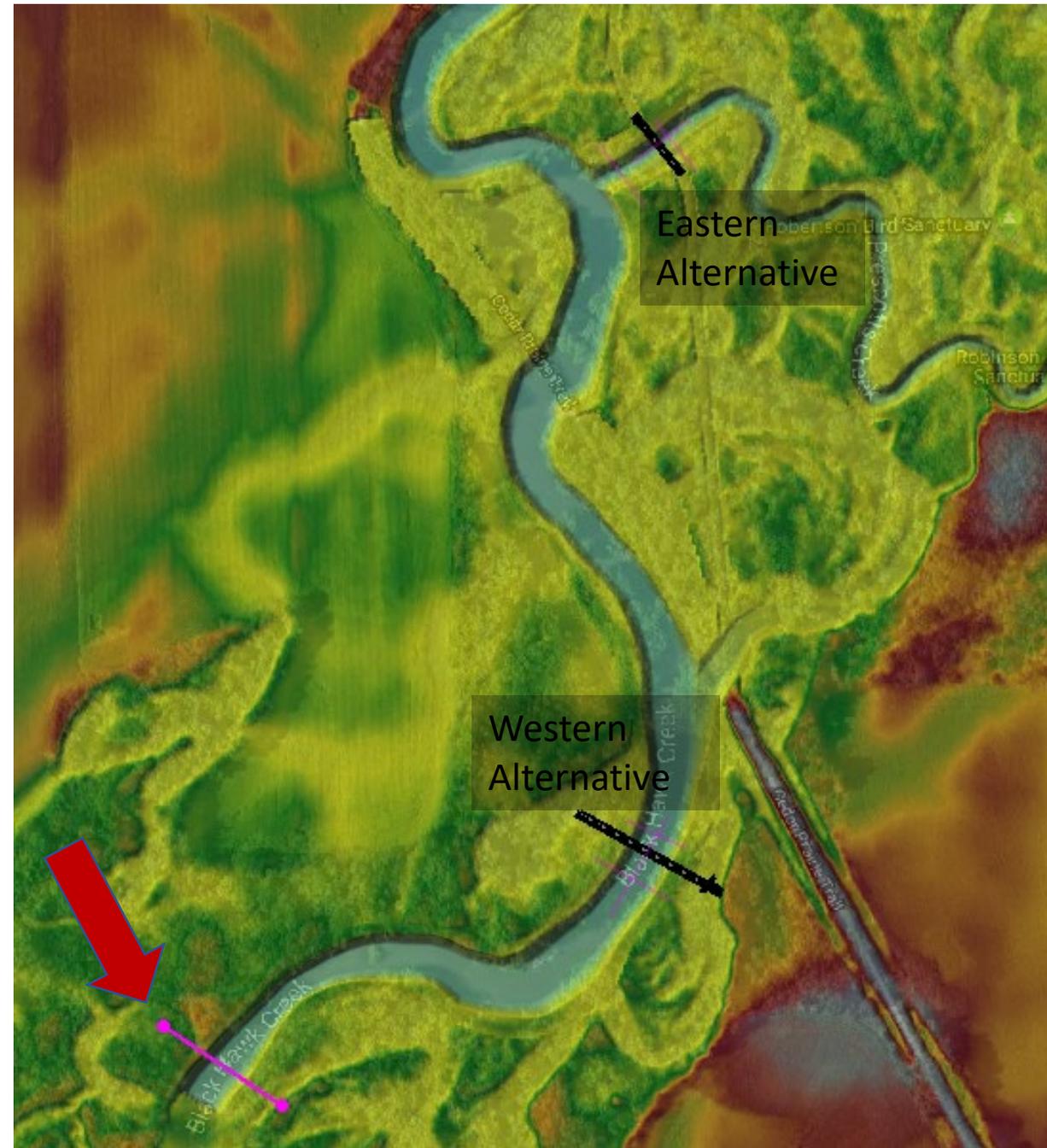
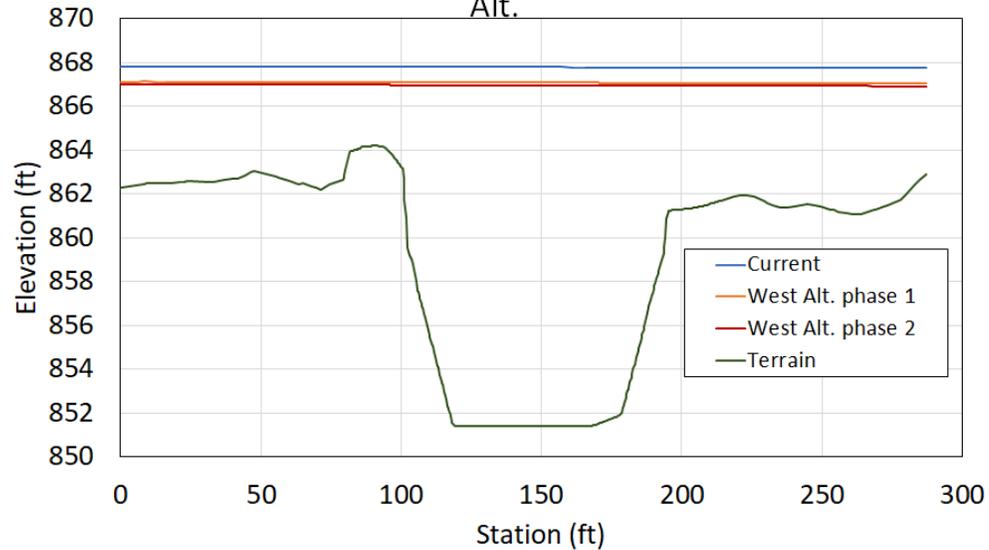
$$y_s = y_2 - y_o = (\text{average contraction scour depth})$$

*Contraction scour only

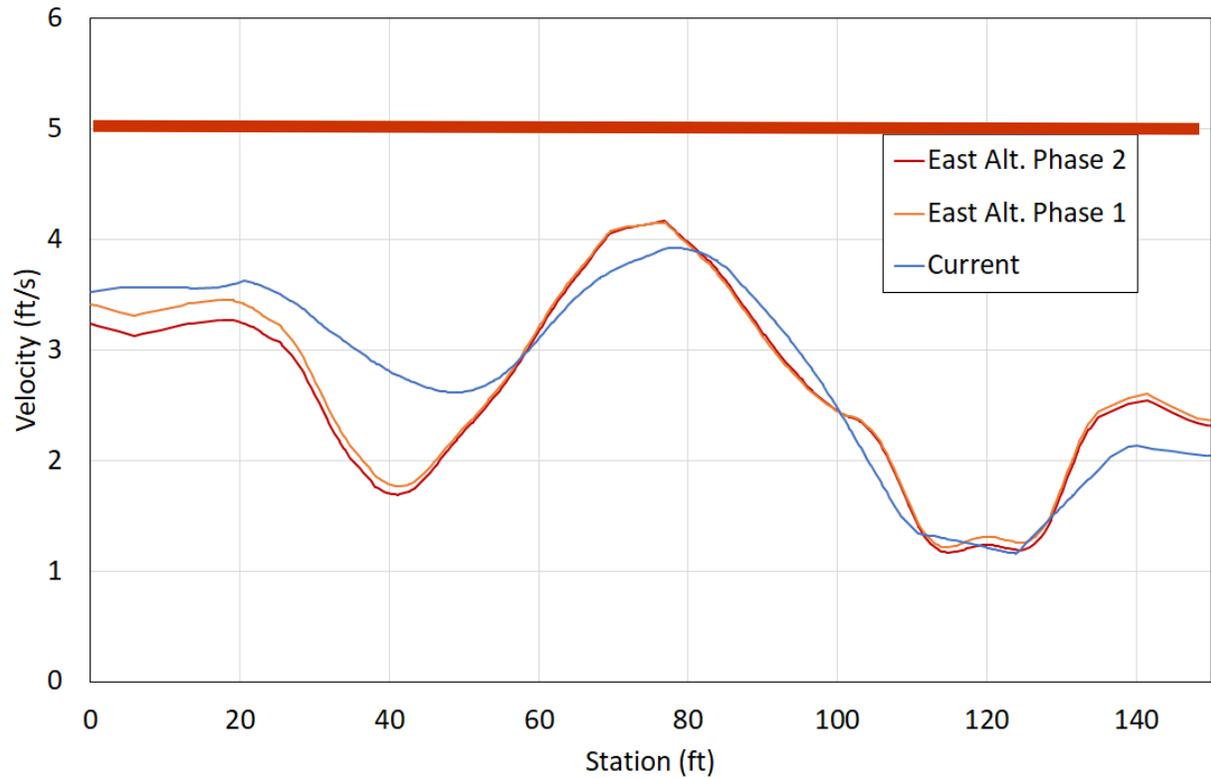
Water Surface Elevation - 100-year Flood Event, East Alt.



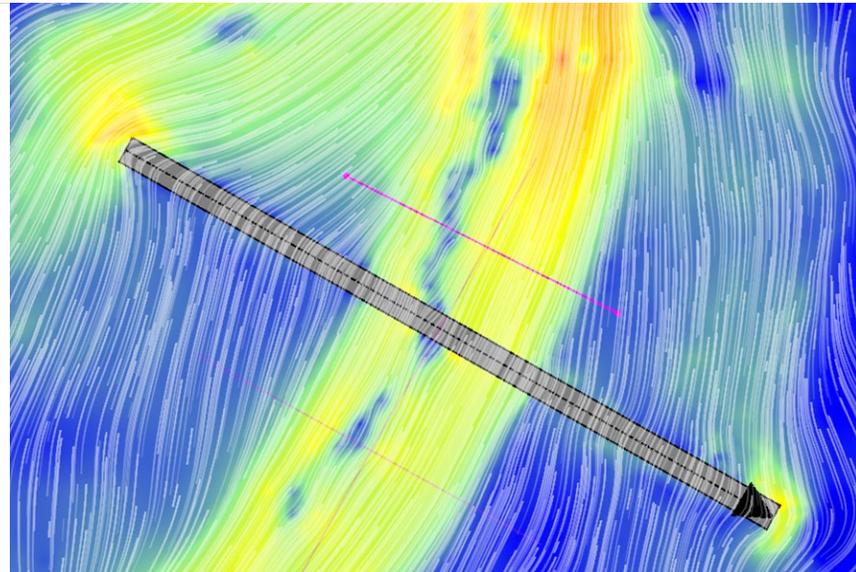
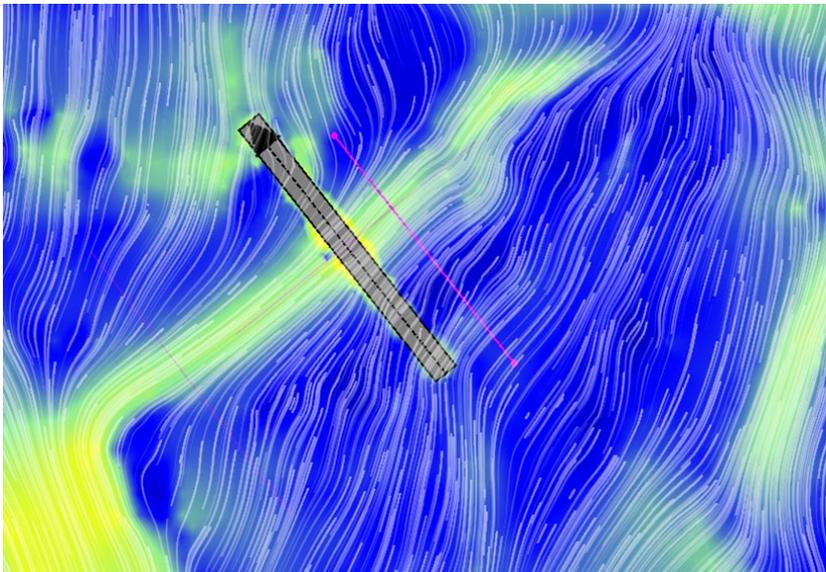
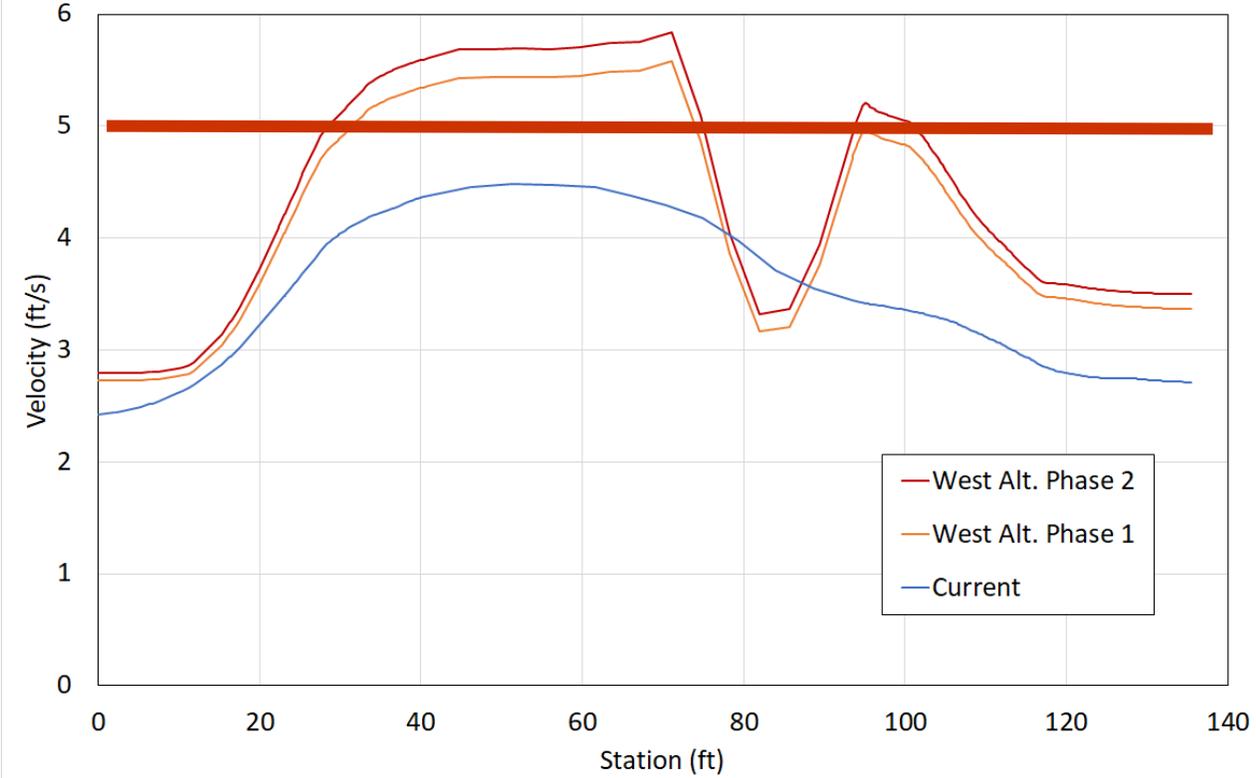
Water Surface Elevation - 100-year Flood Event, West Alt.



Flow Velocity Downstream - 100-year Flood Event, East Alt.



Flow Velocity Downstream - 100-year Flood Event, West Alt.



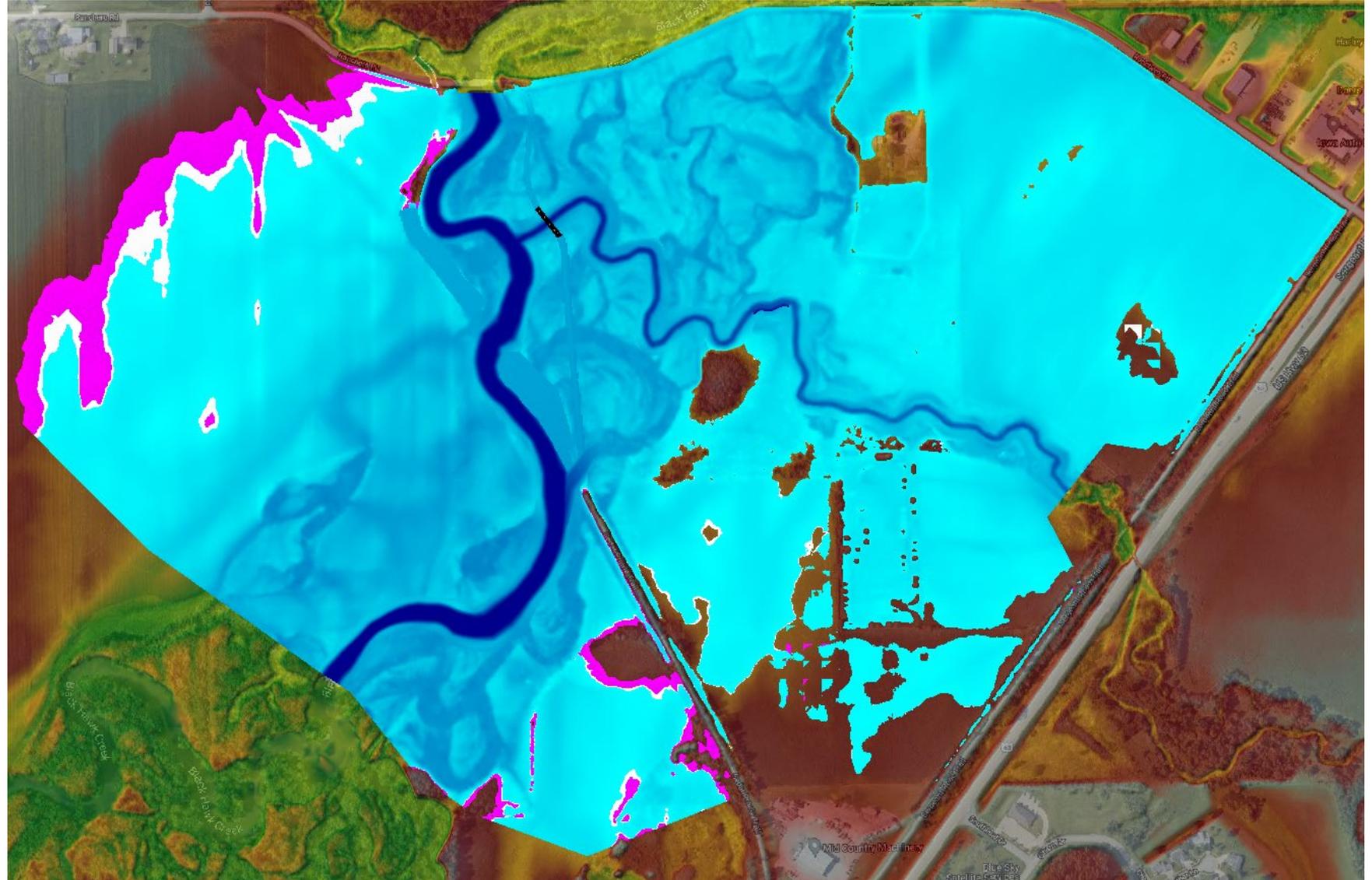
Hydraulic Analysis: Eastern Alignment

100-year floodplain (Steady-state) boundaries-East Alt.

Pink- Current condition

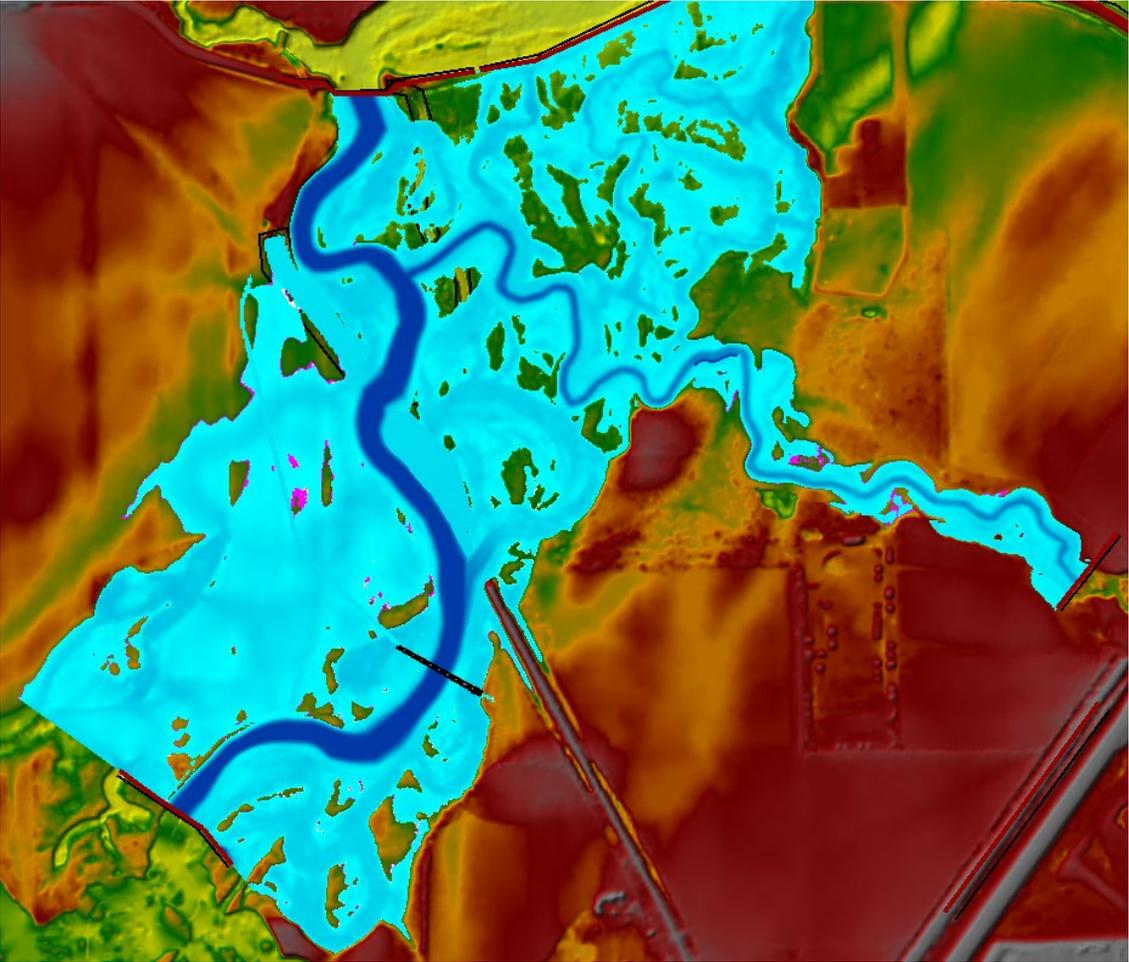
White - Phase 1

Blue - Phase 2

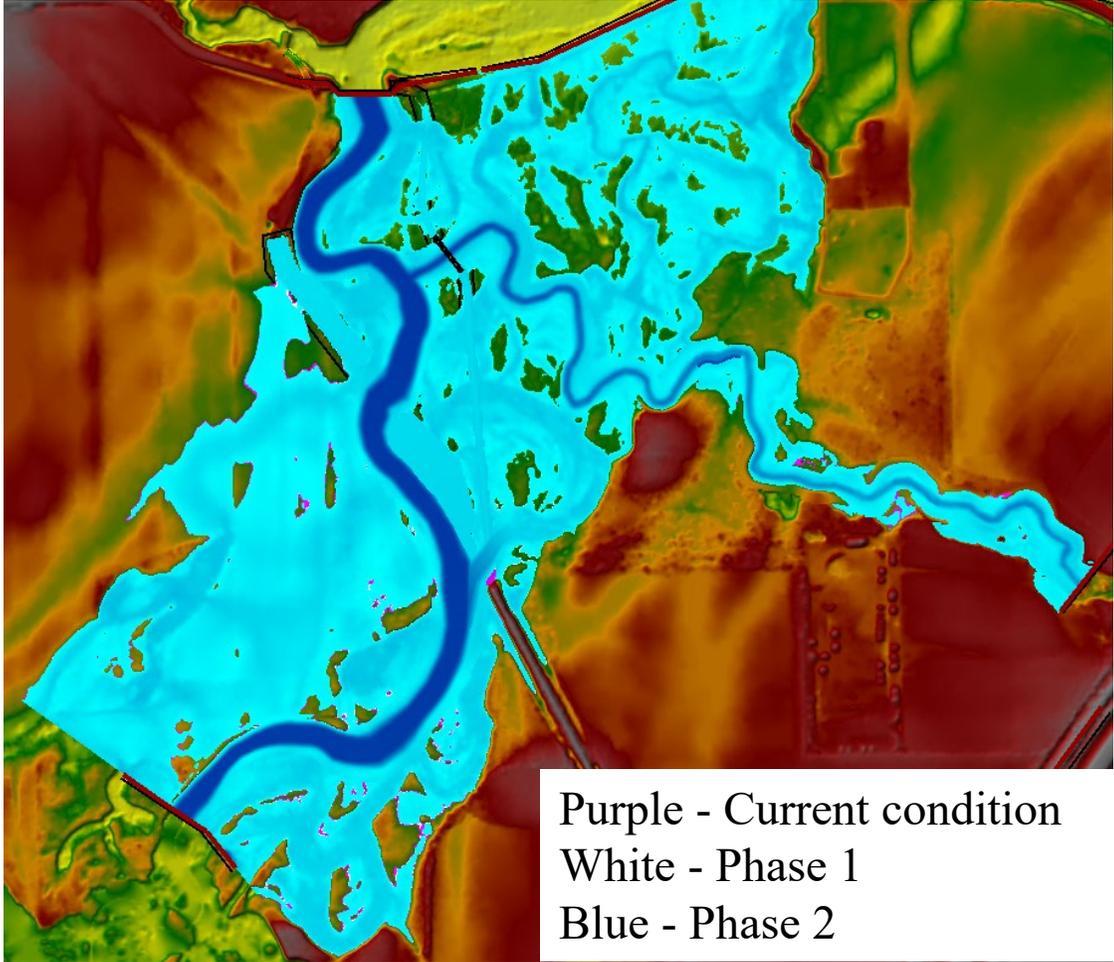


Hydraulic Analysis: 2-year floodplain

Western Alignment



Eastern Alignment

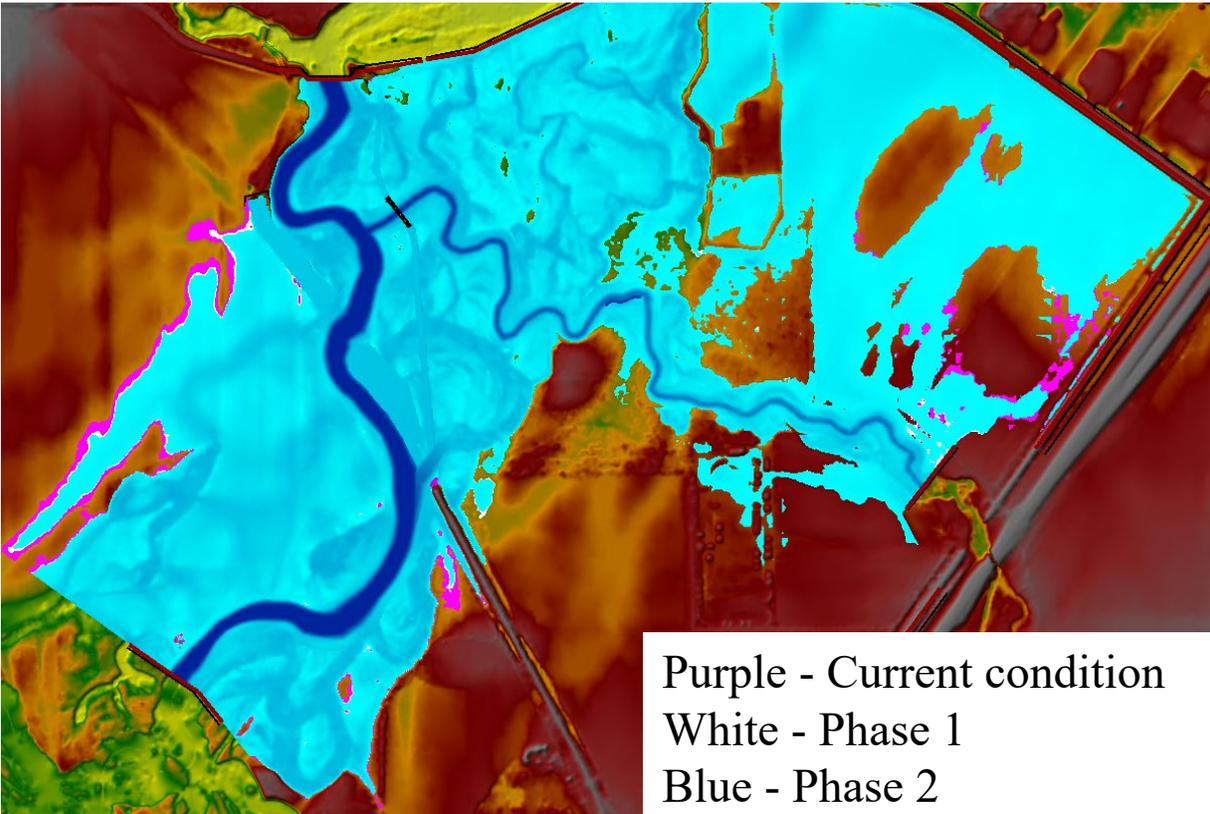
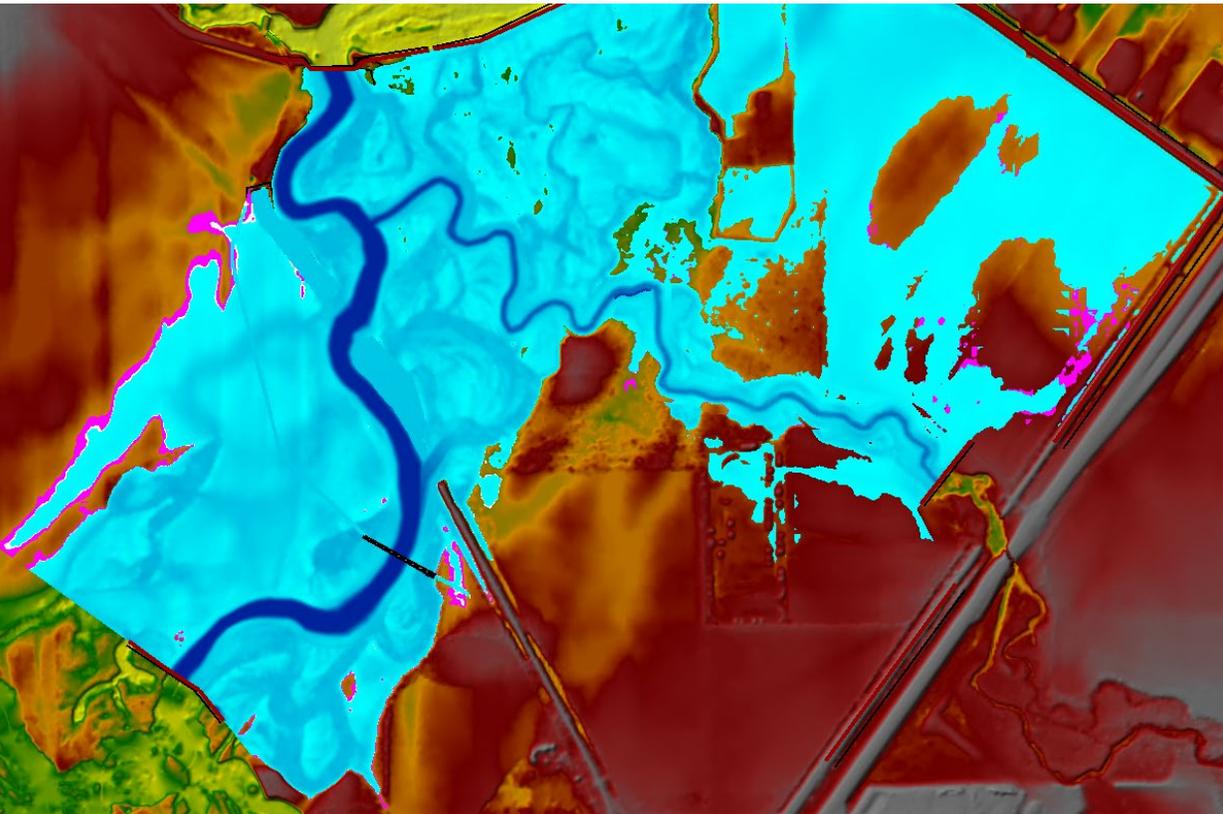


Purple - Current condition
White - Phase 1
Blue - Phase 2

Hydraulic Analysis: 10-year floodplain

Western Alignment

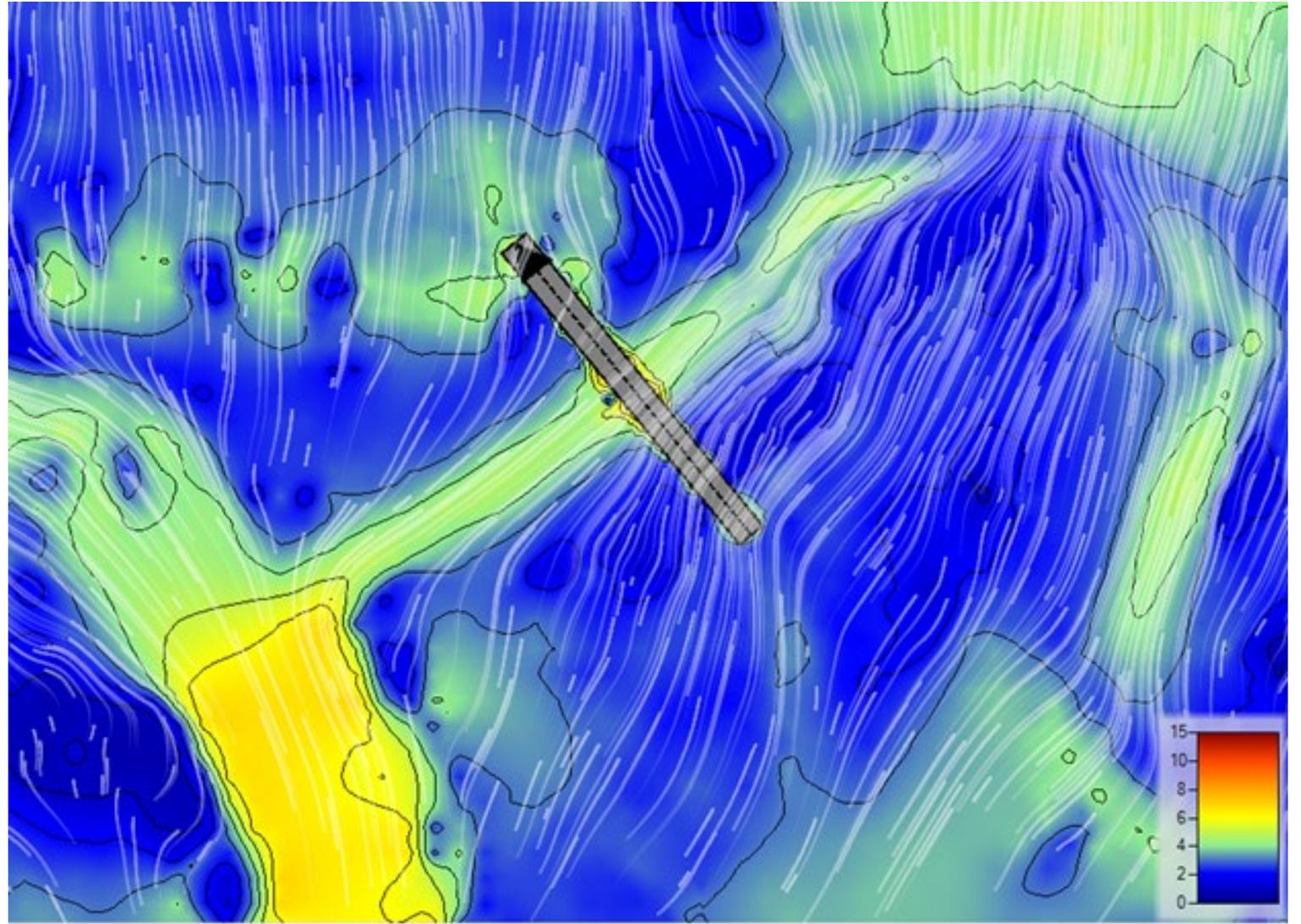
Eastern Alignment



Purple - Current condition
White - Phase 1
Blue - Phase 2

2D Model Approach

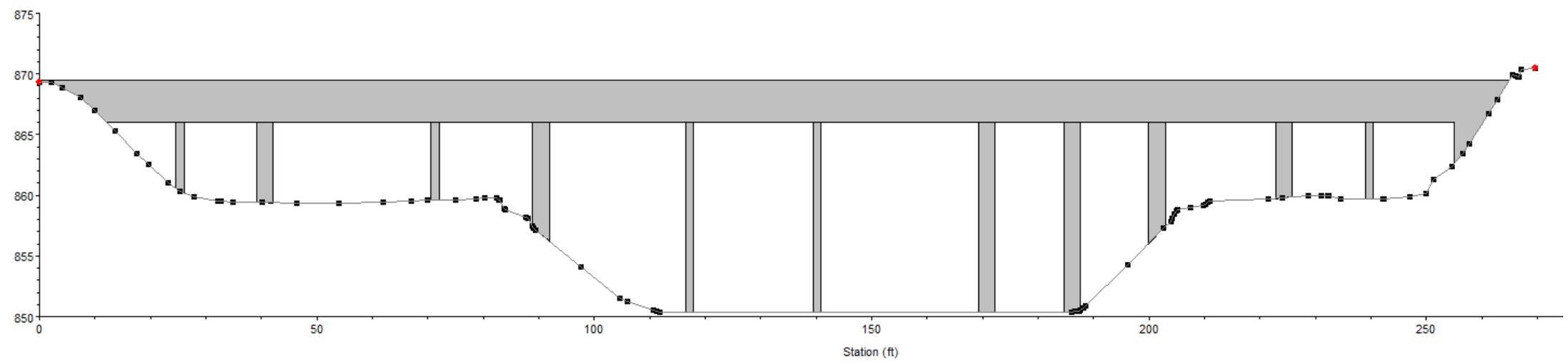
Created using 2m DEM terrain from USDA with streambed elevation provided by the client and land use data from the State of Iowa. Peak-flows from USGS StreamStats were used to perform steady-flow analysis.



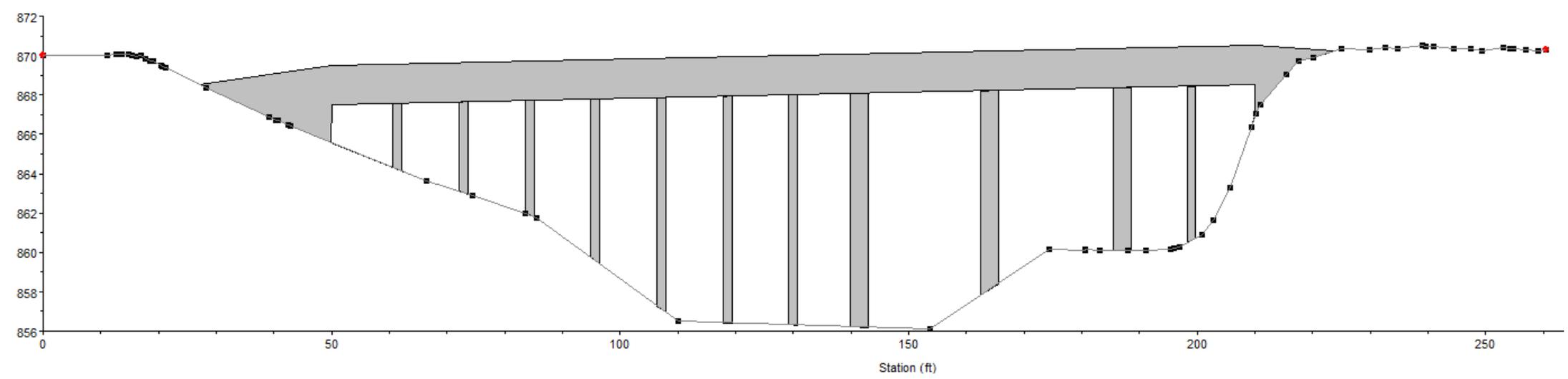
Reversed and lateral flows around the Eastern Alternative during high flows

Model of Current Conditions

NW Bridge
US Inside Bridge

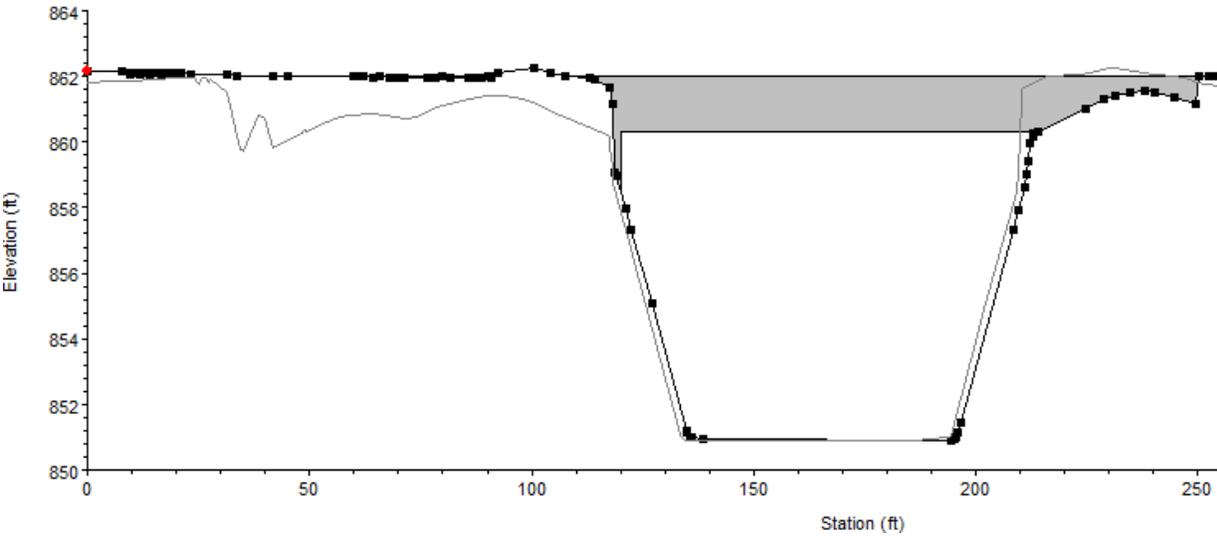


SE Bridge
US Inside Bridge



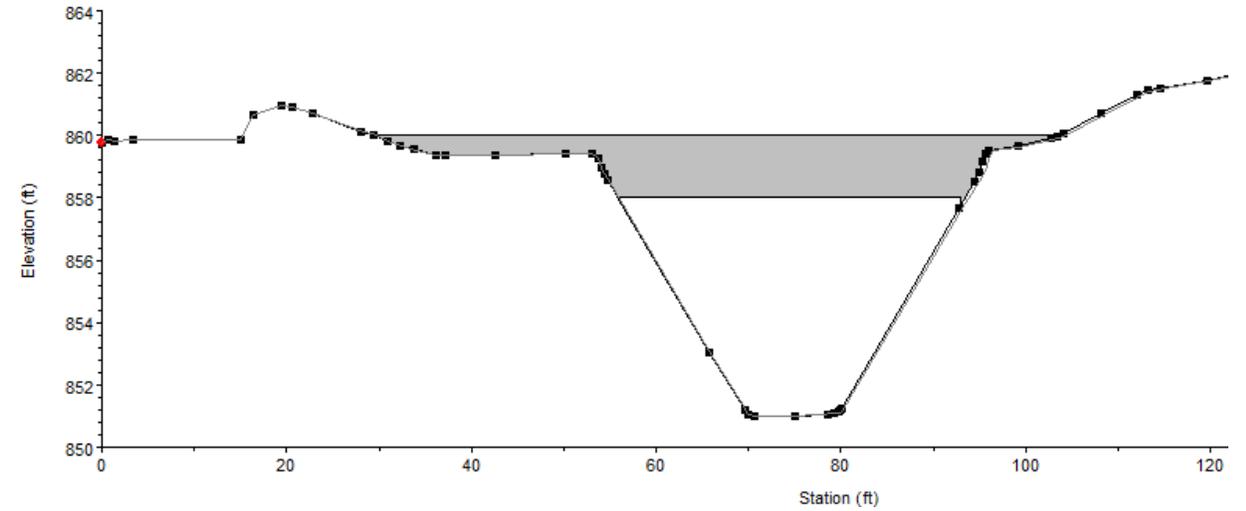
Western Bridge Model

Perimeter 1 To P
DS Inside Bridge



Eastern Bridge Model

Perimeter 1 To P
US Inside Bridge



Project Cost: Western Trail Alternative

Detailed Cost Estimate of Trail Realignment and Bridge Design

Item	Unit	Unit Cost	Quantity	Extended Cost
Trail				
Clearing and Grubbing	acre	\$ 6,000.48	0.89	\$ 5,350
Cut/Fill	CY	\$ 5.56	24.28	\$ 135
Soil Compaction	CY	\$ 0.43	539.64	\$ 230
5" asphalt	SY	\$ 24.93	3237.87	\$ 80,500
Top soil	CY	\$ 8.37	449.70	\$ 3,775
Seeding	Acre	\$ 914.42	0.67	\$ 610
Bridge				
4" x 8" Lumber	LF	\$ 15.30	2532.00	\$ 38,700
Pile Caps	CY	\$ 786.69	31.80	\$ 25,000
Steel Piles HP 10x57	VLF	\$ 121.47	700.00	\$ 85,000
Bearings	Ea.	\$ 1,245.00	4.00	\$ 4,975
HSS4-1/2X4-1/2X5/16	Ea.	\$ 861.69	11.00	\$ 9,475
HSS6X4X5/16	Ea.	\$ 1,390.74	20.00	\$ 27,800
HSS8X6X5/16	Ea.	\$ 2,230.65	18.00	\$ 40,200
HSS10X6X3/8	Ea.	\$ 3,057.93	4.00	\$ 12,200
HSS12X6X3/8	Ea.	\$ 4,021.56	4.00	\$ 16,100
W8x10	LF	\$ 63.57	650.00	\$ 41,300
W10x12	LF	\$ 70.44	132.00	\$ 9,300
Trail				\$ 91,000
Bridge				\$ 310,000
Cont -- 10%				\$ 40,100
Admin & Engineering -- 20%				\$ 80,200
Total				\$ 521,500

Project Cost: Eastern Trail Alternative

Detailed Cost Estimate of Trail Realignment and Bridge Design

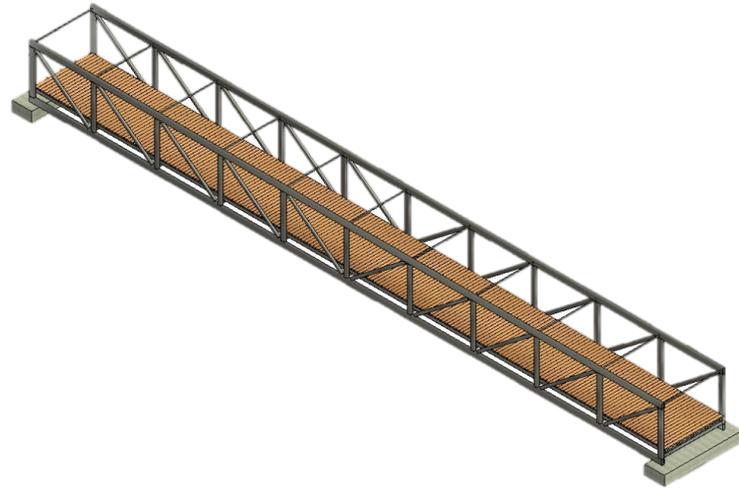
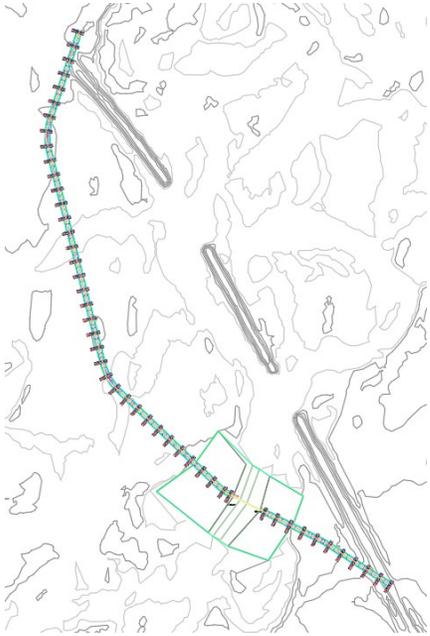
Item	Unit	Unit Cost	Quantity	Extended Cost
Trail				
Clearing and Grubbing	acre	\$ 6,000.48	0.85	\$ 5,125
cut/fill	CY	\$ 5.56	185.26	\$ 1,025
Soil Compaction	CY	\$ 0.43	516.27	\$ 220
5" asphalt	SY	\$ 24.93	3097.60	\$ 77,000
Top soil	CY	\$ 8.37	430.22	\$ 3,600
Seeding	Acre	\$ 914.42	0.64	\$ 585
Bridge				
Link Truss Pedestrian Bridge	Ea.	\$ 60,000.00	1.00	\$ 60,000
Pre-cast abutments and foundation	Ea.	\$ 17,500.00	2.00	\$ 35,000
Trail				\$ 88,000
Bridge				\$ 95,000
Cont -- 10%				\$ 8,800
Admin & Engineering -- 20%				\$ 17,600
Total				\$ 209,500

Project Cost: Removal of Railroad Embankments

Detailed Cost Estimate for Removal of Railroad Embankments

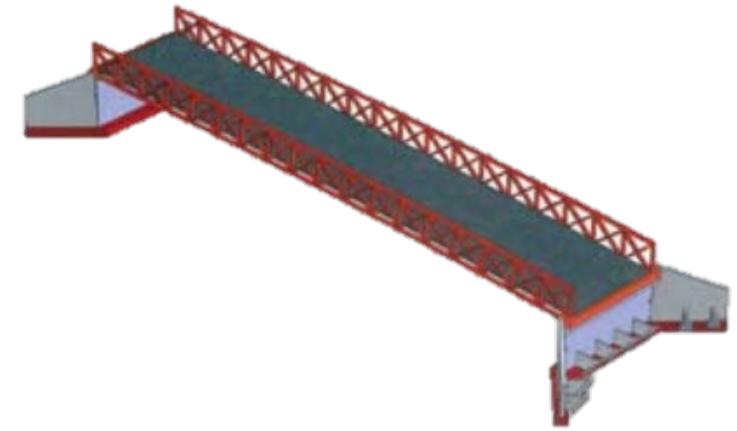
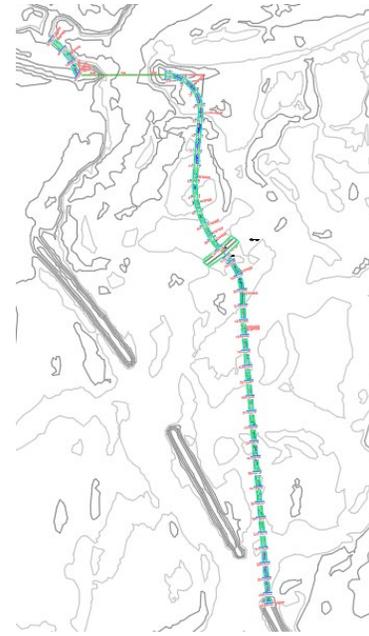
Item	Unit	Unit Cost	Quantity	Extended Cost
Embankment 1 Removal	CY	\$ 5.56	5285.35	\$ 29,400
Embankment 2 Removal	CY	\$ 5.56	5560.2	\$ 30,900
Removal of Embankments				\$ 60,500
Cont -- 10%				\$ 6,050
Admin & Engineering -- 20%				\$ 12,100
			Total	\$ 78,500

Western Trail Alignment



Total Cost: \$521,500

Eastern Trail Alignment



Total Cost: \$209,500

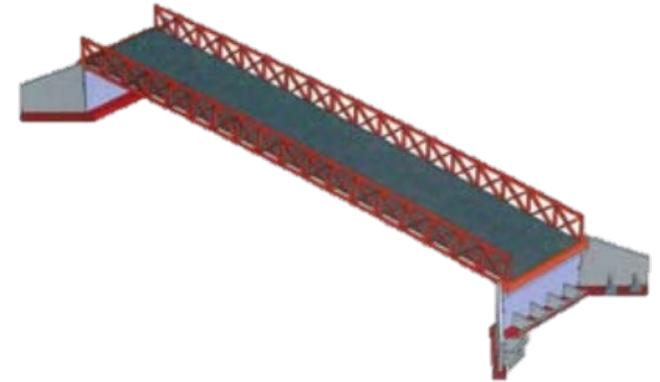
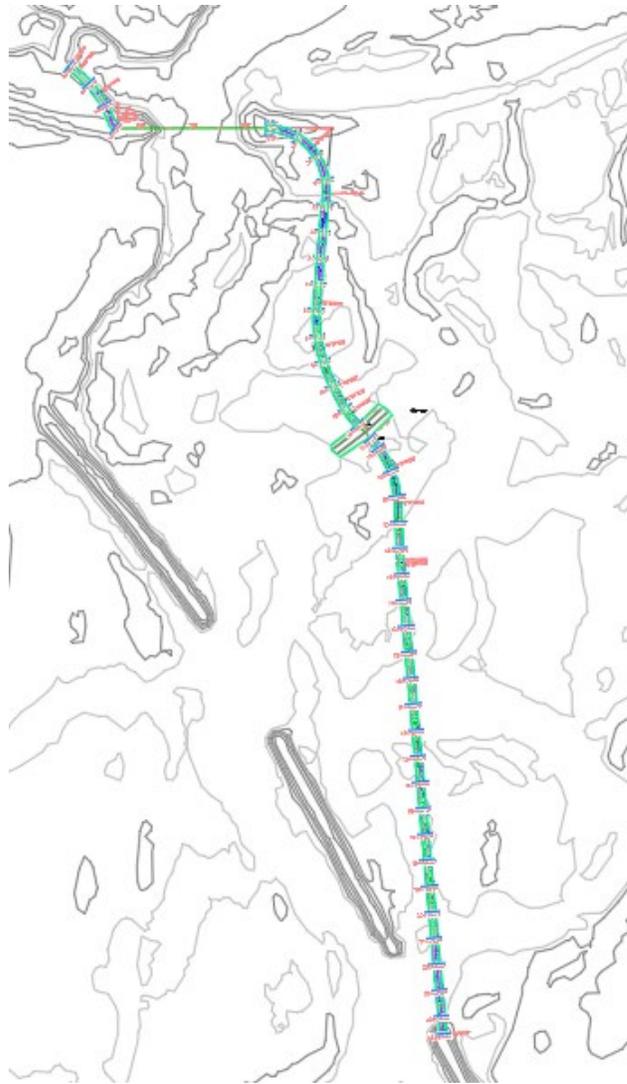
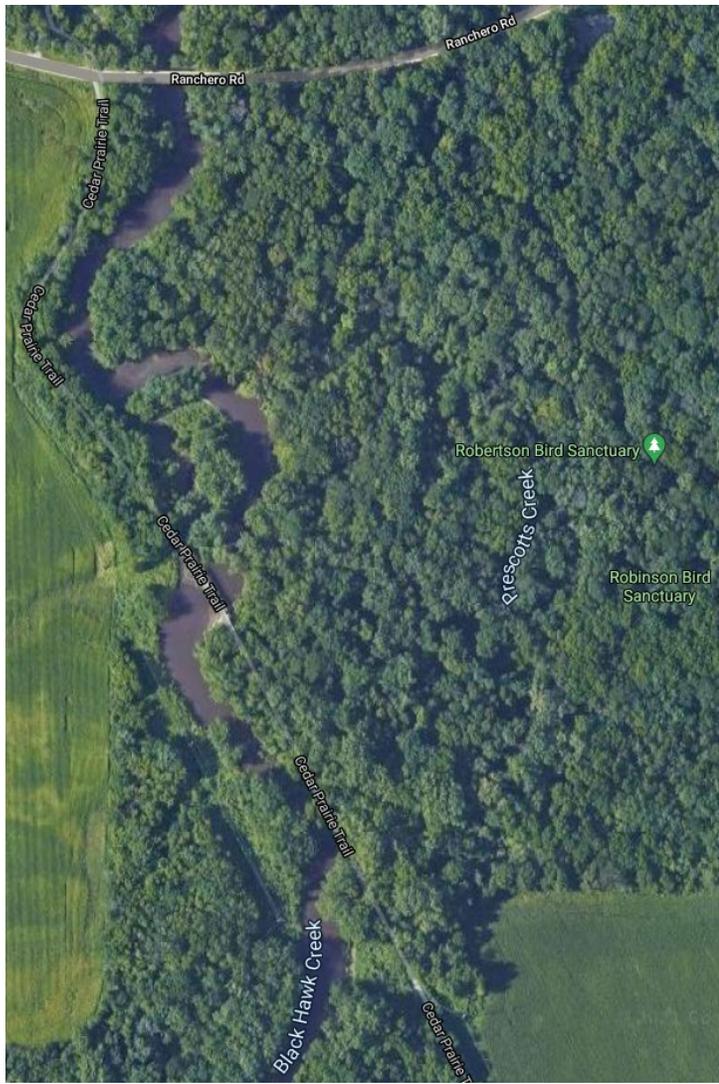
Recommended Design

Decision Matrix

Evaluation Criteria	Weight	Western Alignment	Eastern Alignment
Cost	0.7	2	5
Flooding	0.5	2	1
Removal of Trees	0.2	3	1
Ease of Construction	0.5	4	4
Pedestrian Experience	0.3	3	4
Client Preference	0.4	4	5
Weighted Total		7.5	9.4



**Eastern Trail
Alignment**



Conclusion & Questions