USDA Natural Resources Conservation Service
U.S. DEPARTMENT OF AGRICULTURE

Upper Turtle River Dam 10
Sponsor Meeting February 5, 2025

FARM PRODUCTION AND CONSERVATION
FSA | NRCS | RMA | Business Center

Agenda

- Background/Review – Christi
- Prelim Dam Design – Tom, Jon
- Economic Benefits Analysis - Dana
- Implementation Costs – Christi
- Alternatives to Move Forward - Christi
- Sponsor Decision – WRD & SCD

Background- Upper Turtle Dam 10 Watershed Plan

- **Current planning effort started with GF WRD request Oct 2021 to revive planning for a flood control dam at this site. GF SCD agreed to be a co-sponsor on the planning effort in early 2022.**
- **NRCS wrote a feasibility report, public participation plan early 2022. Public scoping meeting held March 2022 in Larimore, well attended – 49 in person and 11 online. Presentation posted online and comments came in later as well.**

	Hands @ Meeting	Written Responses
Large Permanent Pool	1	1
Small Permanent Pool	1	2
Dry Dam	7	7
Undecided / need more information	4	4
Opposed to anything	7	10

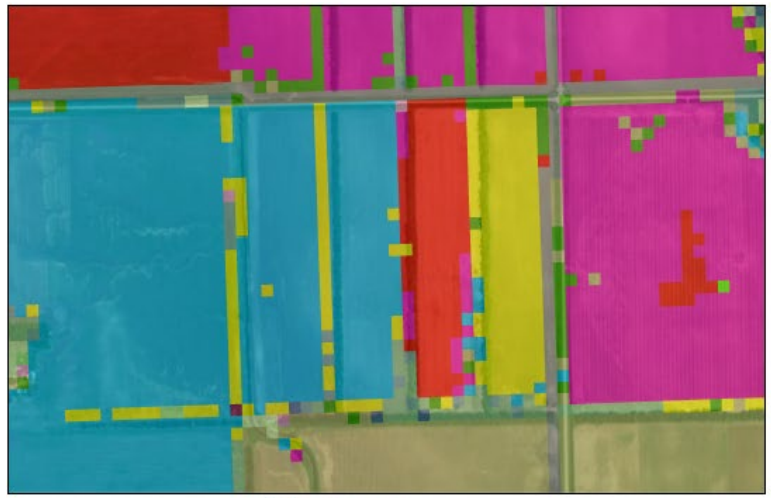
- 5 landowners adjacent or upstream of the project objected to it- roads, public safety, downstream flow reduction, or not willing to sell land.
- 2 landowners supported the concept of a dry dam, opposed to permanent pool or any project to benefit irrigators, wanted to see more details.
- 2 landowners supportive of a dam with a permanent pool & recreation, irrigation- thought that would increase property values.
- 1 resident thought that numerous, small dams would be a better flood control option.
- 1 resident wanted to see a drain ditch built from Anderson's north.
- 2 residents oppose any project due to environmental impacts.
- Grand Forks County strongly in support of dry dam to reduce road damages downstream.
- Elm Grove Township objected to the project- impacts to land.
- Sierra Club objected to the project- invasive species, impacts to plant communities, wildlife.

Direction from SCD/WRD boards to NRCS, to proceed with planning evaluation on the dry dam alternative only.

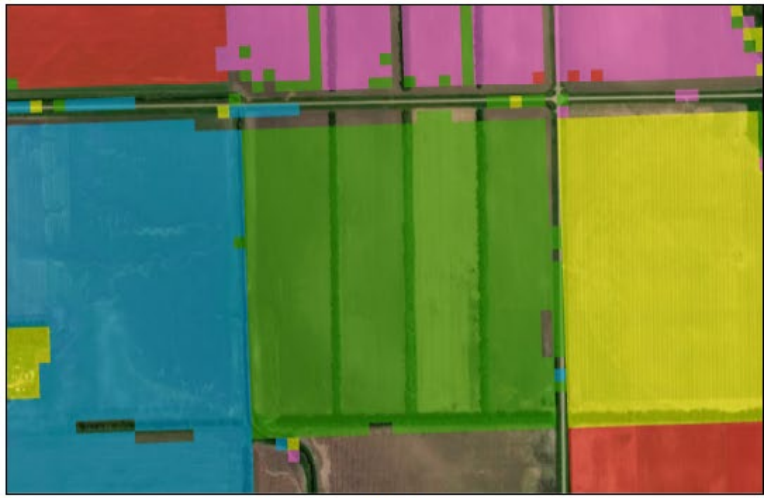
- **Survey work - HDR**
- **Calibrated hydrologic & hydraulic models – originally HDR, NRCS ended up doing final work**
- **Preliminary design - NRCS**
- **Wetland delineation - NRCS**
- **Economic Benefits Analysis – originally HDR, NRCS ended up doing final work**
  - **Initial draft from HDR in Sept 2023 indicated a 0.9 B:C ratio**
  - **Red River Retention Authority / International Water Institute stepped up to assist in improved cropland ID via machine learning, to see if that would put us over the top.**
- **Construction Cost – NRCS**

No in-depth environmental evaluation work, that would be next step

IWI Machine Learning NASS Cropland Reclassification Results



Before



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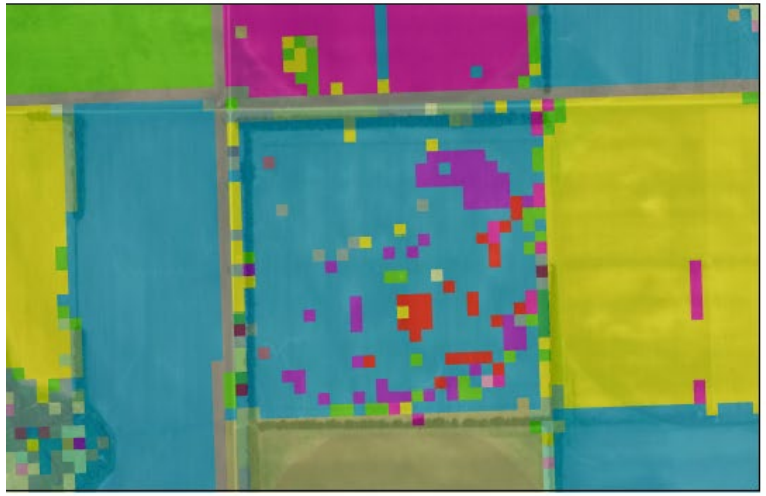
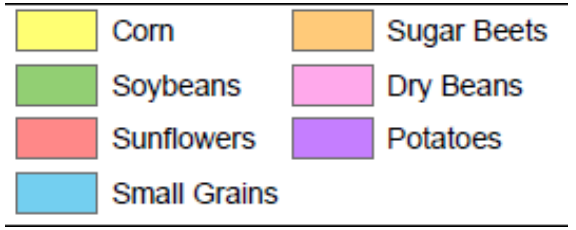




Pre Adjustment 25-Yr Flood Cropland Inundated Area = 9,807 acres (Existing Conditions)

Post Adjustment 25-Yr Flood Cropland Inundated Area = 11,509 acres (Existing Conditions)

17% increase in cropland

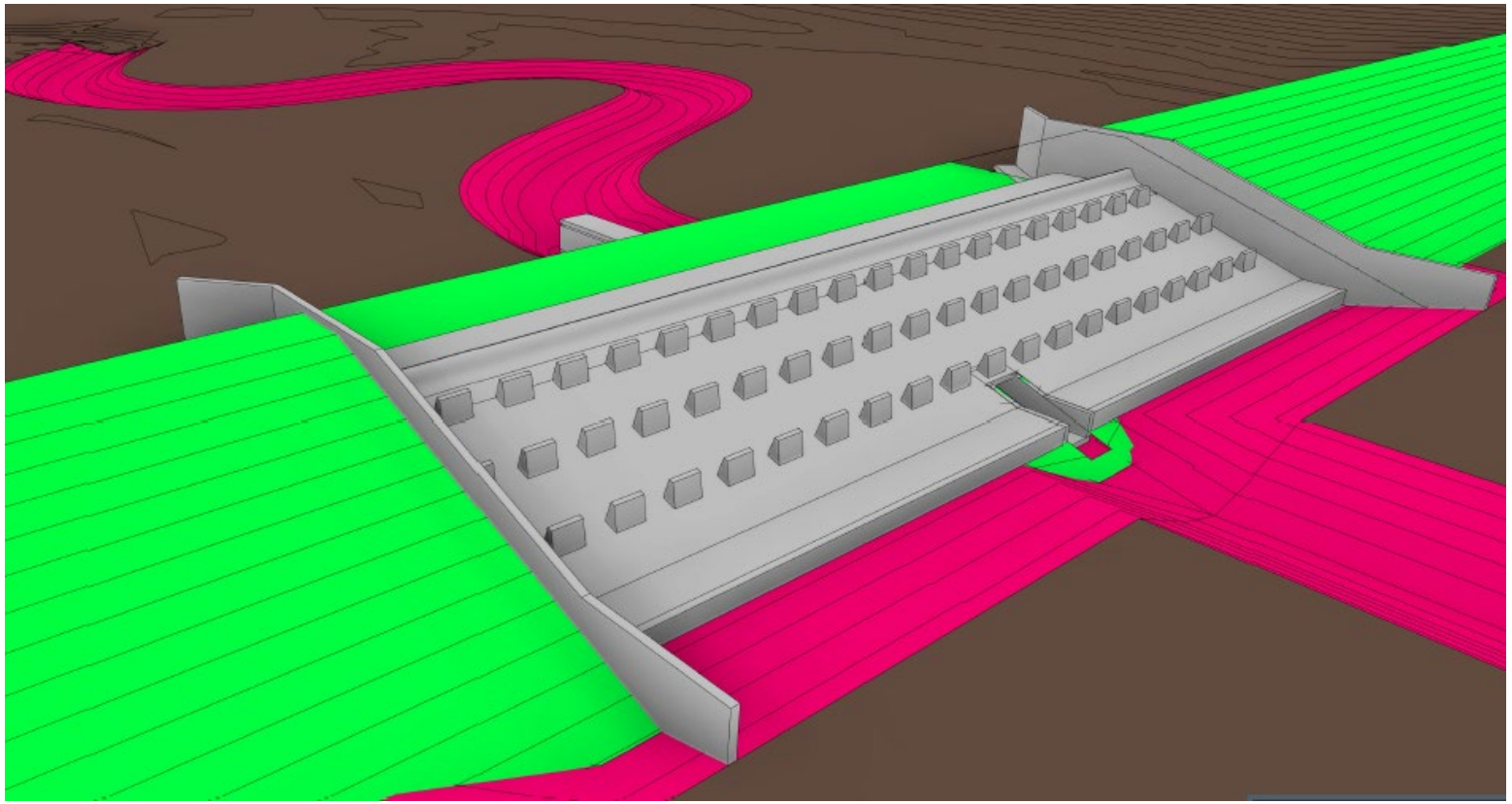
Outline

- Hydrology and Hydraulics
- Layout
- Geotech
- Structures

Preliminary Dam Design

Layout & Dimensions

- **Earth dam** (3,000 ft long, top elevation 1136.0)
- **Principal spillway** (6'x6' box on river grade)
- **Auxiliary spillway** (360 ft long concrete ogee crest, baffle chute; crest elevation 1127.0)

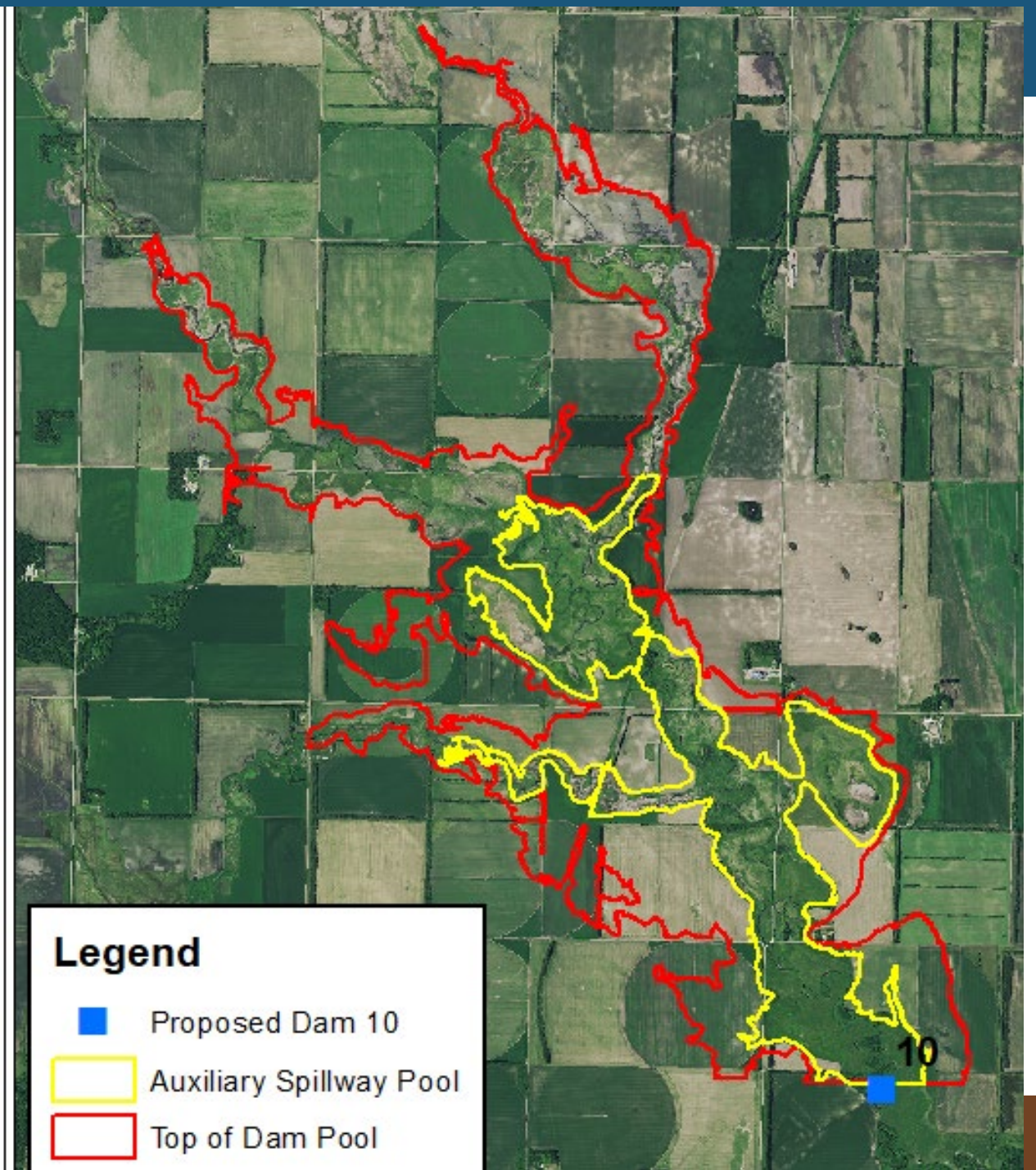


General data	
Purpose	Flood Control
Hazard Classification	High Hazard
Drainage Area	158.7 square miles
Dam Height (Average)	27 feet
Maximum Dam Height	35 feet
Embankment Length	3,000 feet
Embankment Top Width	14 feet
Embankment Upstream Slope	3H:1V
Embankment Downstream Slope	2.5H:1V

Critical Elevations (NAVD88)	
Principal Spillway Invert	1102.0 feet
Auxiliary Spillway Crest	1127.0 feet
Top of Dam	1136.0 feet

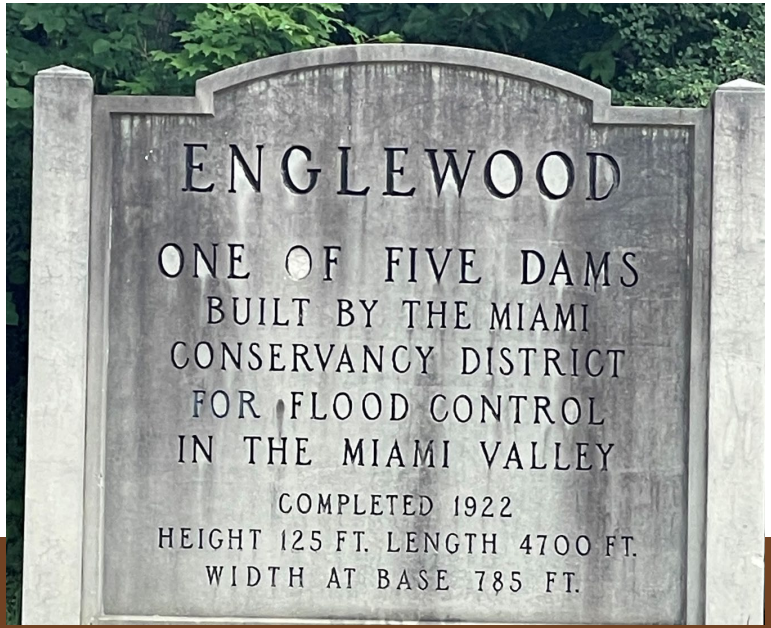
Flood Pool

- Dry Dam: Maintain river functions except during flood events
  - No permanent pool
  - Principal spillway at river level
- Auxiliary Spillway (> 100-yr, 7.9”)
  - 850 acres (Yellow Line)
- Top of Dam (> PMP, 18.6”)
  - 2,770 acres (Red Line)



Dam Features

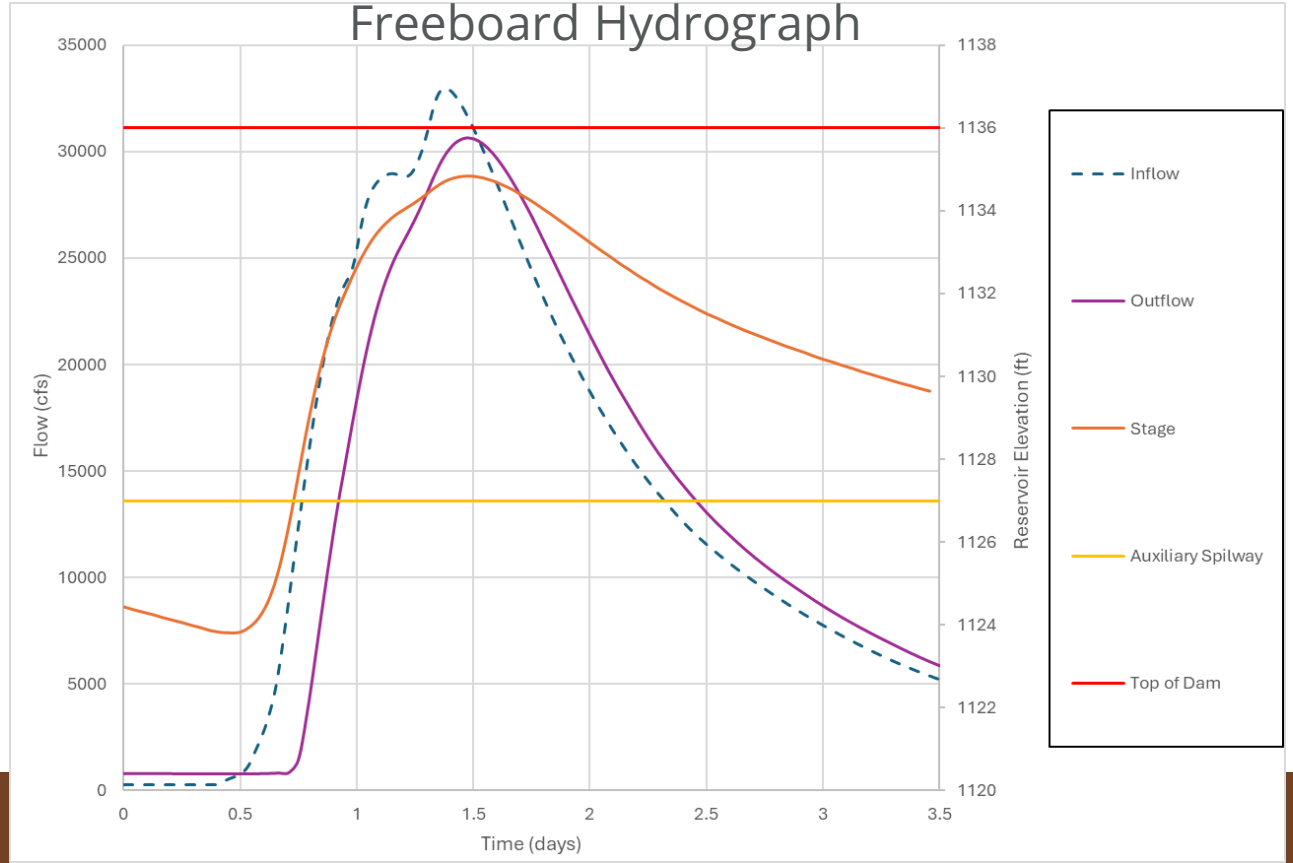
- Principal spillway (6'x6' box)
  - Avoid Wetlands
    - 780.2 ac delineated
  - Avoid Other Waters (Stream Channel)
    - 22.7 ac delineated
  - Aquatic Organisms Passage
    - Limit barriers that restrict or impede movement
  - Stream Temperatures
    - Maintain hyporheic zone (stream and groundwater) interactions
    - Limit high temperature flows from riser tower
    - Maintain trout fishery in Turtle River State Park
  - Maintain similar Sediment Transport Regime



Hydrology and Hydraulics

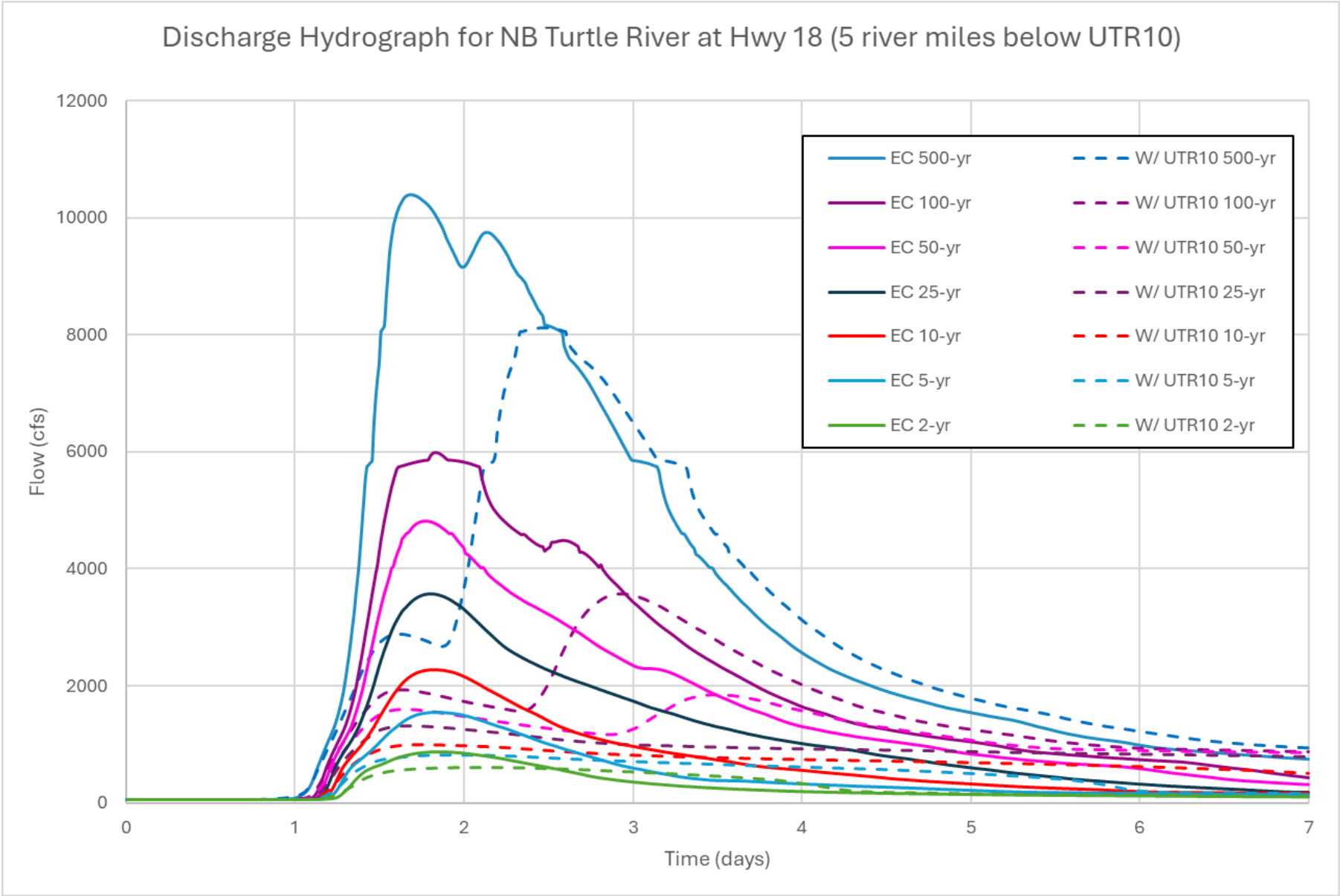
- High hazard dam due to loss of life risk due to breach
- Dam sizing guidance from NRCS & State of North Dakota
  - Calibrated runoff and inundation models used
  - Principal Spillway
  - Auxiliary spillway
  - Dam Height

Design Event Hydrograph	Hydrologic Criteria [1]	Depth (inches)
Principal Spillway Hydrograph (PSH)	P_{100}	4.65[2] 7.87[3]
Auxiliary Spillway Hydrograph (ASH)	P_{100} + 0.26 (PMP-P_{100})[4]	8.72[4]
Freeboard Hydrograph (FBH)	PMP	18.6[5]



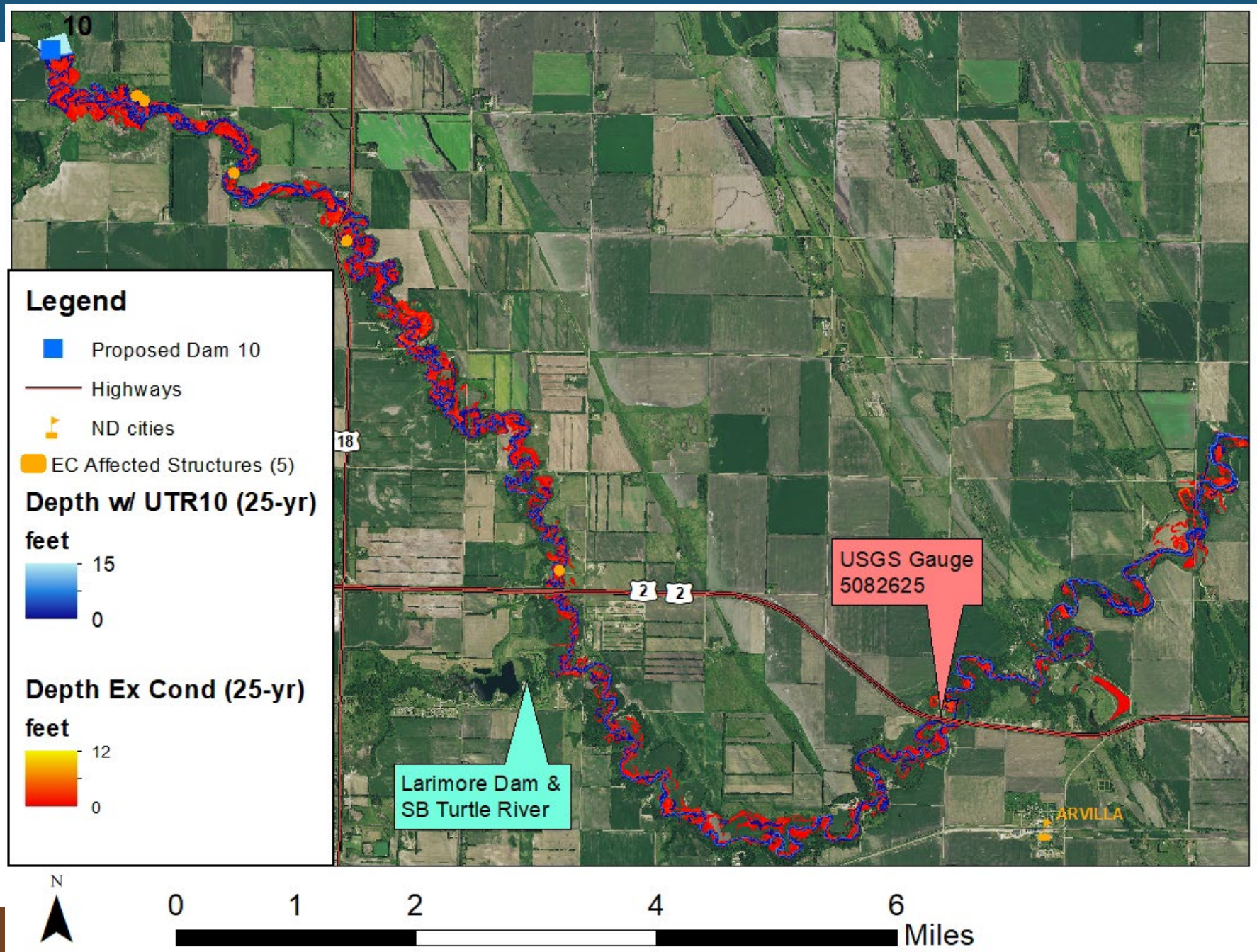
Hydrology and Hydraulics

- Frequency based runoff events modeled
  - Peak flows attenuated behind dam
  - Reduced peak flows downstream of dam
    - 2-yr: 33%
    - 5-yr: 53%
    - 10-yr: 63%
    - 25-yr: 72%
    - 50-yr: 58%
    - 100-yr: 37%
    - 500-yr: 15%

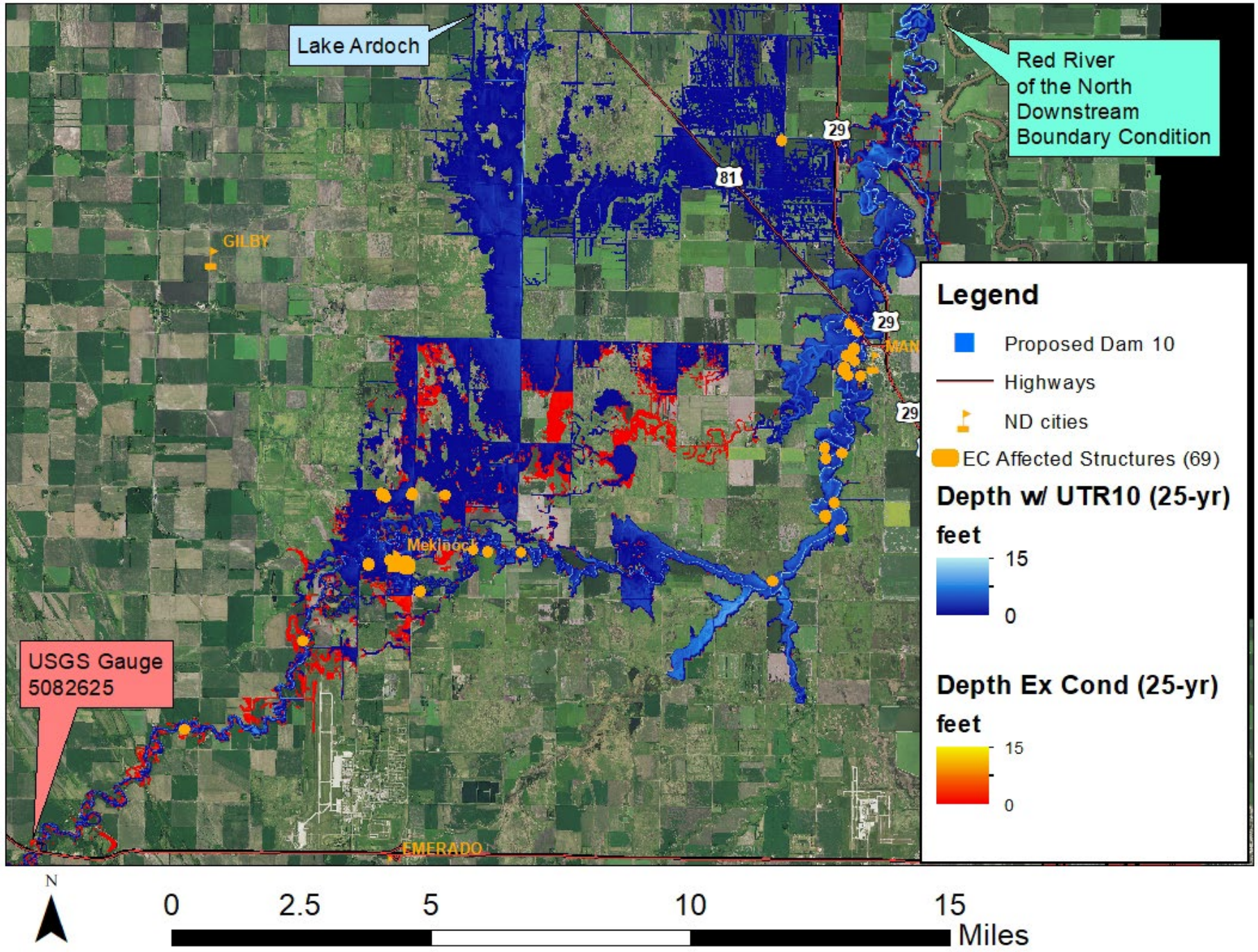


Hydrology and Hydraulics

- Frequency based runoff events modeled
  - Peak flows attenuated behind dam
  - Reduced inundation extents and depths downstream (Red)
    - 25-yr Upper Turtle River (shown)

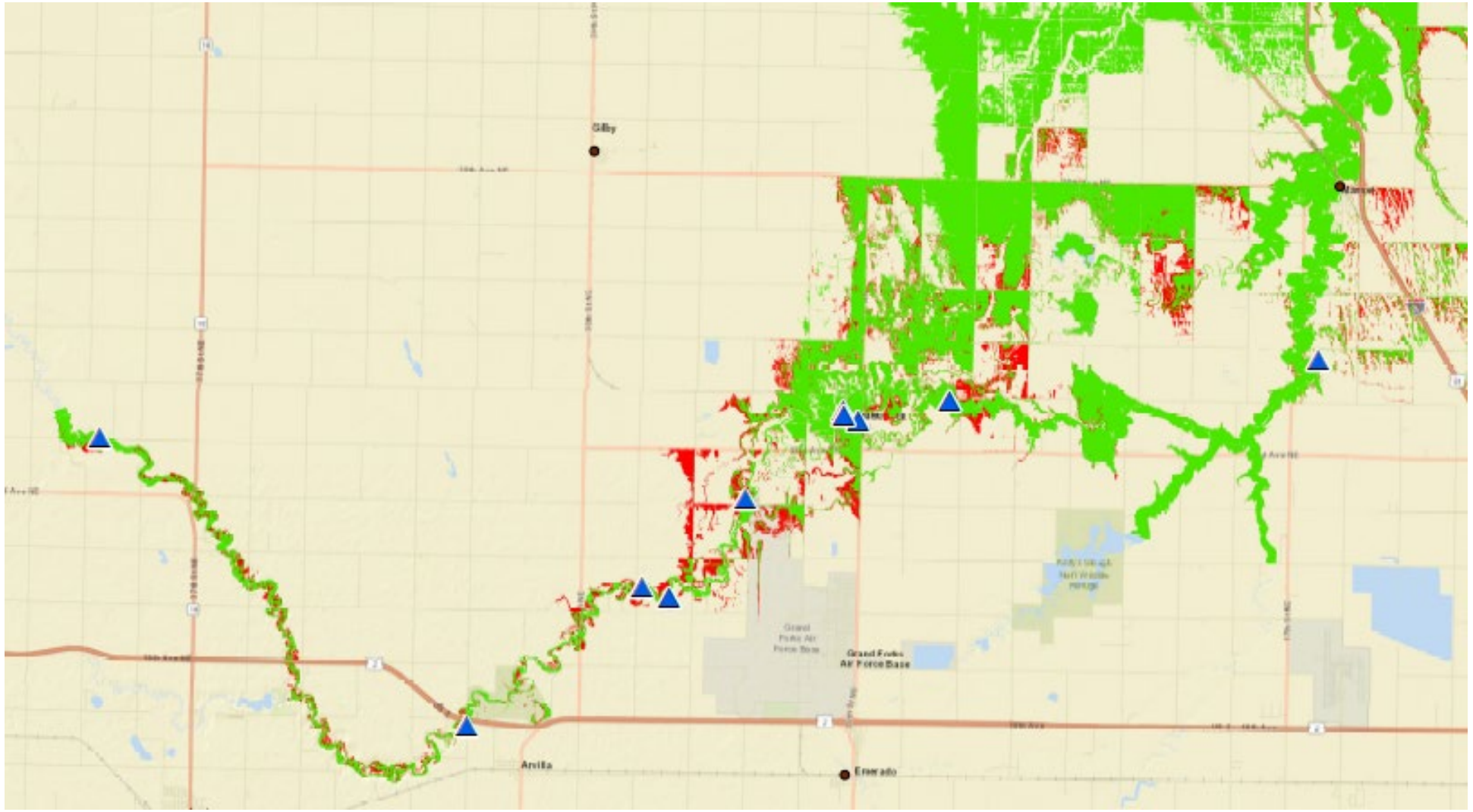


Lower Turtle River 25-year rainfall inundation depths



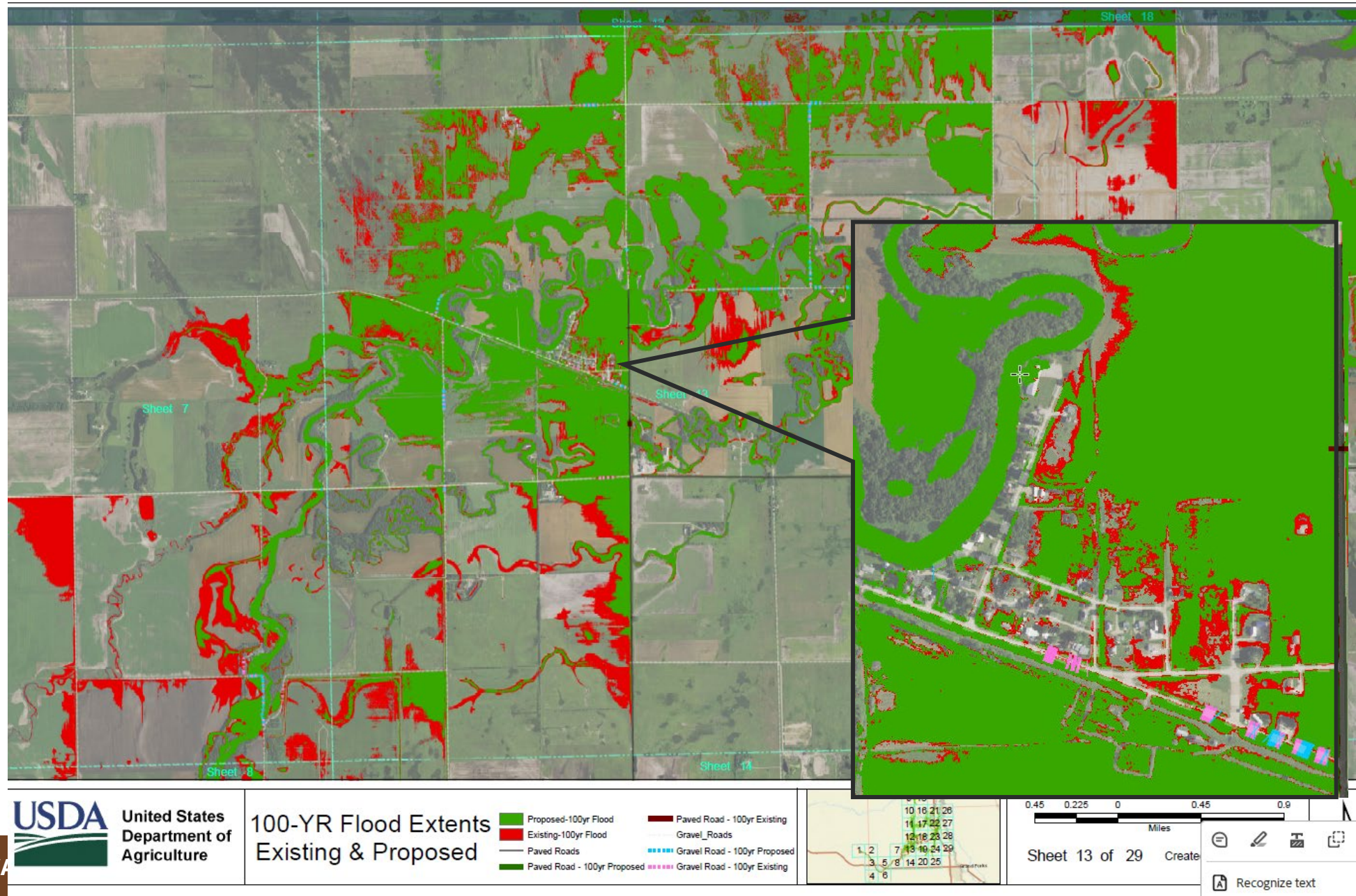
Upper & Lower Turtle 100-year inundations

- Areas no longer inundated (red)
- Blue Triangles show residences removed (overlapping in Mekinock)

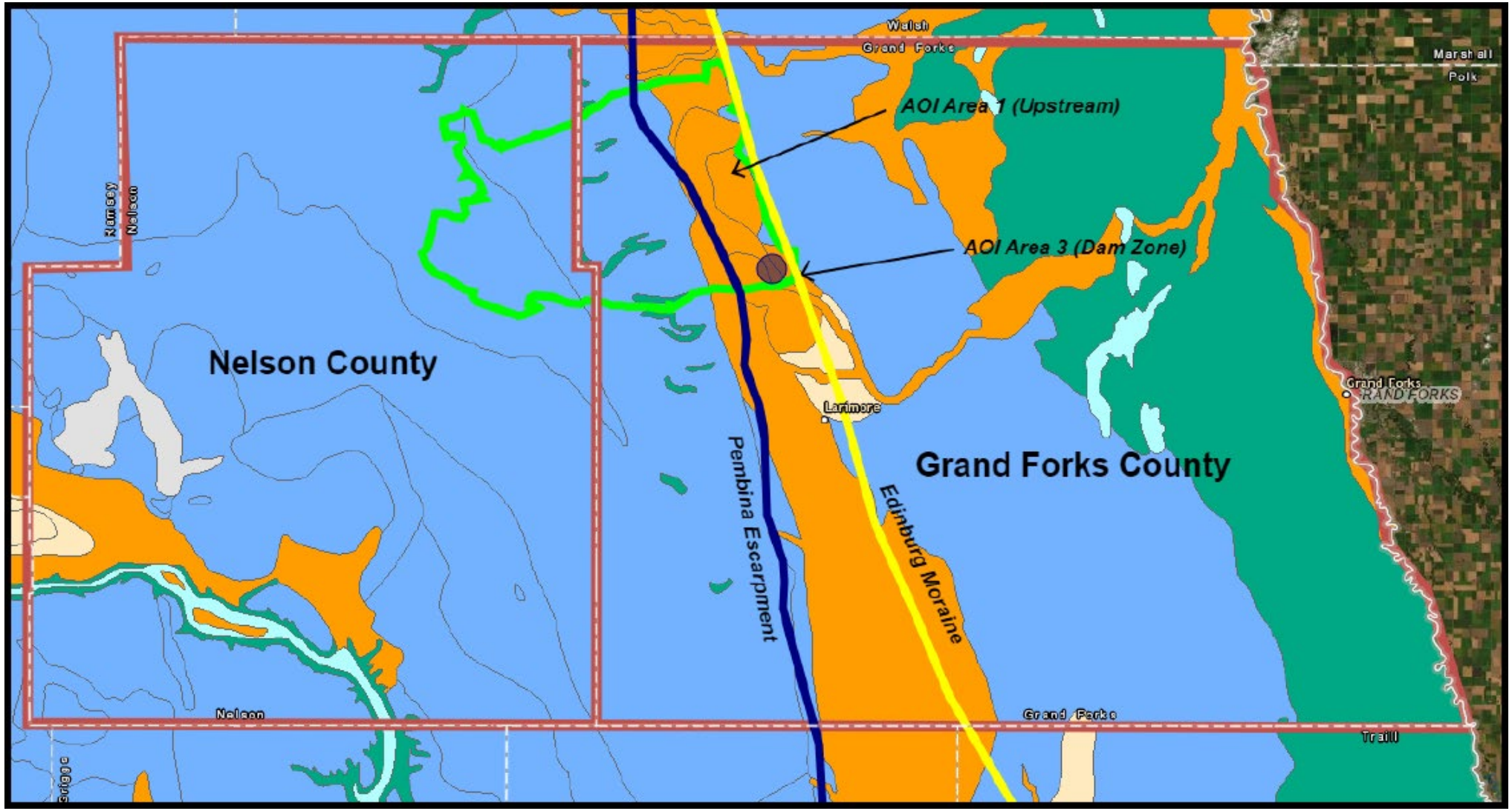


Lower Turtle River near Mekinock, 100-year inundations

- Breakout inundation noticably reduced (red)
- Within Mekinock some reductions



Geotechnical



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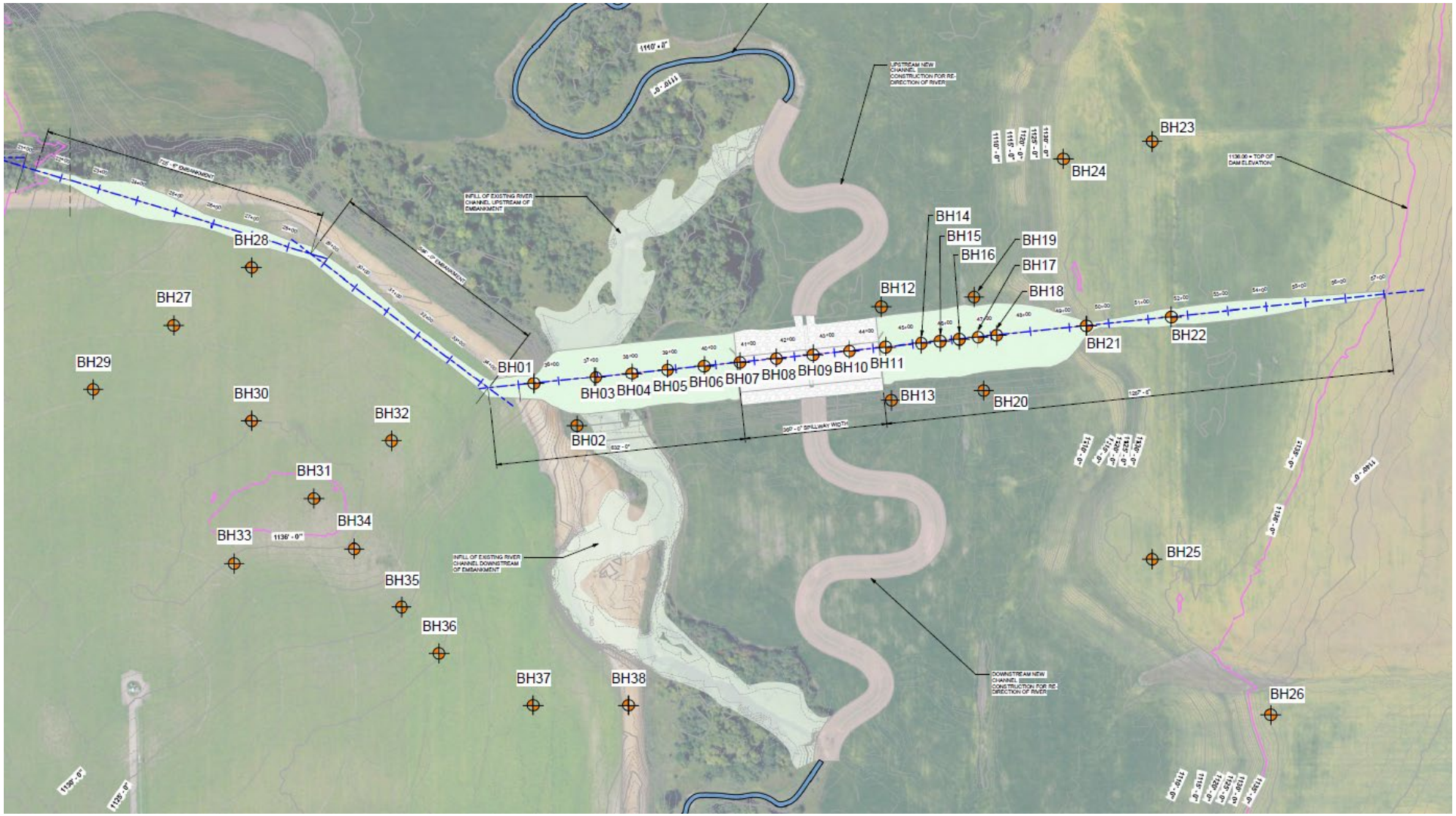

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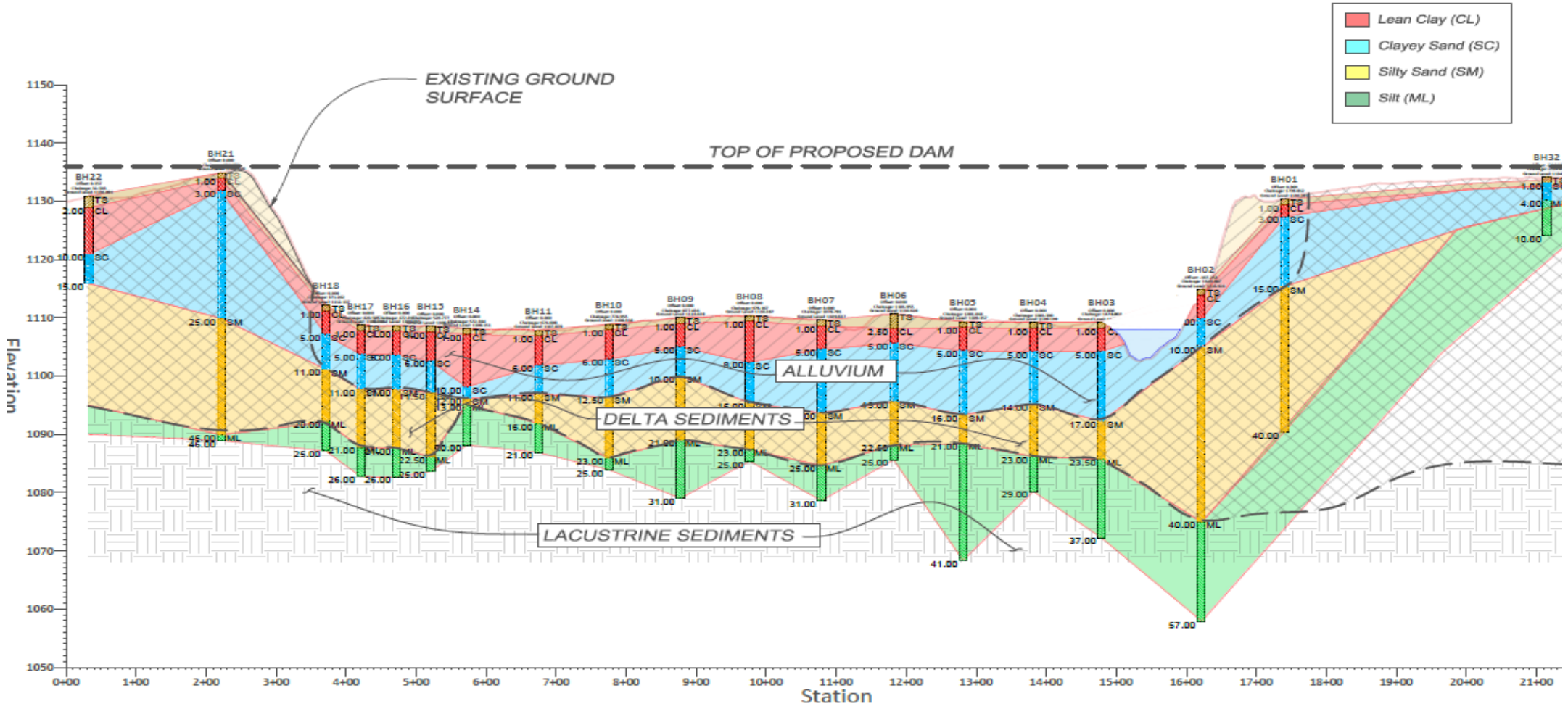
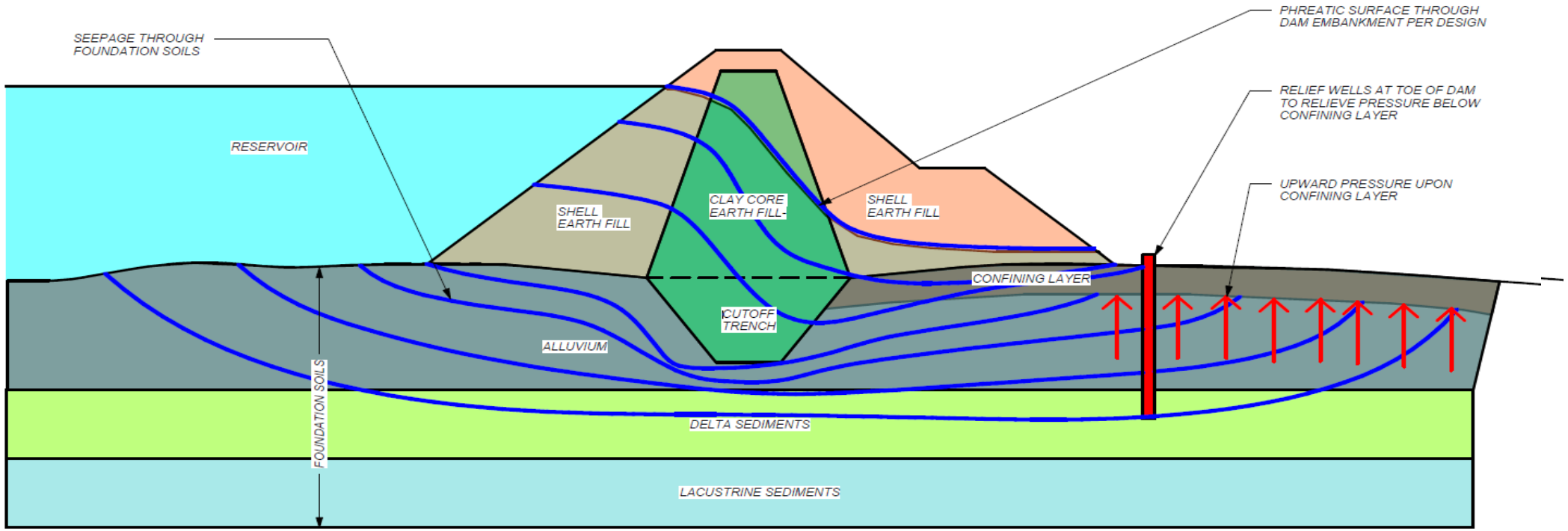


DAM CENTERLINE PROFILE VIEW
SCALE: 10V:1H

Geotechnical

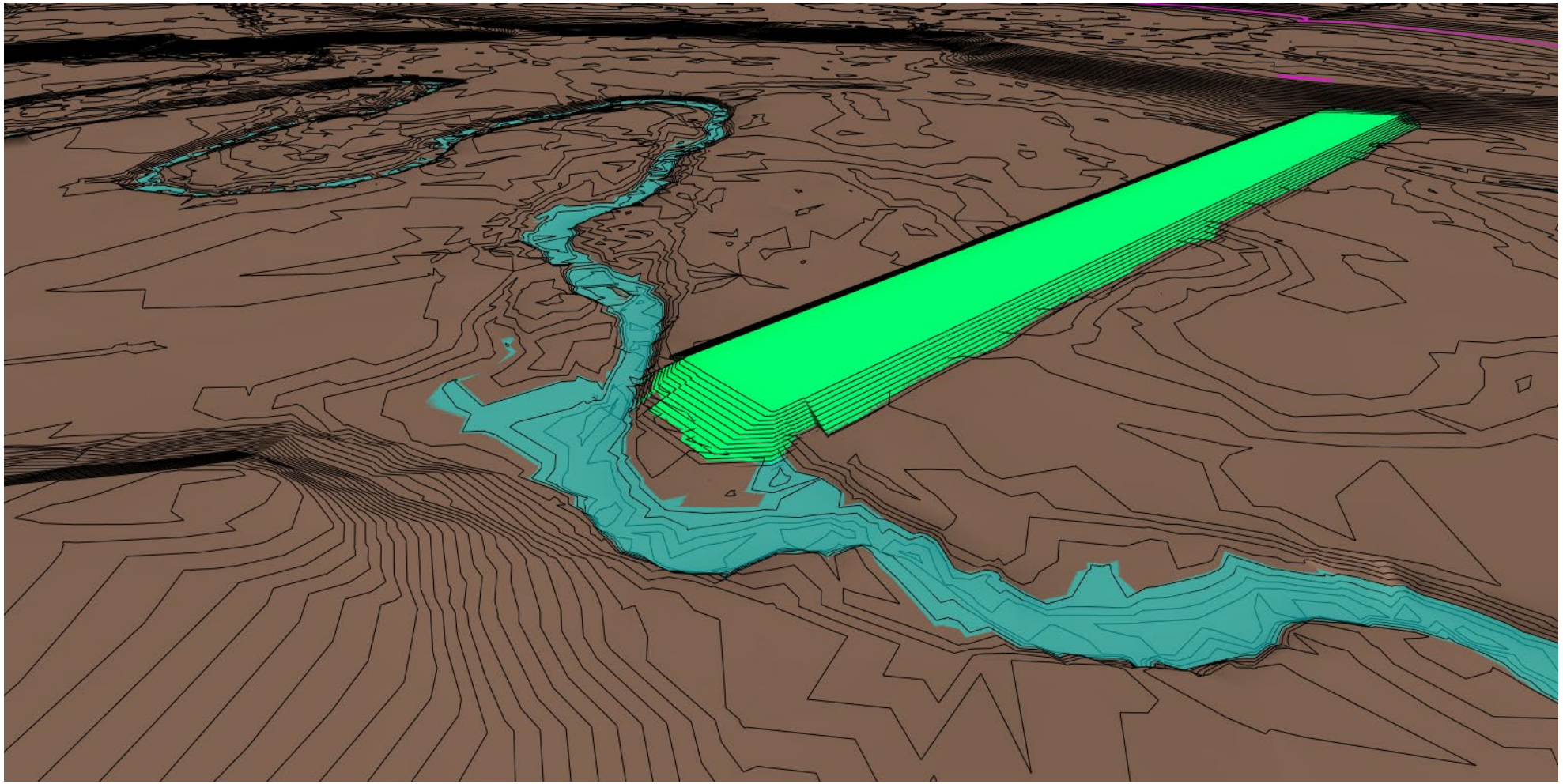
Geotechnical/ Construction Challenges with Foundation Soil

- Prone to increased consolidation - Combat with Preloading
- Clay Confinement Layer – Combat with Relief Wells
- Highly Permeable Foundation Soil – Combat with Cutoff Wall
- Historically high ground water – Combat with no Cutoff Trench



Geotechnical

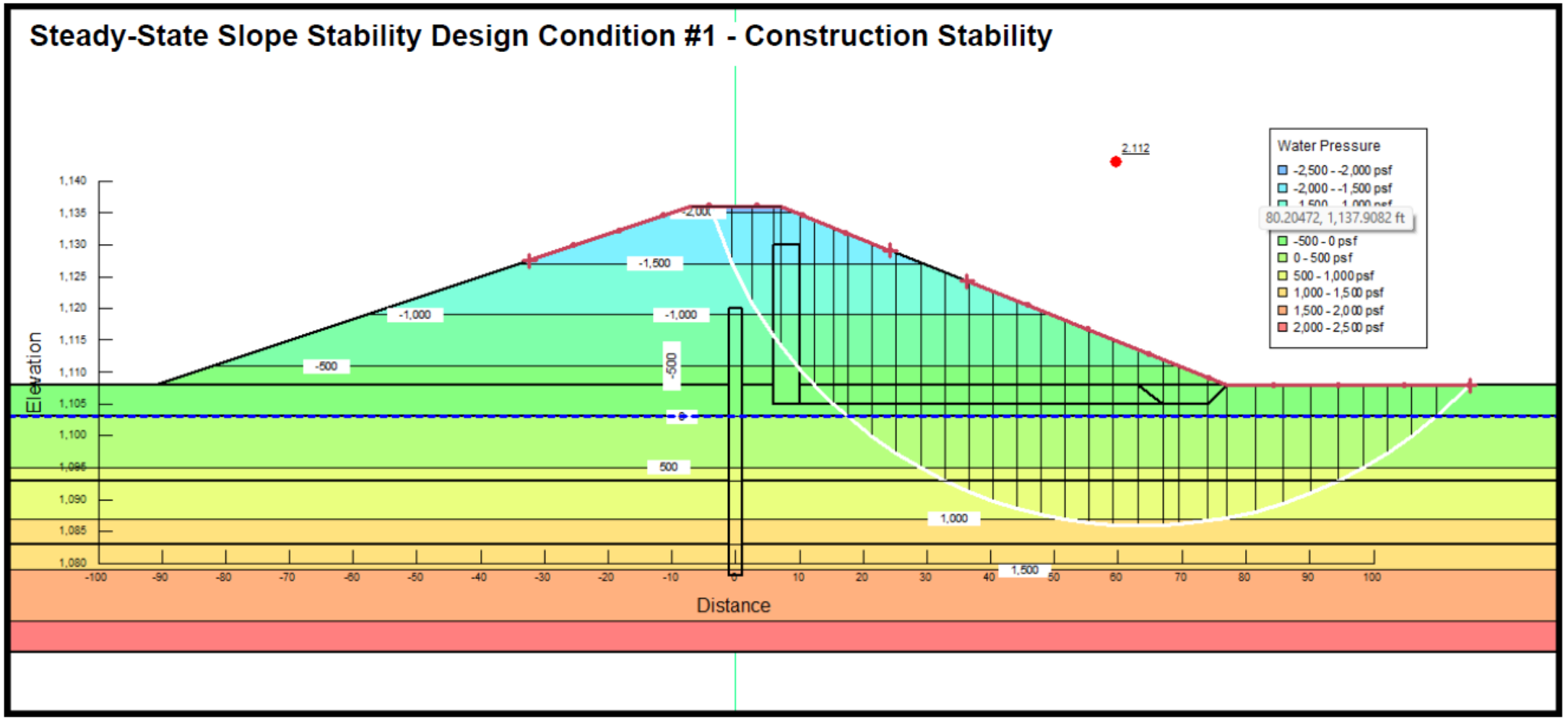
Preloading embankment



Geotechnical

Slope Stability Results			
Design Condition	**Definition**	**Required Factor of Safety**	**Design Factor of Safety**
Steady State Condition #1	Embankment Construction Stability	F.S. ≥ 1.4	F.S. = 2.11
Steady State Condition #2	Embankment Rapid Drawdown Stability	F.S. ≥ 1.2	F.S. = 2.10
Steady State Condition #4	Embankment Floor Surcharge Stability	F.S. ≥ 1.4	F.S. = 1.94
Dynamic Condition	Transient Reservoir Rise and Fall Stability	F.S. ≥ 1.4	F.S. = 2.07

Geotechnical



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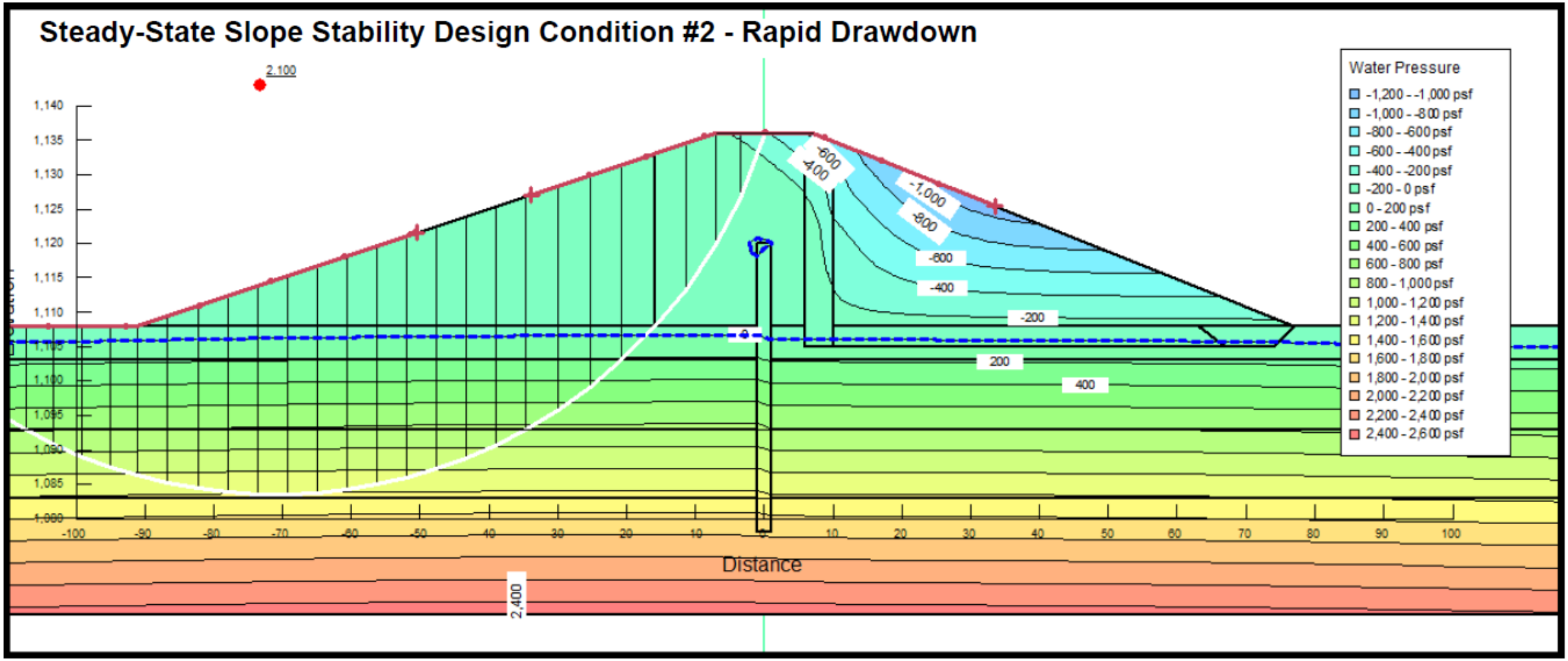

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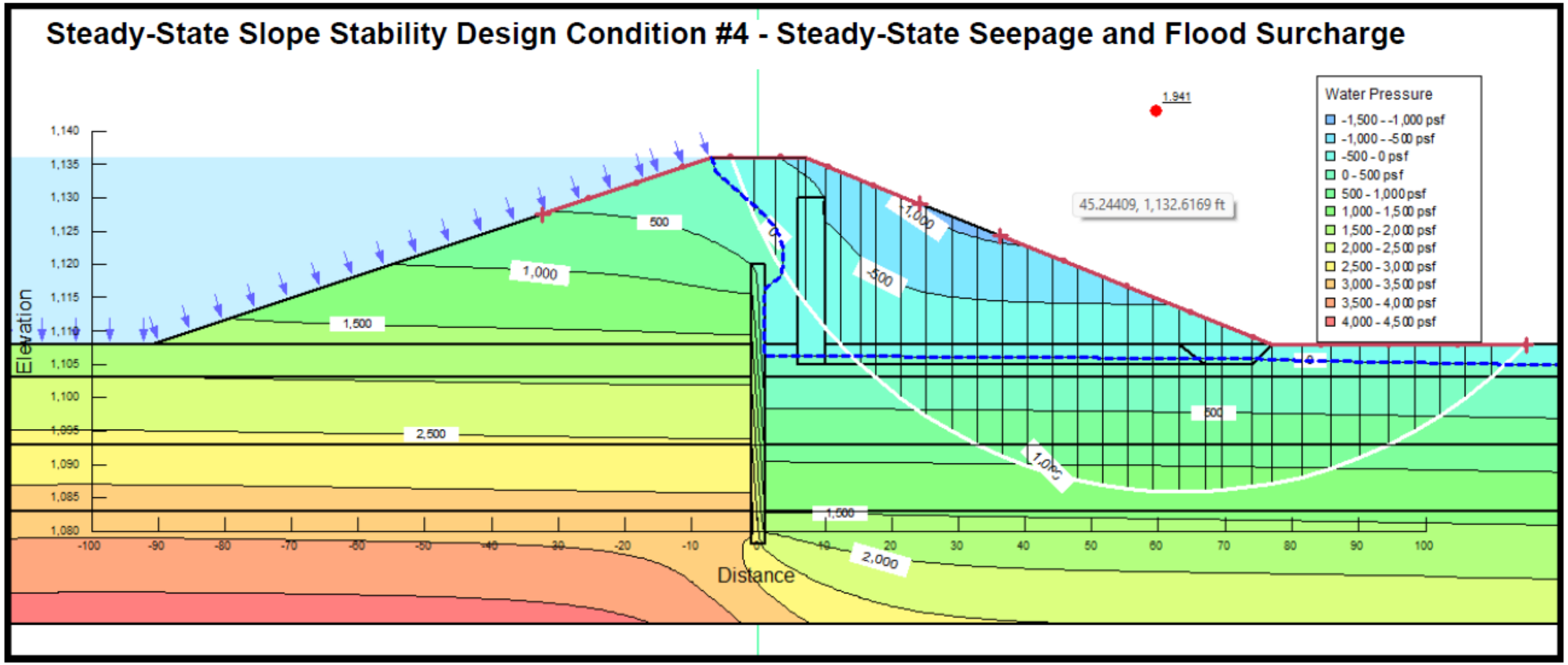

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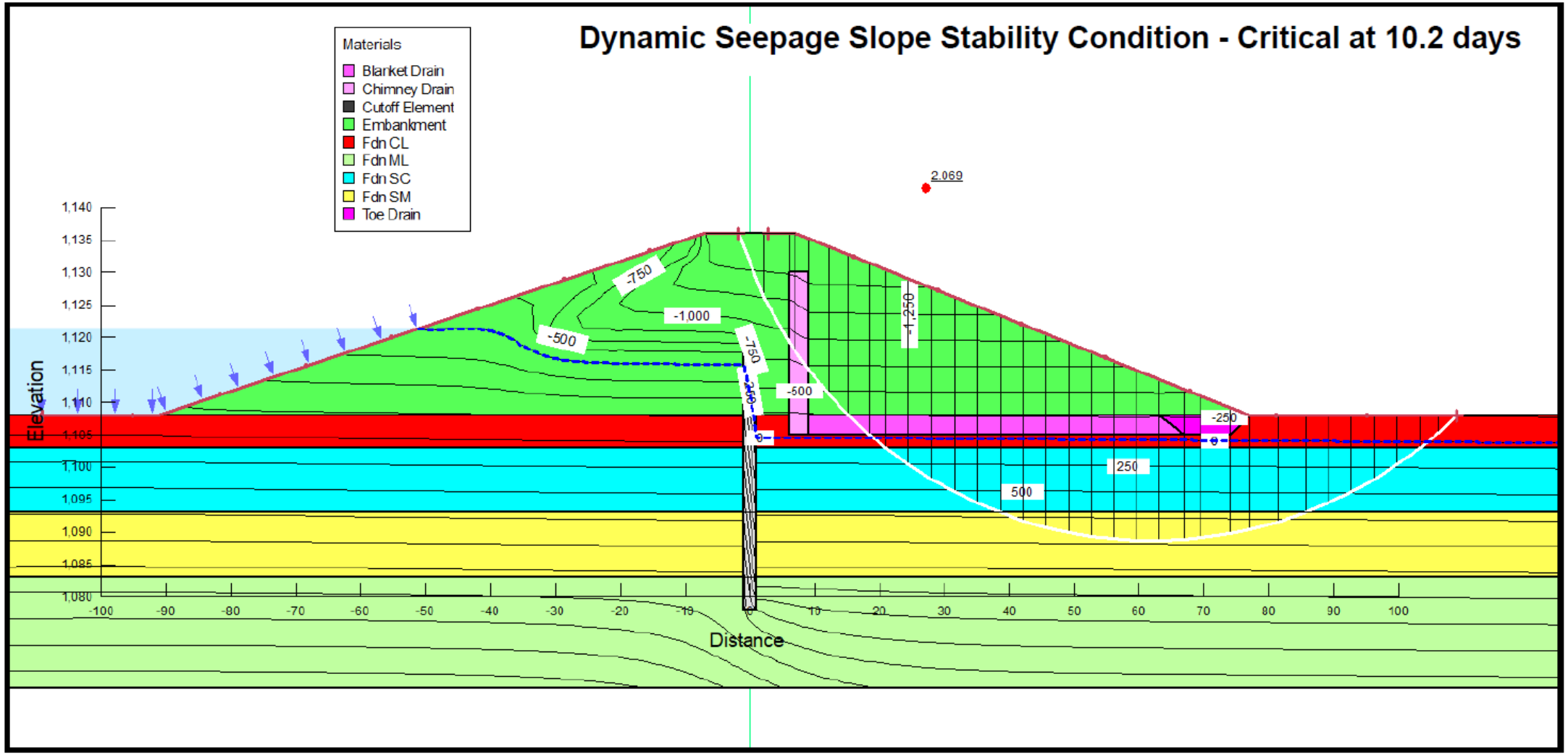
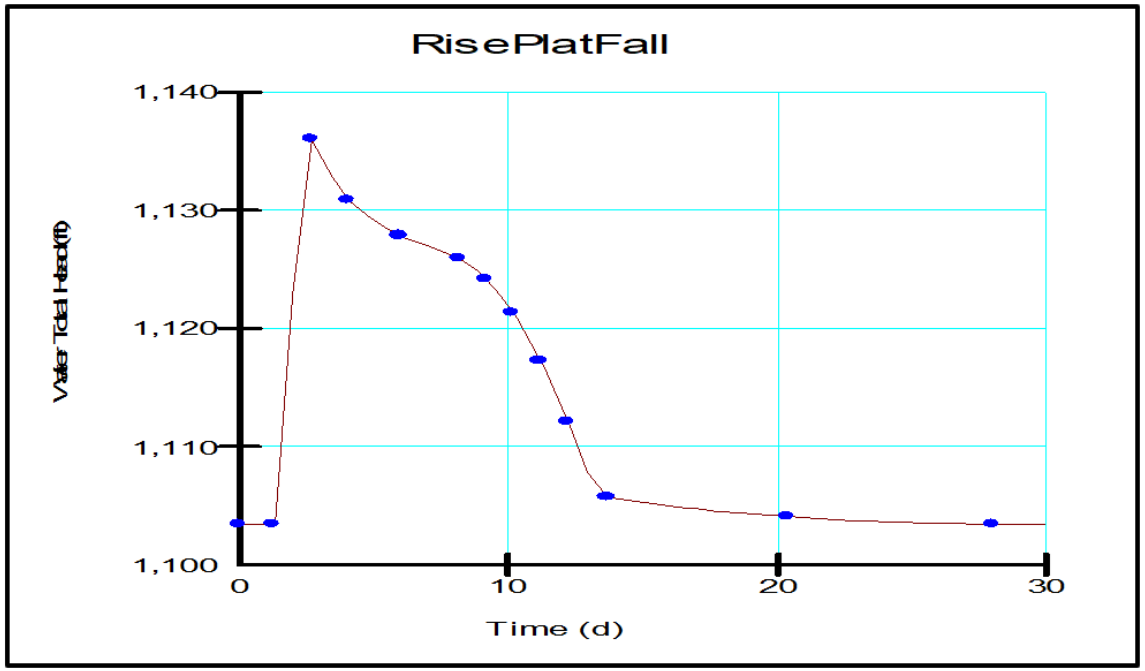


Geotechnical

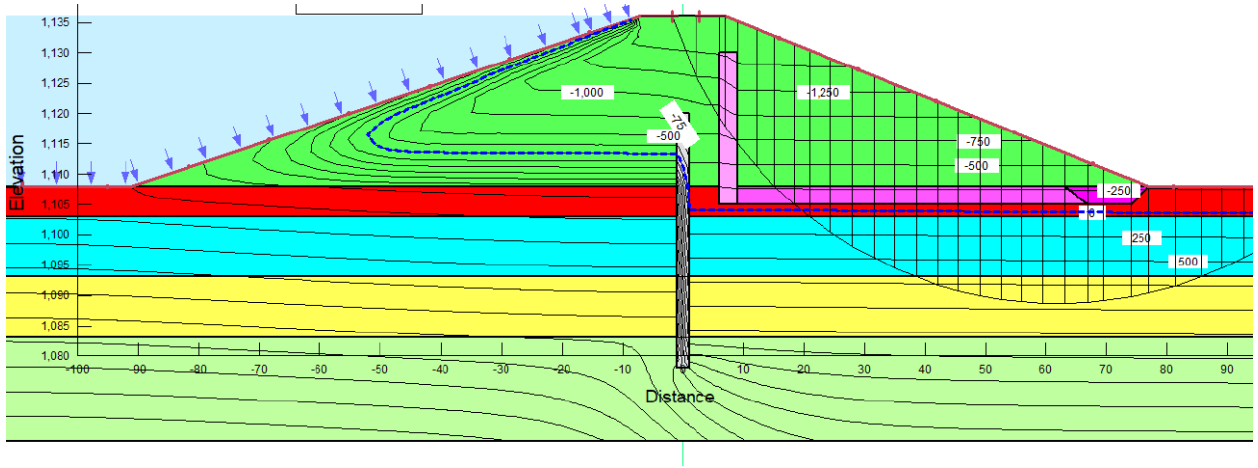
Seepage Analysis Results

Days	0	1.25	2.7	4.1	6.0	8.2	9.2	10.2	11.2	12.2	13.7	20.4	28
Elevation	1103.5	1103.5	1136.0	1130.8	1127.8	1125.9	1124.1	1121.3	1117.3	1112.1	1105.8	1104.0	1103.5

Figure 10: Water Surface Elevation vs. Time for Dynamic Seepage Analysis



Dynamic Seepage Results (ft³/ 28 days)				
Model	**Seepage Element #1 Dam Face**	**Seepage Element #2 Flood Plain**	**Seepage Element #3 Filter**	**Seepage Element #4 Foundation**
Cutoff Wall	0	3,567	6,897	4,606
No Cutoff Wall	13	38,892	107,773	51,247



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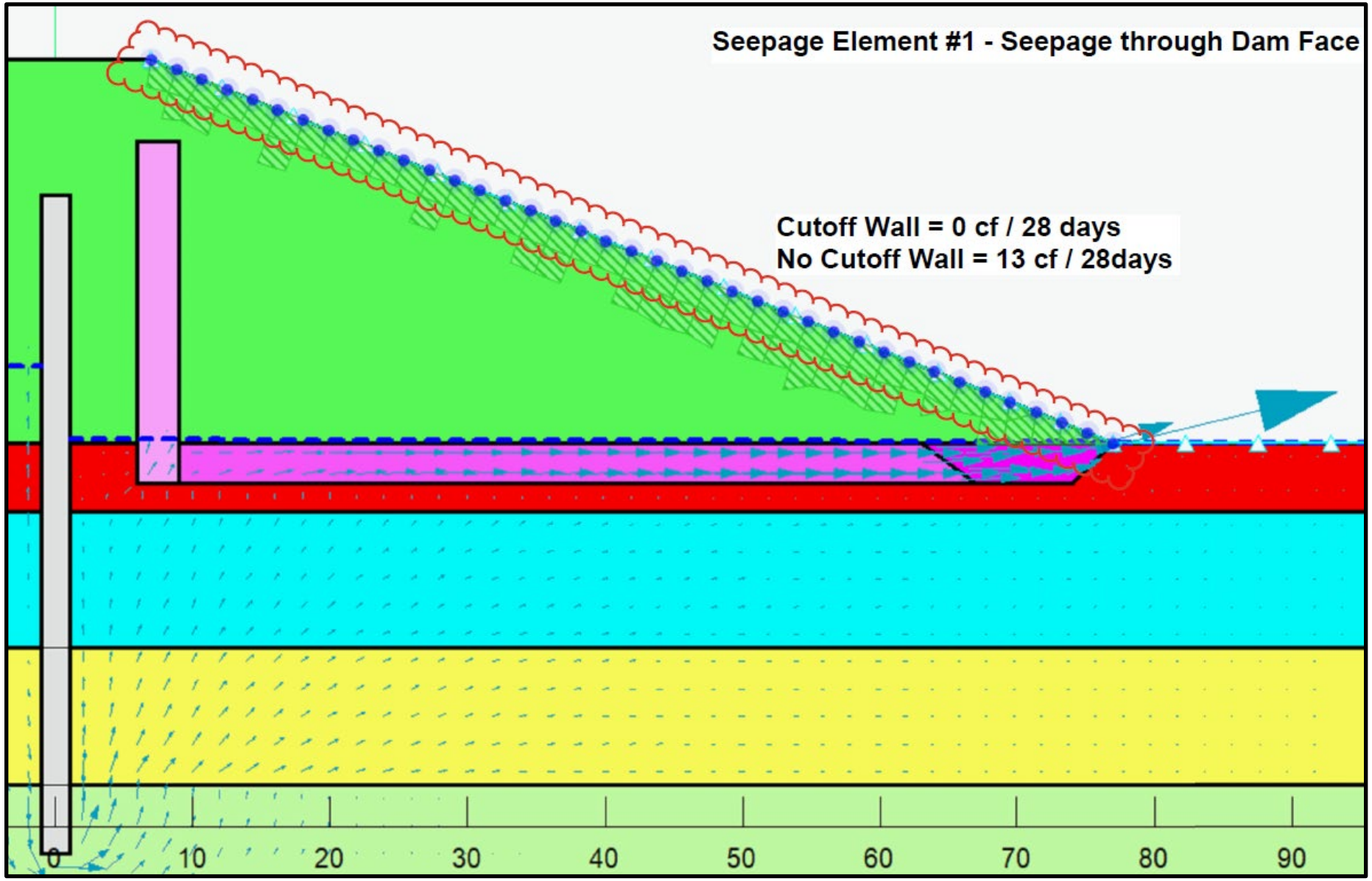

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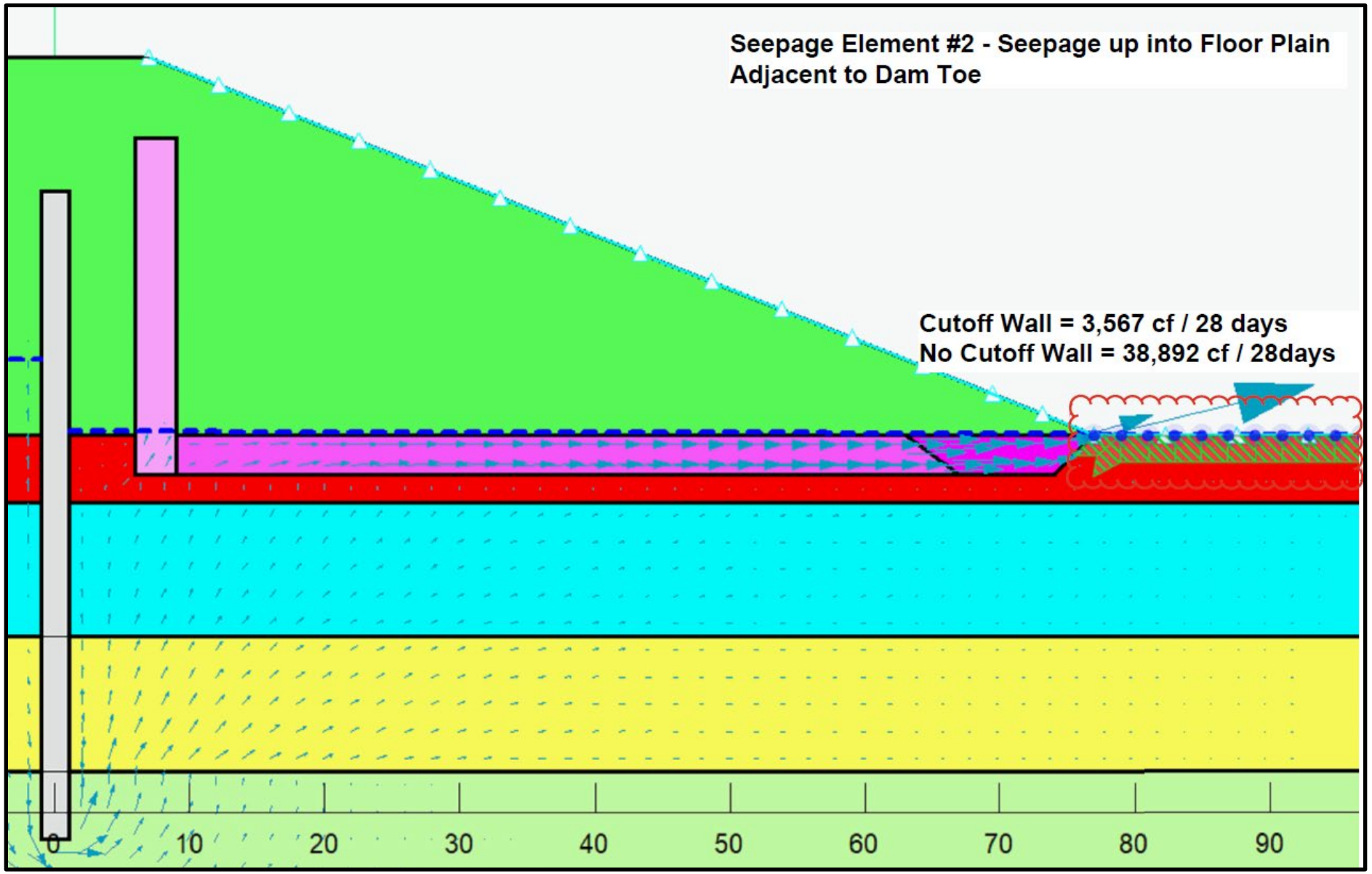

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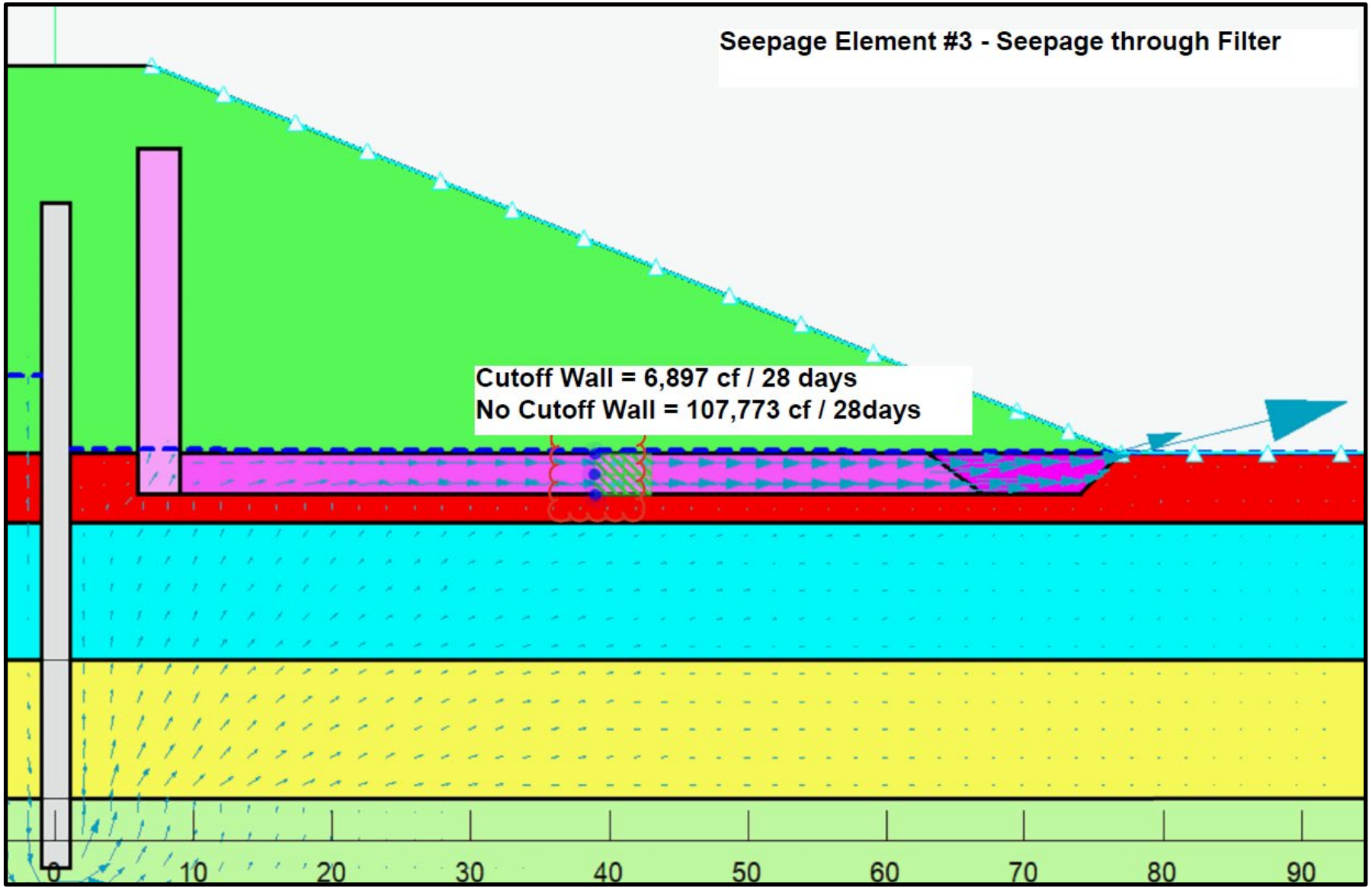

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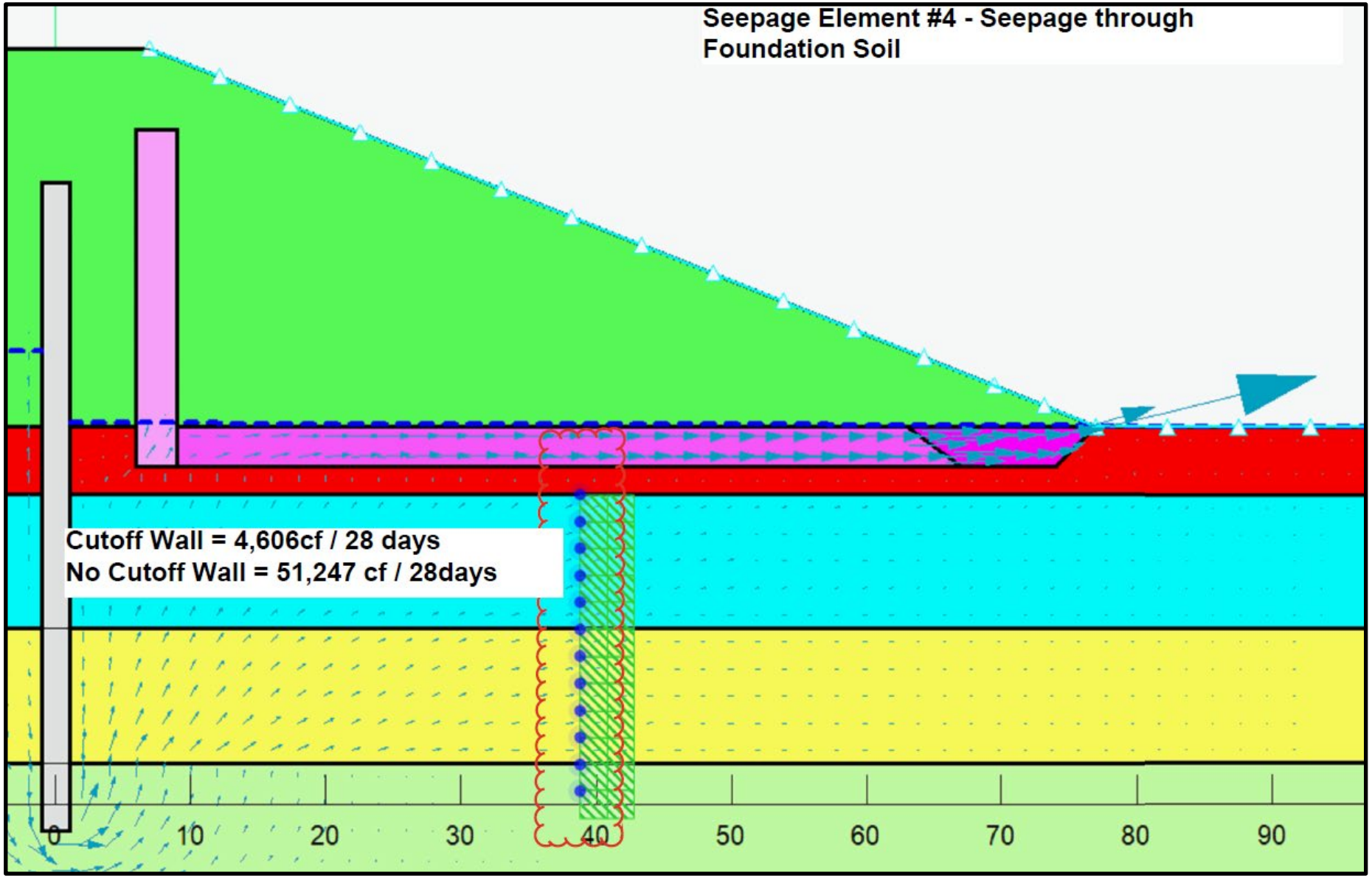
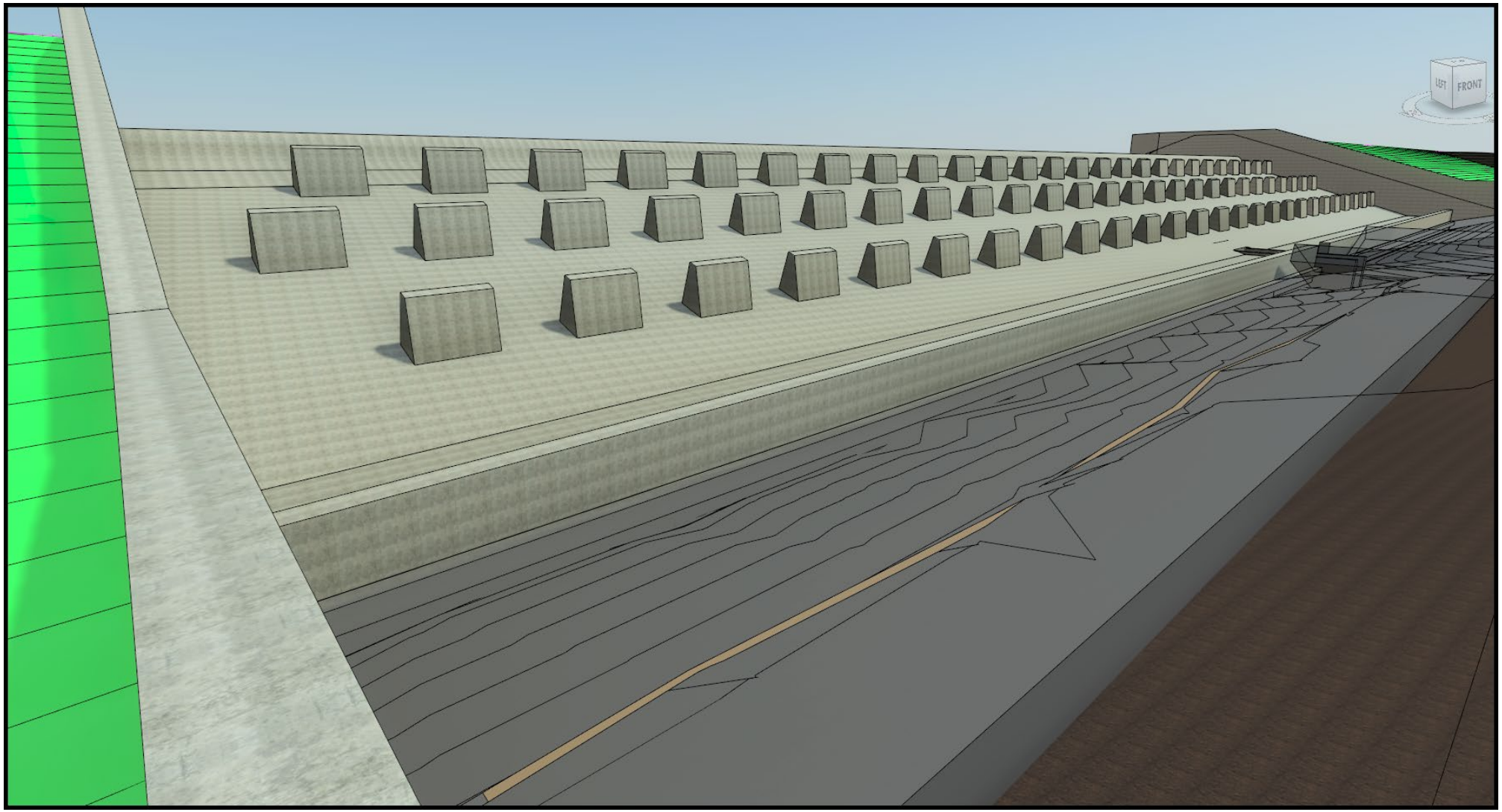
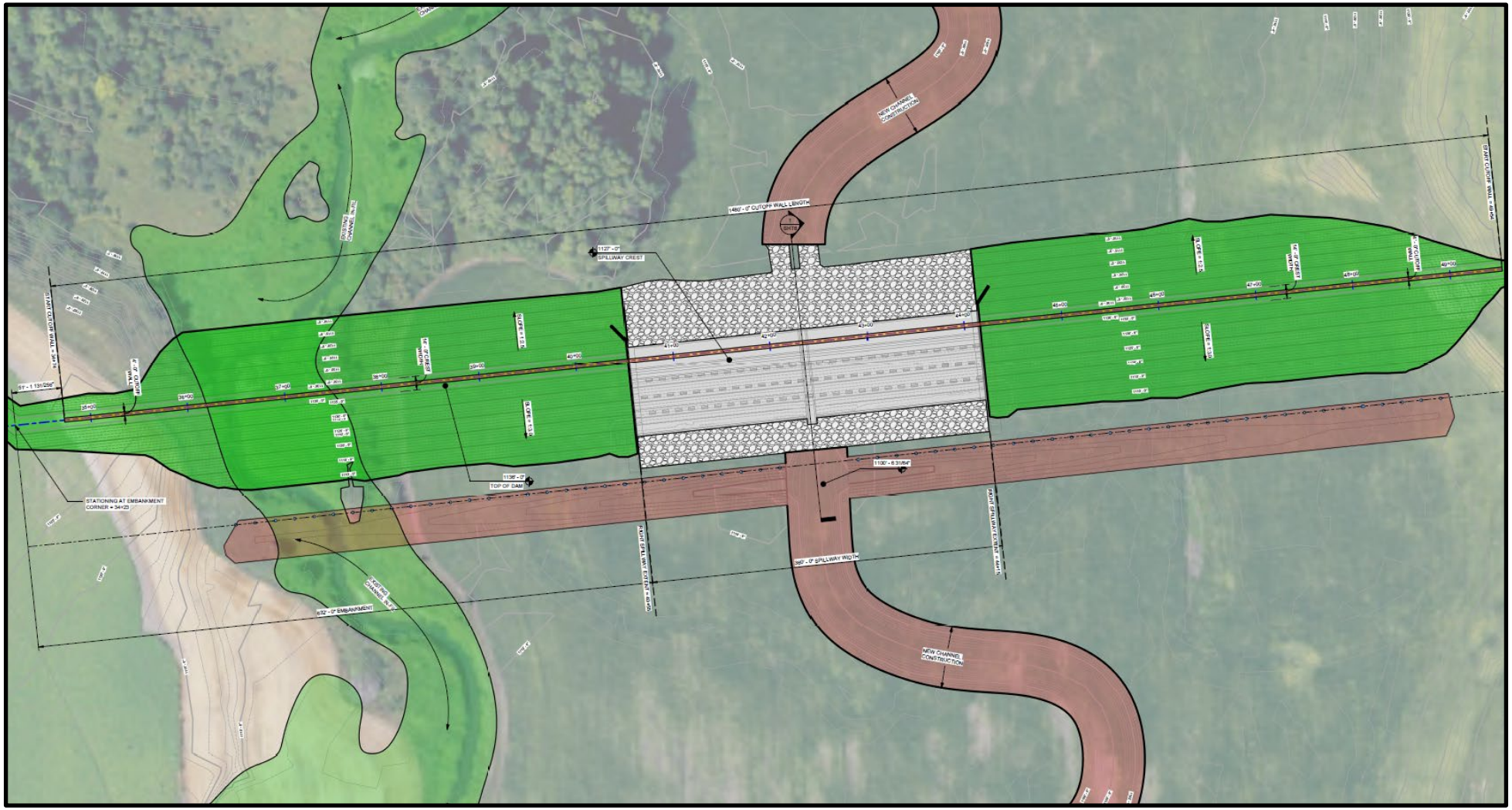


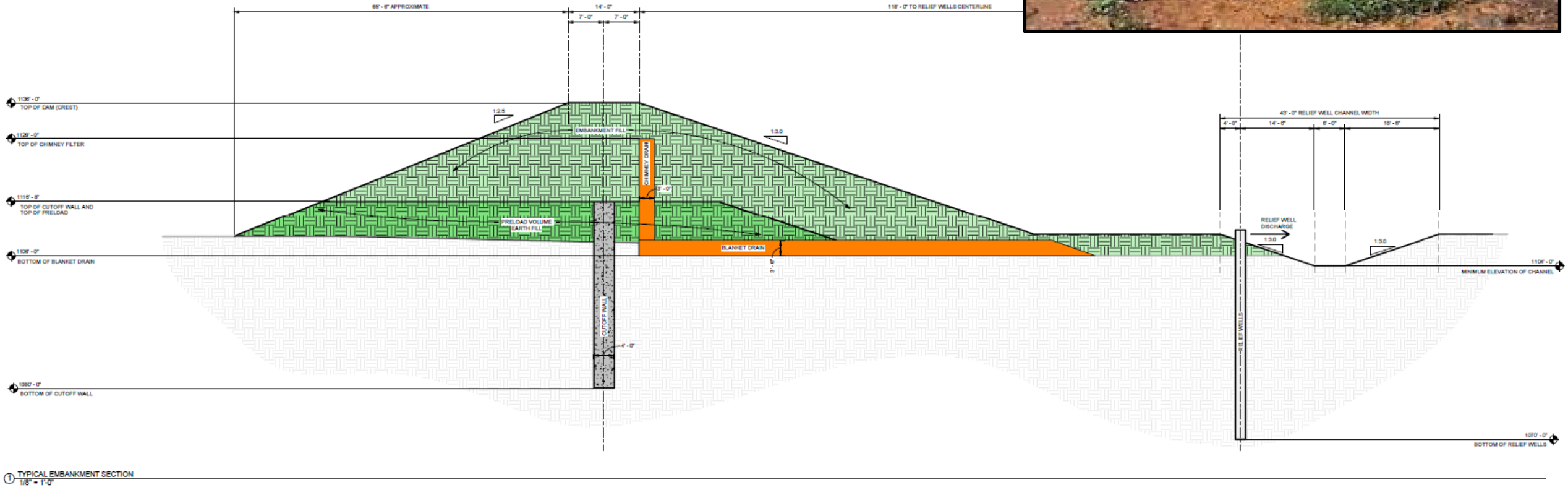
Structures



Structures

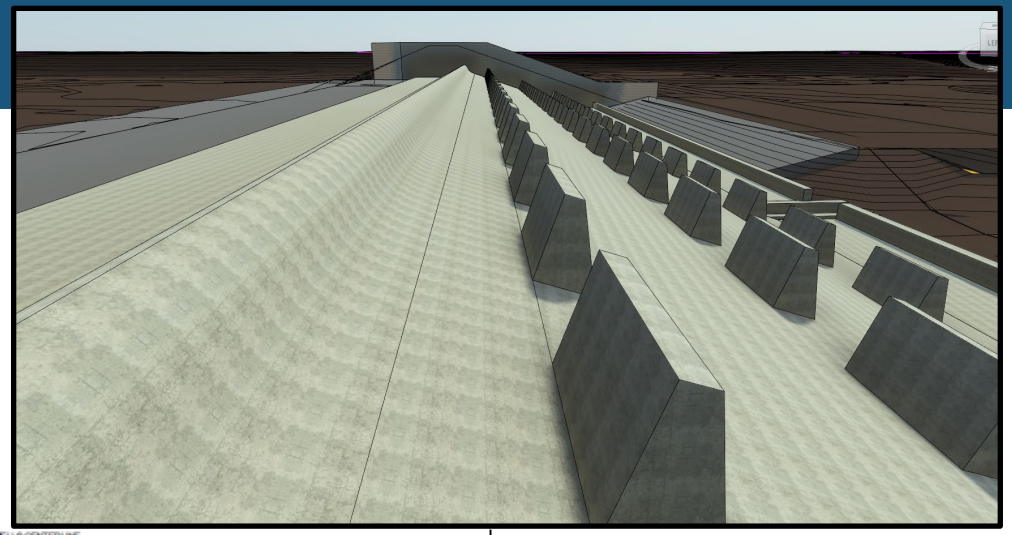

1486' - 0" CUTOFF WALL LENGTH
SPILLWAY CREST
NEW CHANNEL CONSTRUCTION
TOP OF DAM
STATIONING AT EMBANKMENT CORNER = 34+23
360' - 0" SPILLWAY WIDTH
NEW CHANNEL CONSTRUCTION

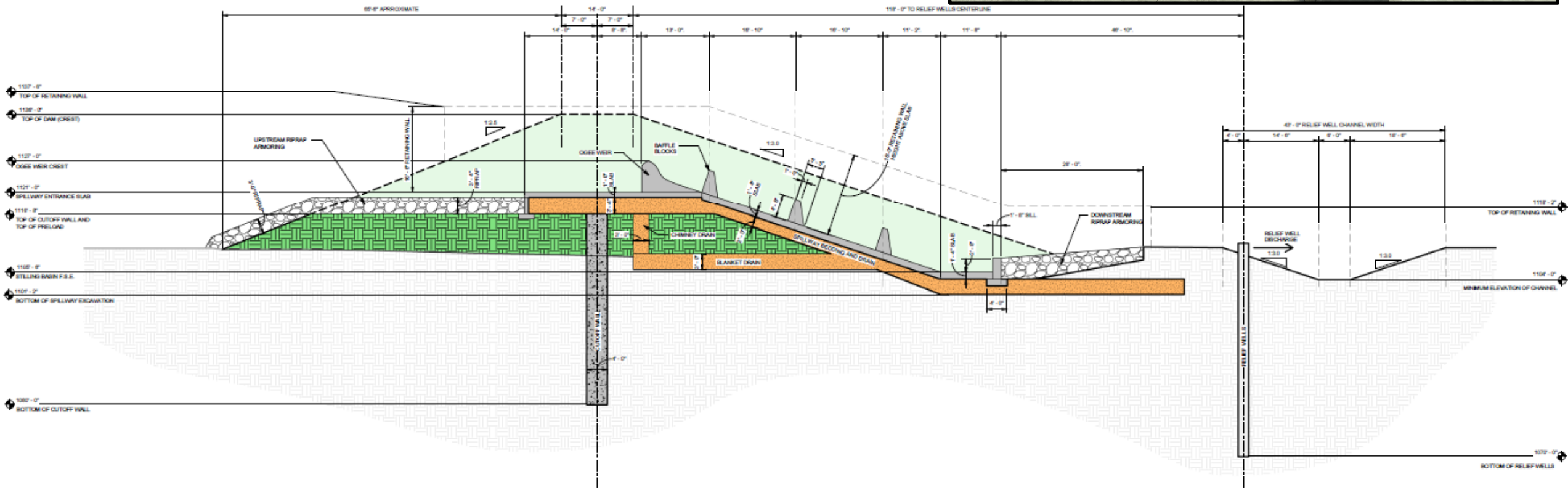
Structures



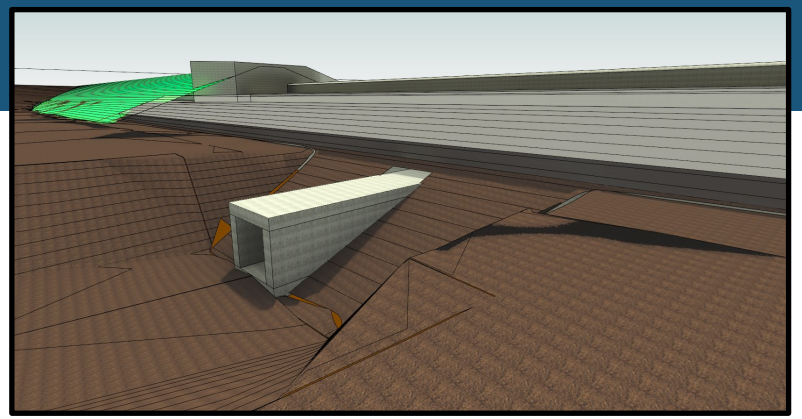
1 TYPICAL EMBANKMENT SECTION
1/8" = 1'-0"

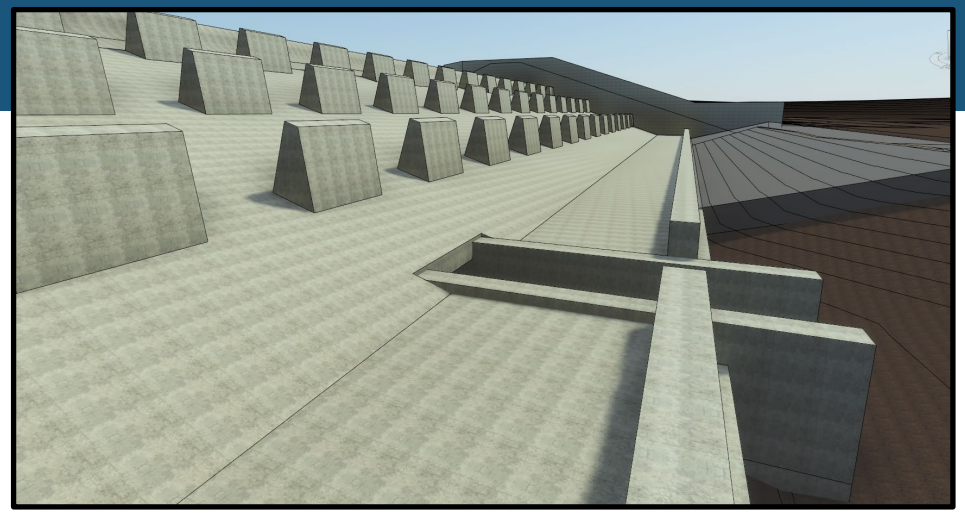
Structures

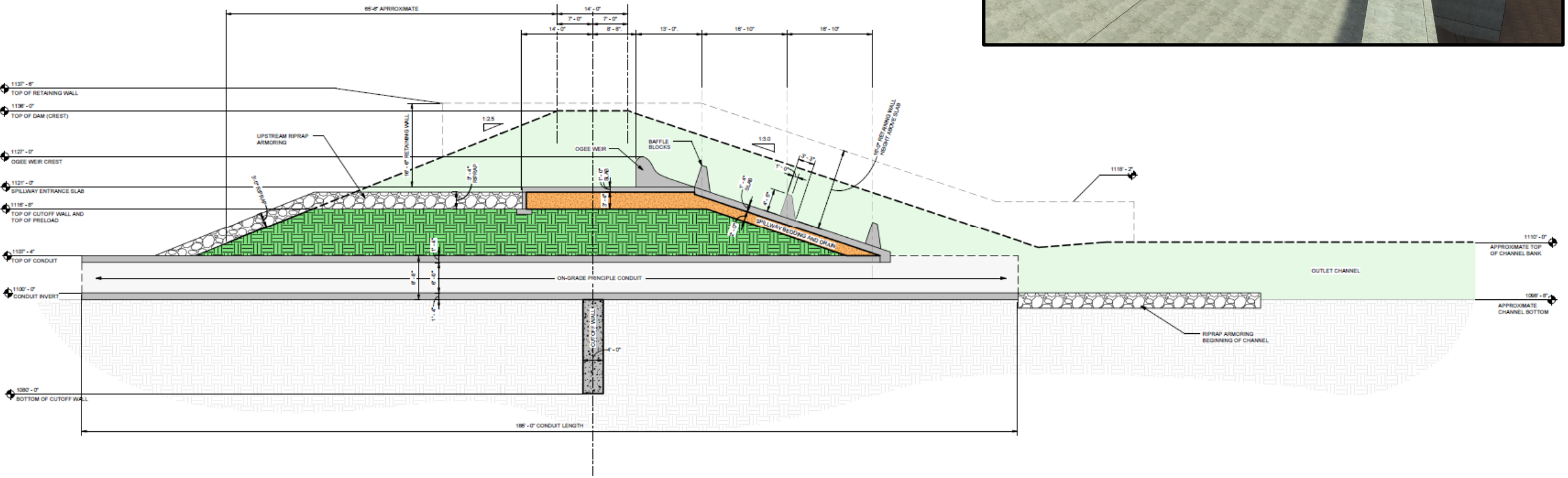



TOP OF RETAINING WALL
TOP OF DAM (CREST)
UPSTREAM RIPRAP ARMORING
OGEE WEIR
BAFFLE BLOCKS
OGEE WEIR CREST
SPILLWAY ENTRANCE SLAB
TOP OF CUTOFF WALL AND TOP OF PRELOAD
CHIMNEY DRAIN
BLANKET DRAIN
SPILLWAY BEDDING AND DRAIN
DOWNSTREAM RIPRAP ARMORING
STILLING BASIN F.S.E.
BOTTOM OF SPILLWAY EXCAVATION
CUTOFF WALL
BOTTOM OF CUTOFF WALL
RELIEF WELLS
RELIEF WELL DISCHARGE
TOP OF RETAINING WALL
MINIMUM ELEVATION OF CHANNEL
BOTTOM OF RELIEF WELLS

Structures

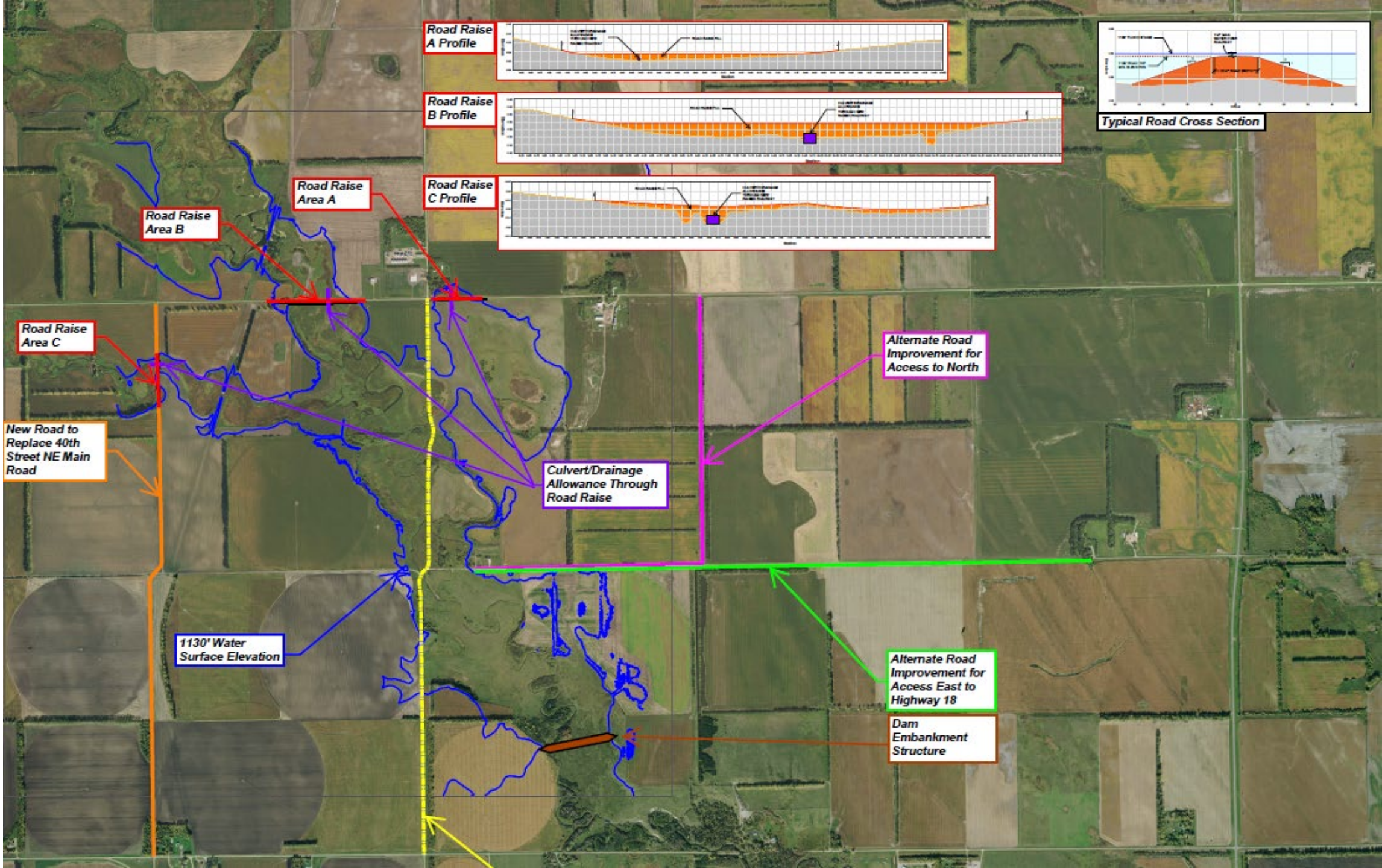






1 STRUCTURAL SPILLWAY SECTION AT CONDUIT
1/8" = 1'-0"

Roads

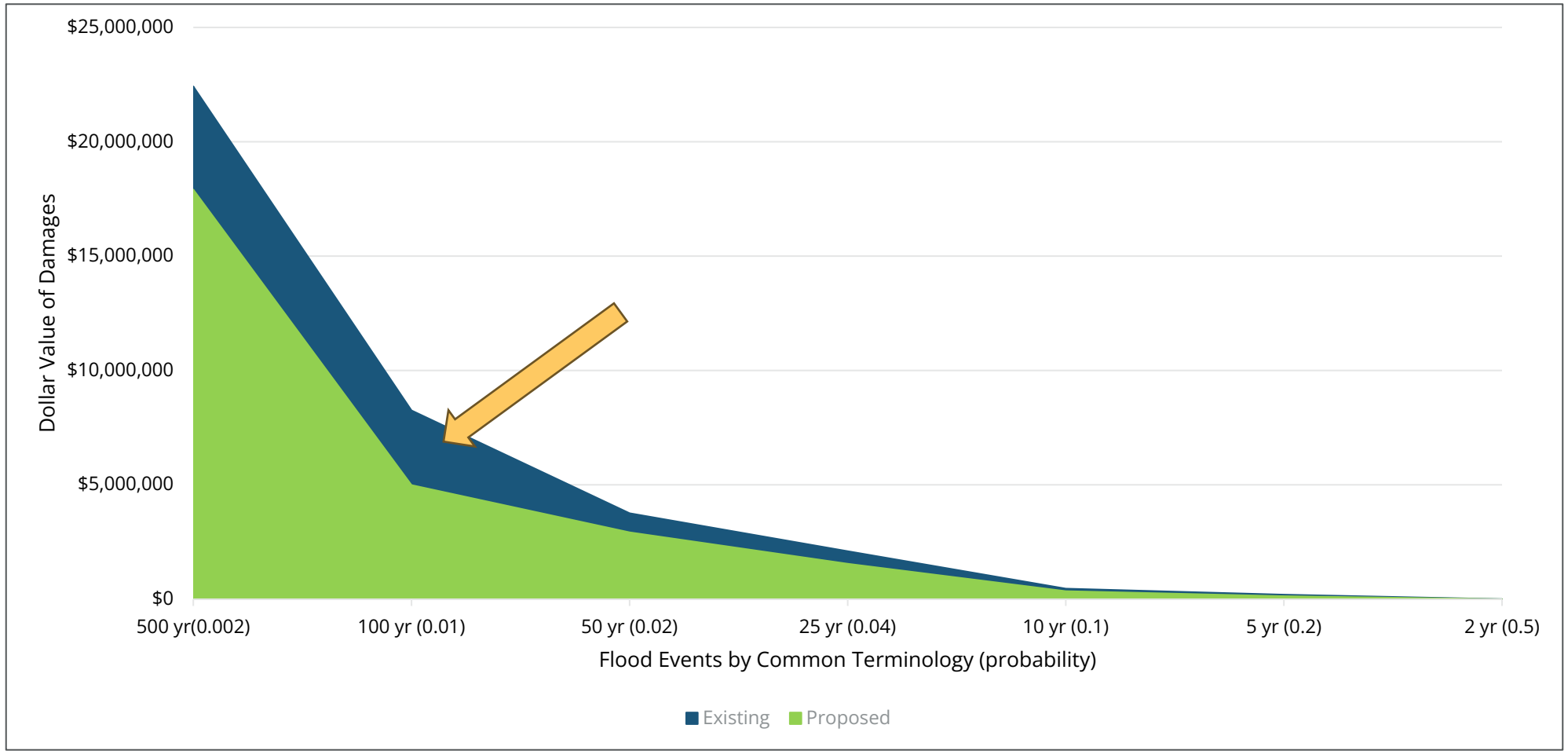

Road Raise A Profile
Road Raise B Profile
Road Raise C Profile
Typical Road Cross Section
Road Raise Area A
Road Raise Area B
Road Raise Area C
New Road to Replace 40th Street NE Main Road
Culvert/Drainage Allowance Through Road Raise
Alternate Road Improvement for Access to North
1130' Water Surface Elevation
Alternate Road Improvement for Access East to Highway 18
Dam Embankment Structure

Outline

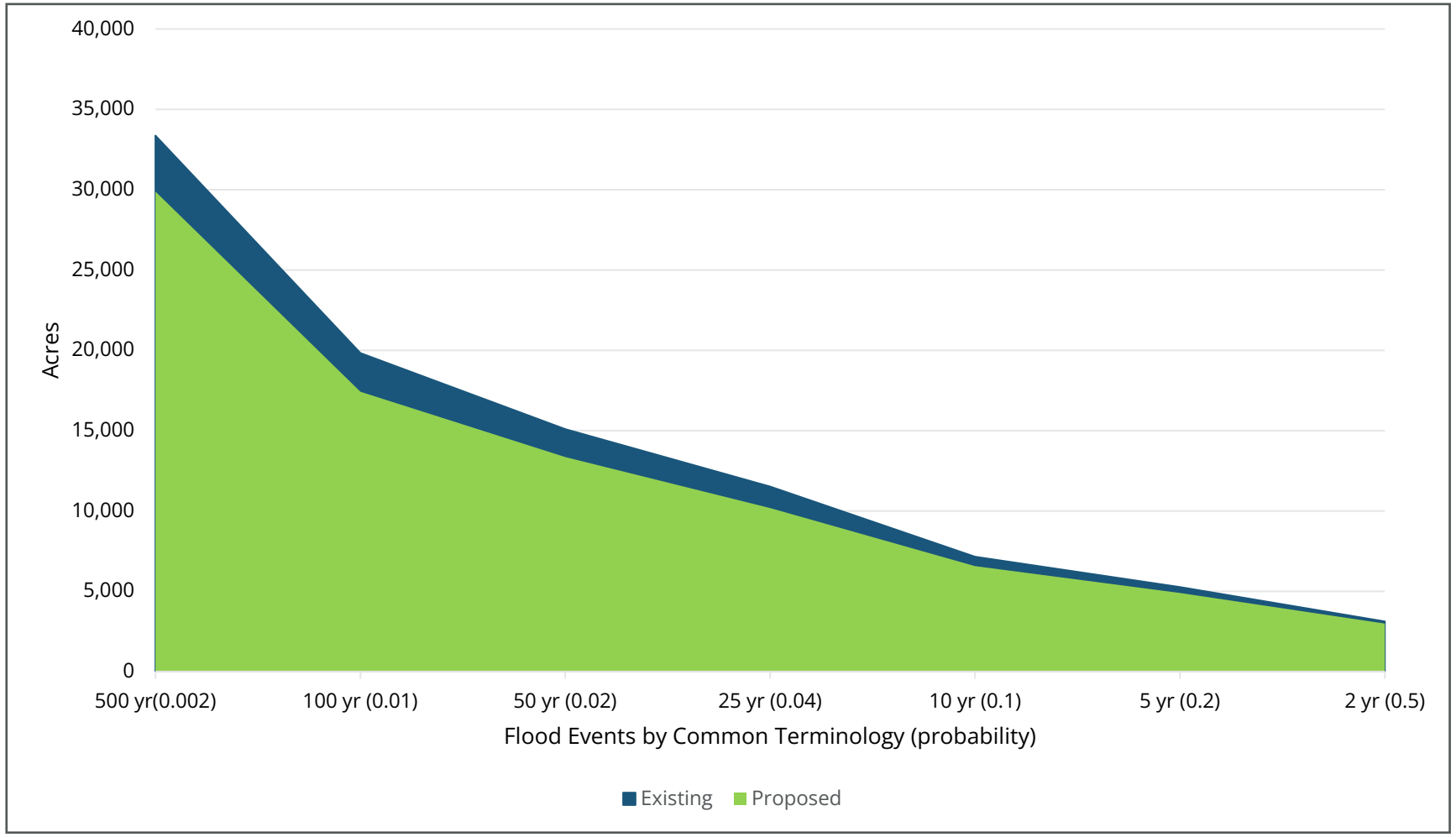
- Benefits
- Overview and visualization
- Crop damage considerations
- Summary

Economic Analysis

Frequency Damage Curve for Structures and Vehicles, existing condition



Inundated Acreage by Flood Magnitude, all crops



Decrease in Inundated Acres	
Flood Event (probability)	Acreage Change
2 yrs (0.5)	132
5 yrs (0.2)	366
10 yrs (0.1)	578
25 yrs (0.04)	1,327
50 yrs (0.02)	1,733
100 yrs (0.01)	2,405
500 yrs (0.002)	3,485

Considerations for Crop Damage Calculation

Damage Categories

- Land rehabilitation
  - Acreage, whether within or outside of growing season
- Delayed plant
  - Percent planted, late plant yield loss
- Planted, outside of replant window
  - Crop damage factors
- Planted, within replant window
  - Comparison of replant threshold with crop damage factors
  - Offsetting revenue

Considerations for Crop Damage Calculation

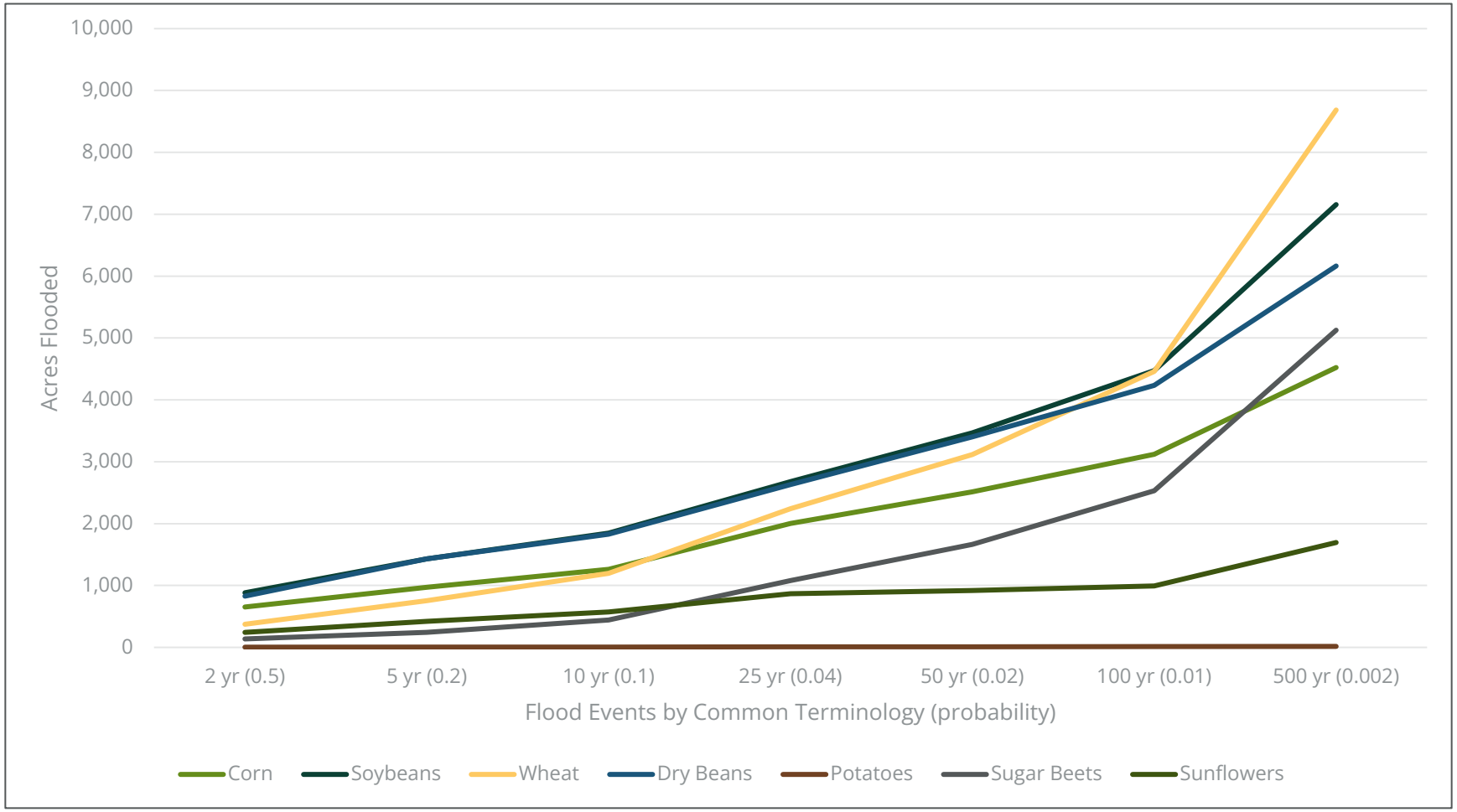
Crop Considerations

- Seed and planting costs for replant
- Harvest, drying, and hauling costs
- Crop damage factors
- Late plant yield loss

Data

- Flood inundation and duration acreage, 2020 CDL, enhanced
- National Agricultural Statistics Service (NASS), Economic Research Service (ERS)
- Historical distribution of flood events by month
- Annual exceedance probability of flood events by severity

Affected Acres by Crop and Flood Magnitude, Existing Condition



Crop Yield and Price Values

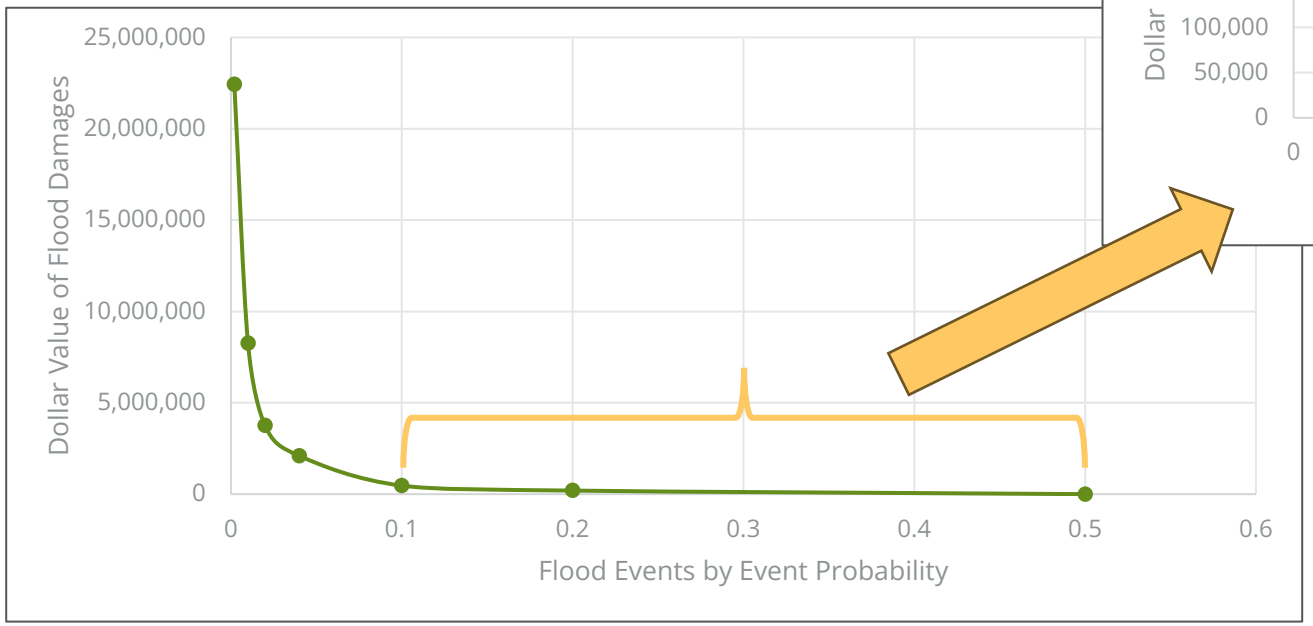
Crop (units)	ND statewide yield	County-level yield
Corn (bu)	131.60	142.52
Soybeans (bu)	32.20	34.10
Wheat (bu)	46.10	54.71
Dry Beans (cwt)	15.32	17.01
Potatoes (cwt)	320.00	NA
Sugar Beets (ton)	27.00	NA
Sunflowers (cwt)	17.30	19.90

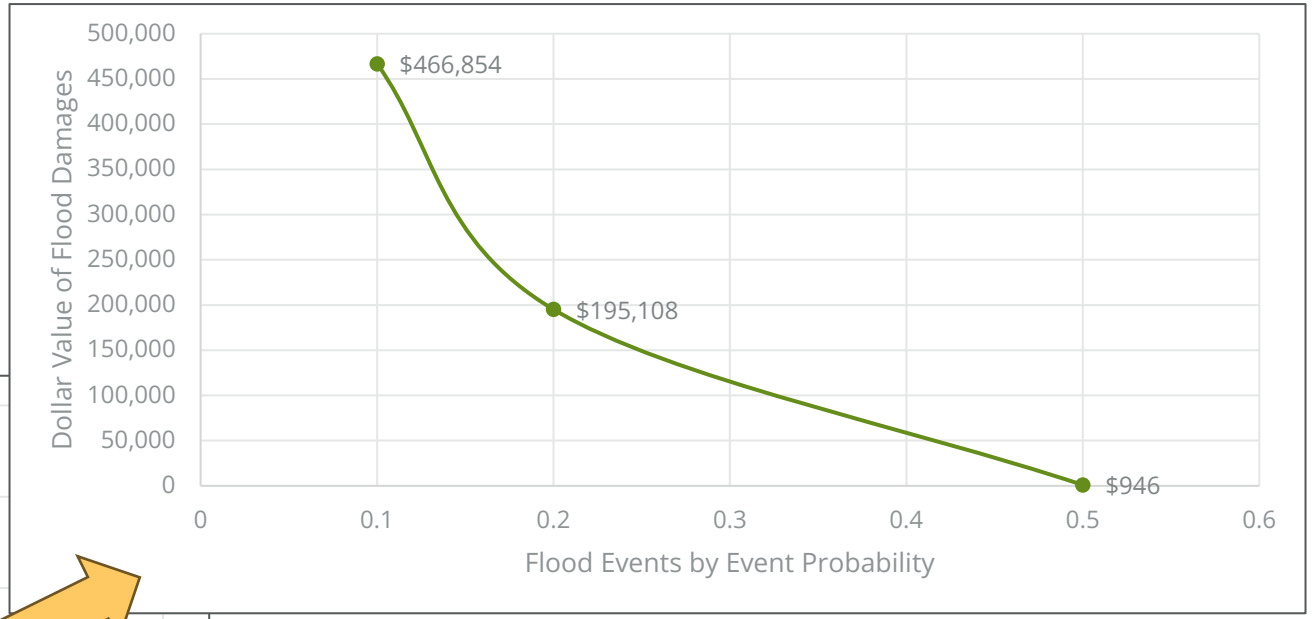
	Corn	Soybeans	Wheat	Dry Beans	Potatoes	Sugar Beets	Sunflowers
Units	bu	bu	bu	cwt	cwt	tons	cwt
Yield (units per acre)	142.52	34.10	54.71	17.01	320.00	27.00	19.90
Price per unit	$4.67	$10.55	$6.80	$31.50	$11.42	$53.09	$23.22
Revenue per acre	$665.57	$359.76	$372.03	$535.82	$3,654.40	$1,433.43	$462.08

Cost Factors

	Corn (bu)	Soybeans (bu)	Wheat (bu)	Dry Beans (cwt)	Potatoes (cwt)	Sugar Beets (ton)	Sunflowers (cwt)
Replant Cost Factors ($/acre)							
Seed	$94.50	$65.80	$30.00	$86.63	NA	$277.44	$41.04
Planting	$22.96	$21.02	$22.79	$27.24	NA	$24.60	$23.60
Avoided Cost Factors							
Harvest Cost	$44.30	$40.29	$12.61	$46.53	$126.11	$78.82	$40.54
Additional Post-Harvest Costs	$0.20	$0.00	$0.00	$0.00	$1.19	$0.00	$0.40
Hauling Cost	$0.21	$0.21	$0.23	$0.79	$0.39	$3.53	$0.59

Frequency Damage Curve for Structures and Vehicles, existing condition





Estimated Flood Damage Reduction Benefits

Item	Expected Annual Damages		Damage Reduction Benefits
	Existing	Proposed	
Structures and Vehicles	$425,532	$313,015	$112,516
Agricultural	$790,305	$753,371	$36,934
Roadways	$132,260	$110,189	$22,071
NFIP Savings			$3,776
Total	$1,348,097	$1,176,575	$175,297

Potential Cost Breakdown

Item	Estimated Cost
Dam Construction	$11,676,800
Road & Bridge Construction	$795,400
Engineering	$1,300,000
Relocation	$300,000
Fee Title Property	$18,900
Flowage Easements	$7,543,200
Construction Easements	$11,000
Contract Admin, Legal	$310,000
Total	$21,955,300

*** conservative – 100% land value to top of dam**

Fee Title (10 ac) & Flowage Easements (2,651 ac)

$5,531 / ac irrigated cropland

$3,531 / ac non-irrigated cropland

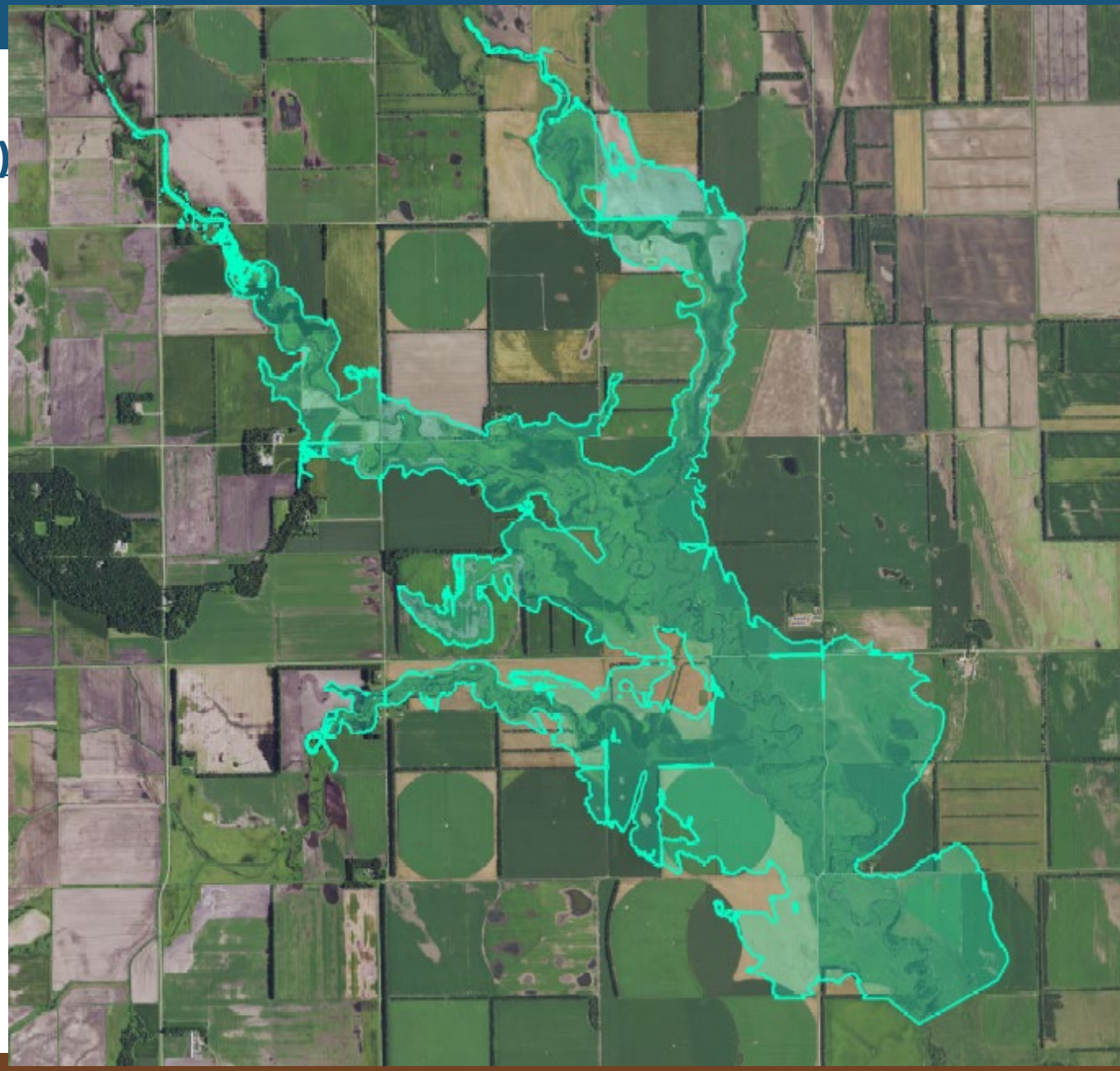
$1,938 / ac pastureland, natural lands

Construction Easements (117 ac)

$91.20 / ac / yr cropland

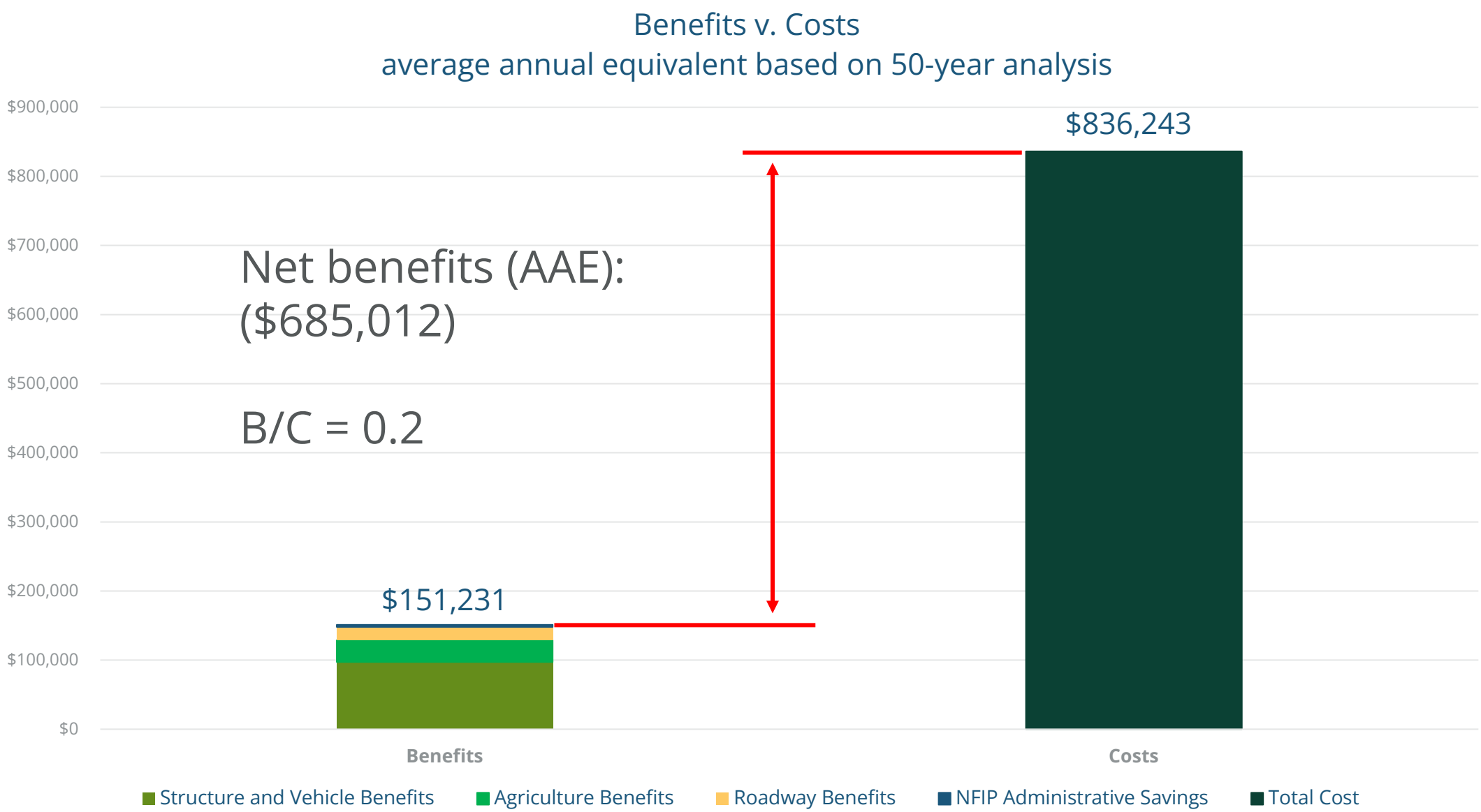
$22.50 / ac / yr pastureland, natural lands

Note: this is higher than typical flowage easements costs



Potential Funding Sources

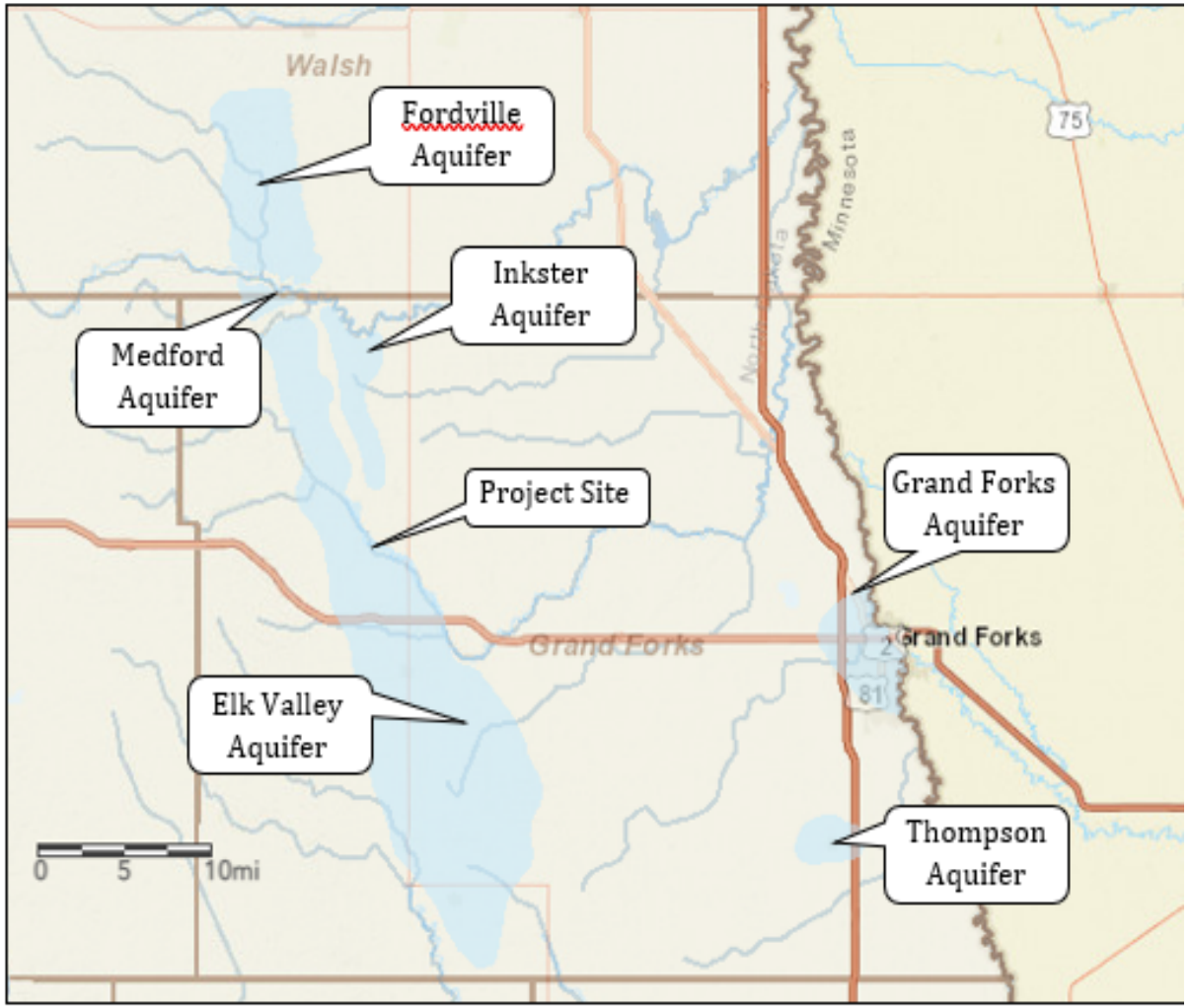
Item	Estimated Cost	NRCS	ND DWR	RRJWRD	GF WRD
Engineering	$ 1,300,000	$ 1,300,000	$ 0	$ 0	$ 0
Land Rights	$ 7,573,100	$ 0	$ 4,543,800	$ 1,969,000	$ 1,060,200
Relocation	$ 300,000	$ 0	$ 0	$ 0	$ 0
Construction	$ 12,472,200	$ 12,472,100	$ 0	$ 0	$ 0
Contract Admin, Legal	$ 310,000	$ 0	$ 186,000	$ 80,600	$43,400
	$ 21,955,300	$ 14,072,200 64%	$ 4,729,900 22%	$ 2,050,500 9%	$ 1,102,700 5%


Benefits v. Costs
average annual equivalent based on 50-year analysis
$900,000
$800,000
$700,000
$600,000
$500,000
$400,000
$300,000
$200,000
$100,000
$0
$836,243
$151,231
Net benefits (AAE):
($685,012)
B/C = 0.2
Benefits
Costs
Structure and Vehicle Benefits
Agriculture Benefits
Roadway Benefits
NFIP Administrative Savings
Total Cost

Authorized Watershed Project Purposes:

- **Flood Damage Reduction** **20%**
- **Irrigation (managed aquifer recharge)**
- **Watershed Protection**
- **Public Recreation**

Irrigation



Elk Valley Aquifer has more requests for irrigation permits than available water.

Rated as high potential for managed aquifer recharge.

Temporary pool would generate recharge. Could also construct recharge basins or possibly wells.

Issue is low retention time… aquifer movement to the Turtle River. Likely that water would have to utilized within 4-6 weeks of a flood event. Not a significant benefit to irrigation.

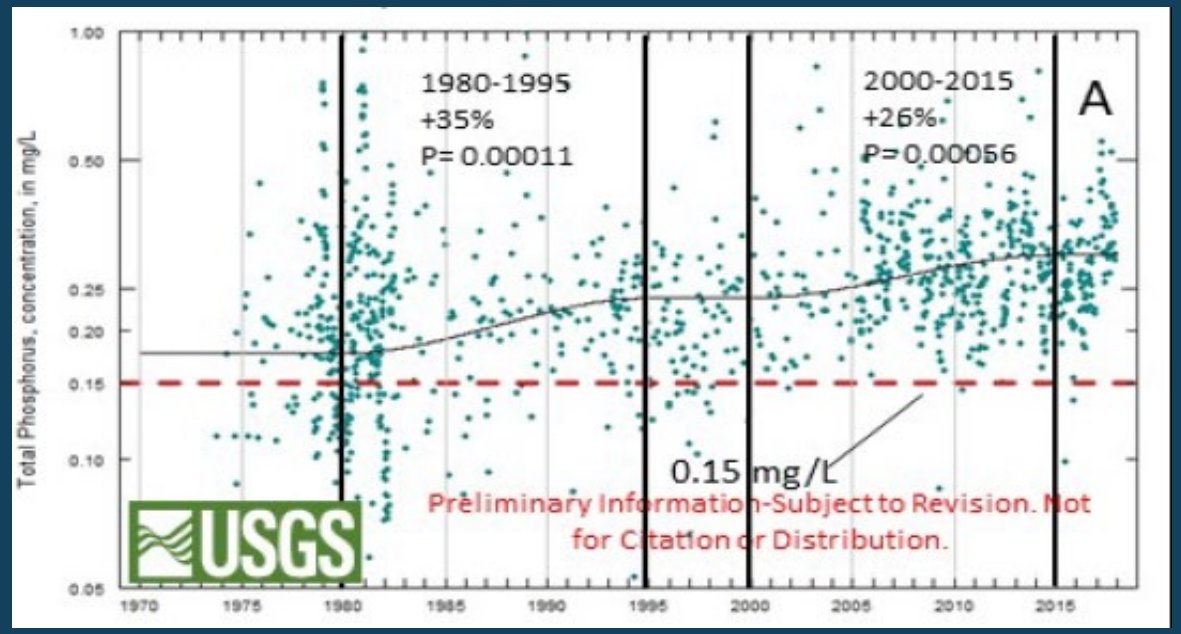
Watershed Protection – Phosphorus Reduction

1909 BOUNDARY WATERS TREATY

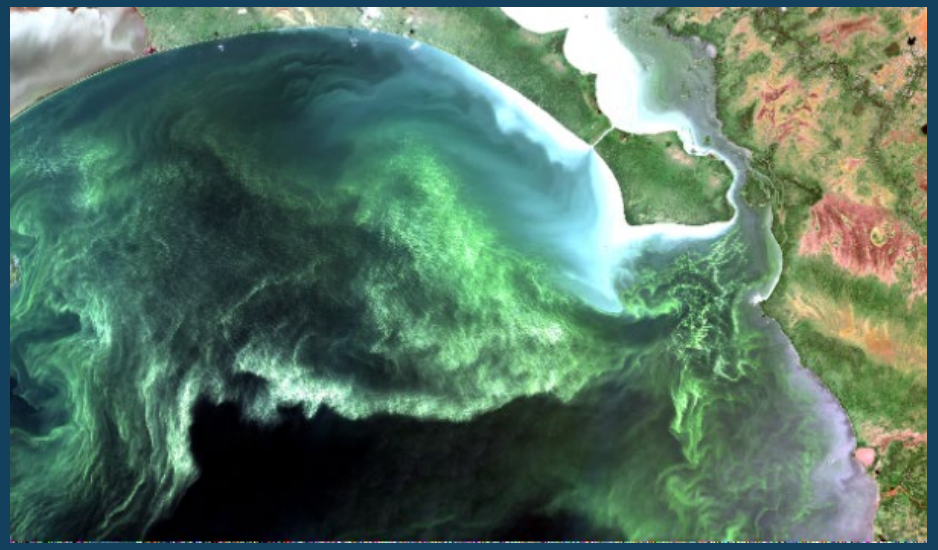
Article IV: "Boundary waters or waters flowing across the boundary shall not be polluted to the injury of the other."

IJC (U.S. & Canadian Governments) agreed to 0.15 mg/L TP objective @ Red River Border Crossing

Flow Averaged Trendline, TP @ Red River Border Crossing

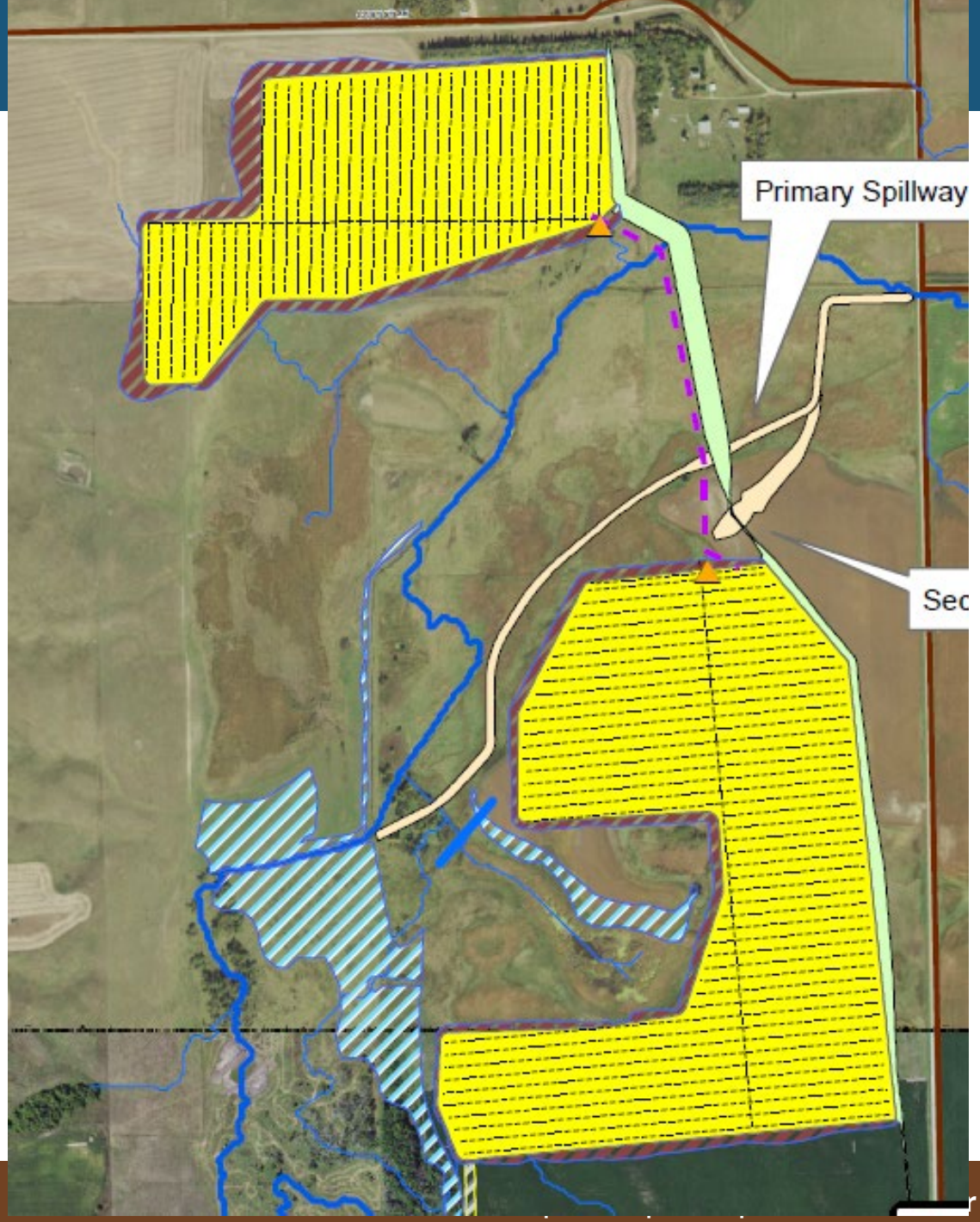


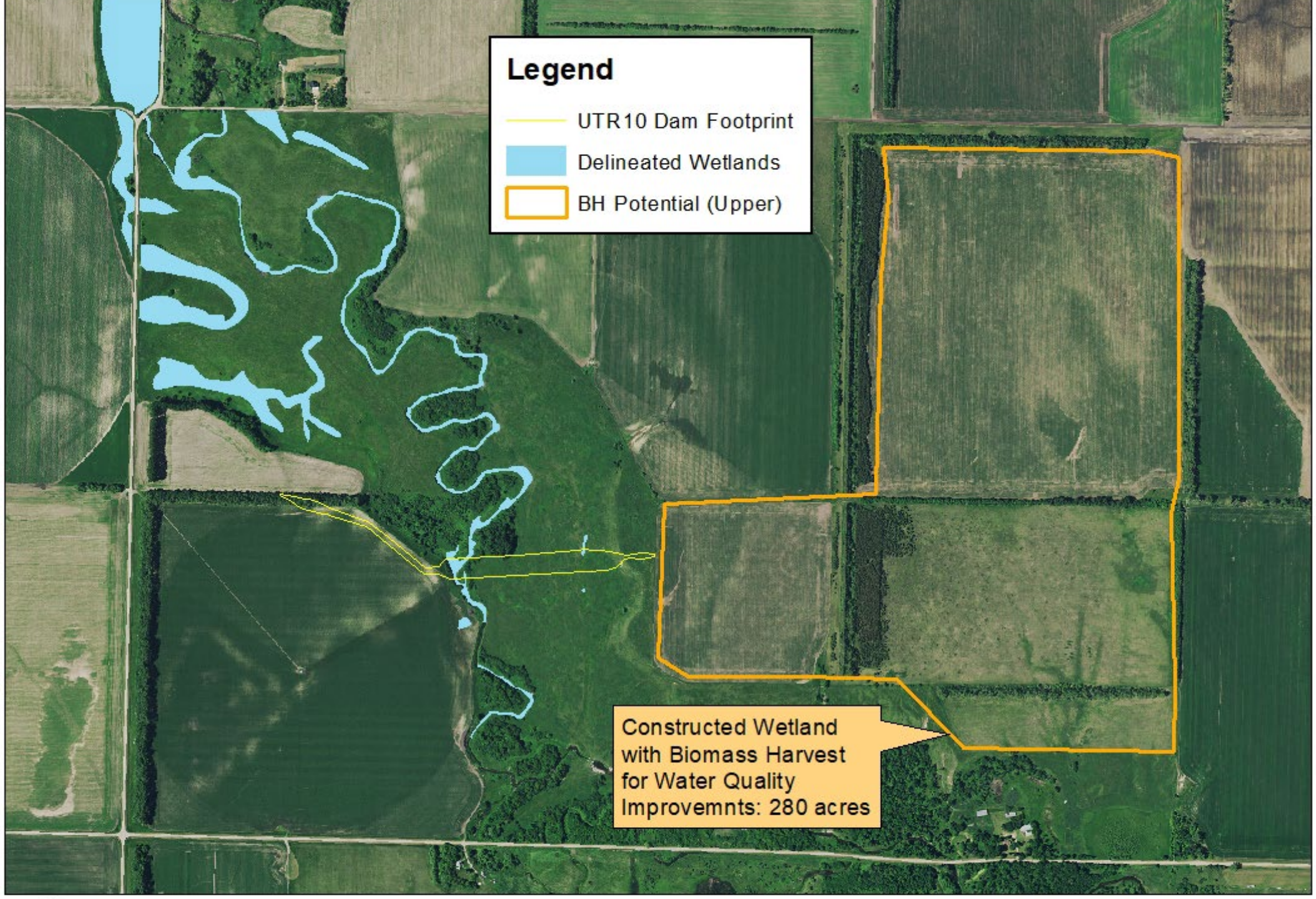
Red River Outlet to Lake Winnipeg



Lake Winnipeg Beach

Watershed Protection – Nutrient Removal




Legend
UTR10 Dam Footprint
Delineated Wetlands
BH Potential (Upper)
Constructed Wetland with Biomass Harvest for Water Quality Improvemnts: 280 acres

Big Picture: Red River Basin Retention

Project	B/C	Cost	Storage to AS (ac-ft)	Storage to TOD (ac-ft)
Upper Maple River Dam *(built)*	**n/a**	**$ 9.2 M (2015)**	**5,325 ac-ft $1,728/ac-ft**	**9,950 ac-ft $925/ac-ft**
Upper Turtle Dam 10	**0.2**	**$ 22 M (2024)**	**7,000 ac-ft $3,143/ac-ft**	**20,300 ac-ft $1,084/ac-ft**
NB Park River – Cart Creek Site 1 *(pending authorization)*	**0.4**	**$ 12 M (2024)**	**2,593 ac-ft $4,628/ac-ft**	**4,412 ac-ft $2,720/ac-ft**
Upper Maple River Site 2A *(in planning/approved)*	**0.2**	**$ 15 M (2024)**	**2,863 ac-ft $5,239/ac-ft**	**9,235 ac-ft $1,624/ac-ft**
Shortfoot Creek Site 7 *(in planning/approved)*	**0.3**	**$ 13 M (2024)**	**1,250 ac-ft $10,400/ac-ft**	**4,055 ac-ft $3,206**

Questions?

Decision:

- Terminate Watershed Planning Effort

  or

  Investigate a multi-purpose project
- Public meeting?