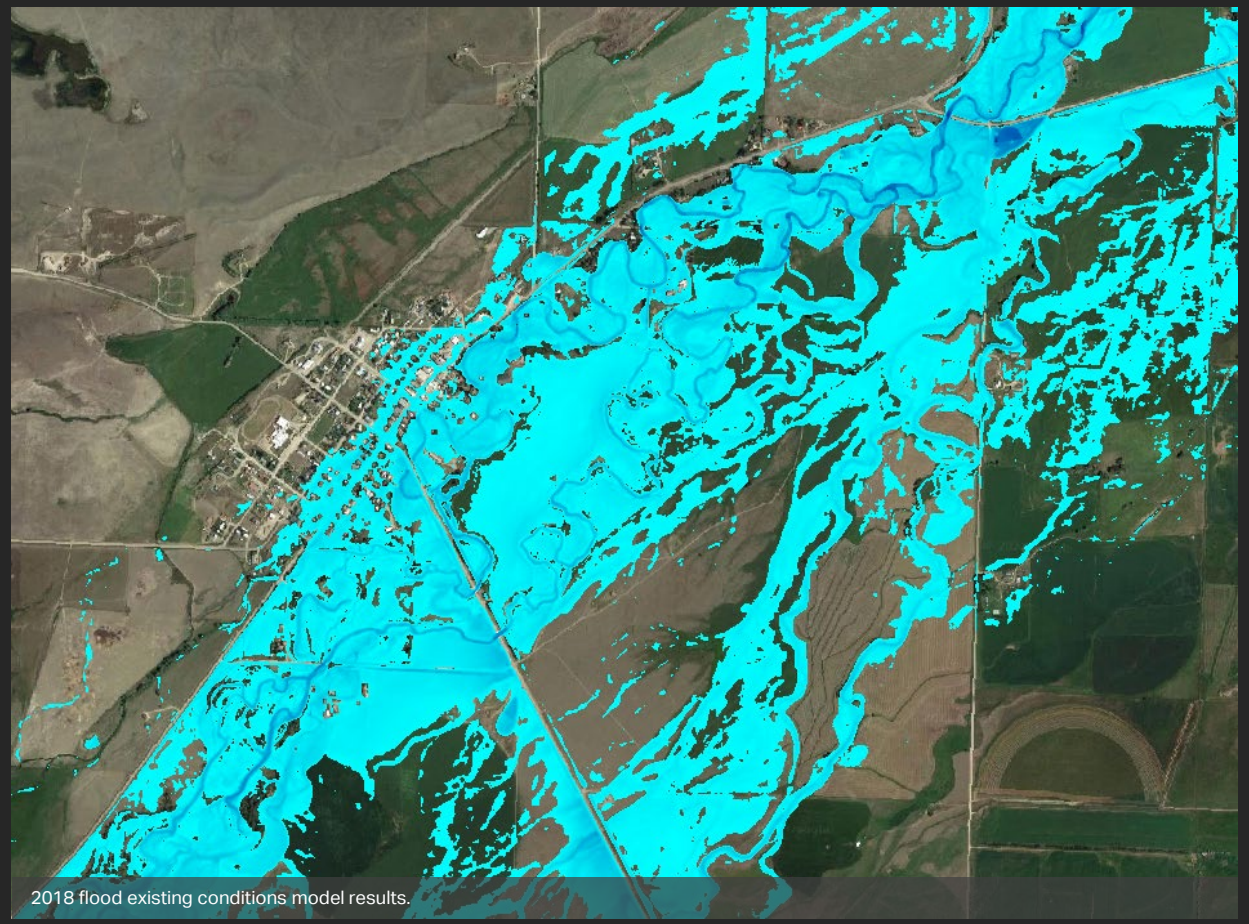


2018 flood existing conditions model results.

Aerial photo of 2018 flooding at Augusta and Highway 287, courtesy of Montana Department of Transportation.

ELK CREEK FLOOD MITIGATION ALTERNATIVES

AUGUSTA, MONTANA

LEWIS AND CLARK COUNTY

MAY 6, 2022

RESPEC

PRESENTATION OUTLINE

- Recap from Meeting 1 and Public Comment Summary
- Mitigation Alternatives
- Cost Comparison
- Considerations
- Recommended Alternatives and Phasing
- Permitting
- Next Steps
- Discussion

RECAP FROM MEETING 1 AND PUBLIC COMMENTS

- Existing Conditions Hydraulic Analysis
  - Utilized measured flows at USGS gage
    - USGS 06084500 Elk Creek at Augusta MT
  - All flooding sources modeled in one 2D area
  - Bridges and Culverts based on RPA survey and field measured elevations
  - Study area:
    - Upstream Extent: 0.5 mi NE of Smith and Elk Creek confluence
    - Downstream Extent: 0.25 mi NE of abandoned railroad berm east of Augusta
  - Simulated the Existing Conditions (EX) – 1964, 1975, 2018 floods
    - Focused mitigation on 2018 flood

RECAP FROM MEETING 1 AND PUBLIC COMMENTS

- Public Comments Summary
  - Concern for diverting flow to Hogan Slough and implications to flood risk and FEMA FIRM
  - Elk Creek Reservoir
  - Floodplain restoration, SRF opportunity?
  - Reduce blockages, debris, and backwater. Relocate the town?

CONSIDERATIONS

- ALTERNATIVES ARE NOT FINAL DESIGN
- NEED DESIGN AND PERMITTING TO IMPLEMENT

MITIGATION ALTERNATIVES

1. Backwater Improvement Concepts
2. Diversion Concepts
3. Berm Implementation Concepts

BACKWATER IMPROVEMENT CONCEPTS

1. Channel and floodplain debris cleaning
2. US 287 removal
3. US 287 bridge opening size increase
4. US 287 re-alignment

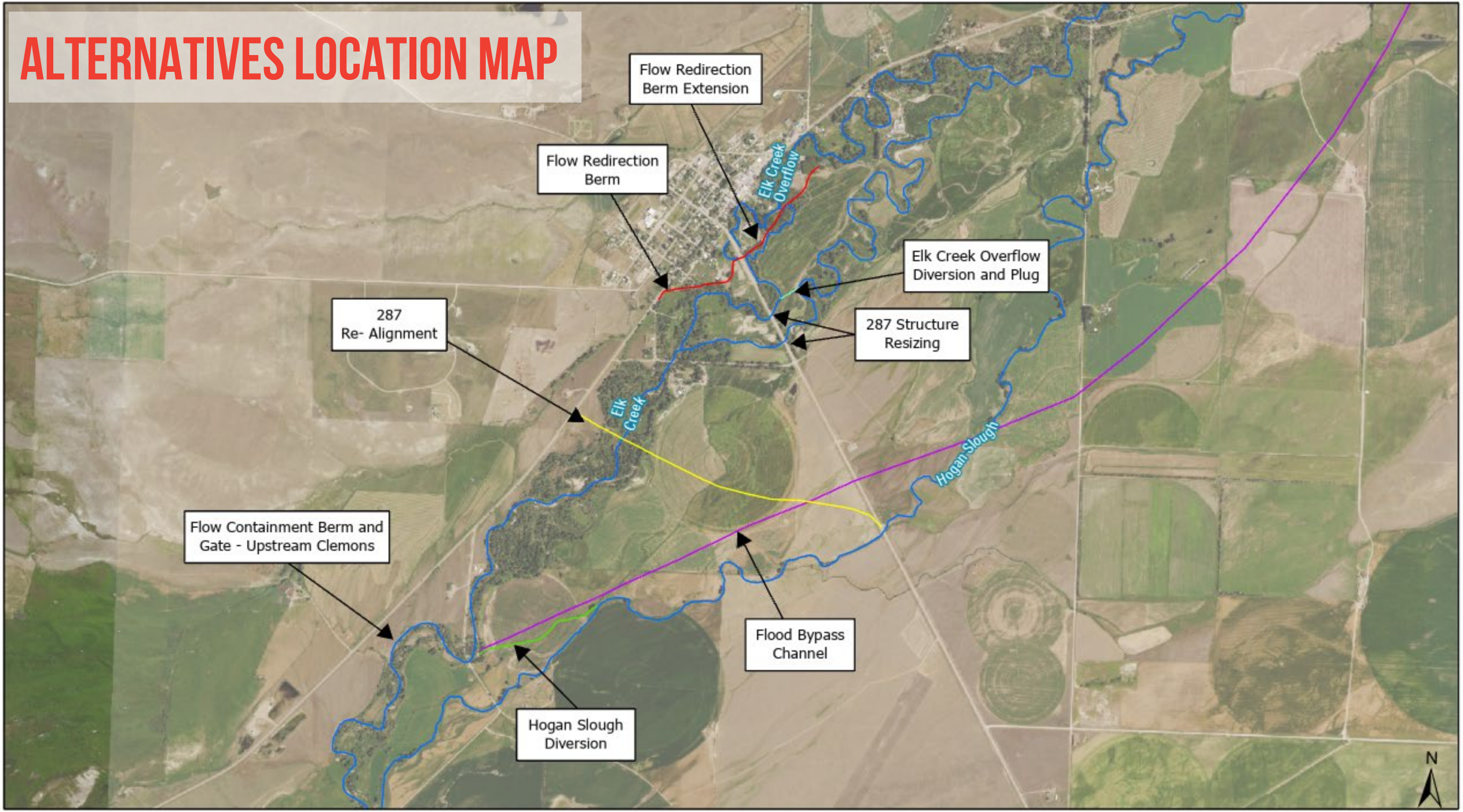
DIVERSION CONCEPTS

1. Florence Canal diversion
2. Flow diversion from Elk Creek Overflow to Elk Creek
3. Hogan Slough diversion
4. Flood bypass channel

BERM IMPLEMENTATION CONCEPTS

1. Flow containment berm and gate upstream of Augusta Clemons Rd
2. Flow redirection berm
3. Flow redirection berm with extension

ALTERNATIVES LOCATION MAP



CHANNEL AND FLOODPLAIN CLEARING

CHANNEL AND FLOODPLAIN CLEARING

- Will help to lower flooding depths in debris build-up locations
- Overall small depth reductions throughout model
- Low cost
- Coordinated effort with the CD and FWP
- Annual monitoring and maintenance

Model Results Percentage of Total Flow In Each Region Just Downstream of US 287

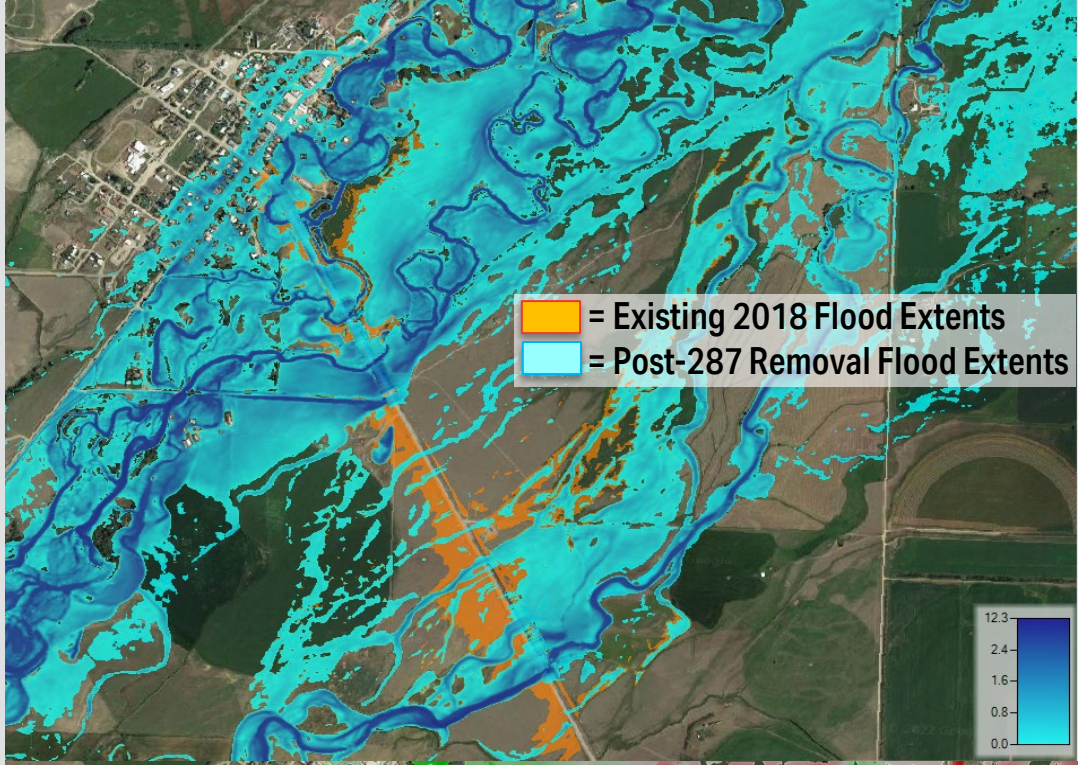
Scenario	Elk Creek Overflow + Floodplain	Elk Creek Main + Floodplain	Hogan Slough + Floodplain
2018 Flood	37%	43%	20%
Channel and Floodplain Debris Clearing	38%	43%	19%

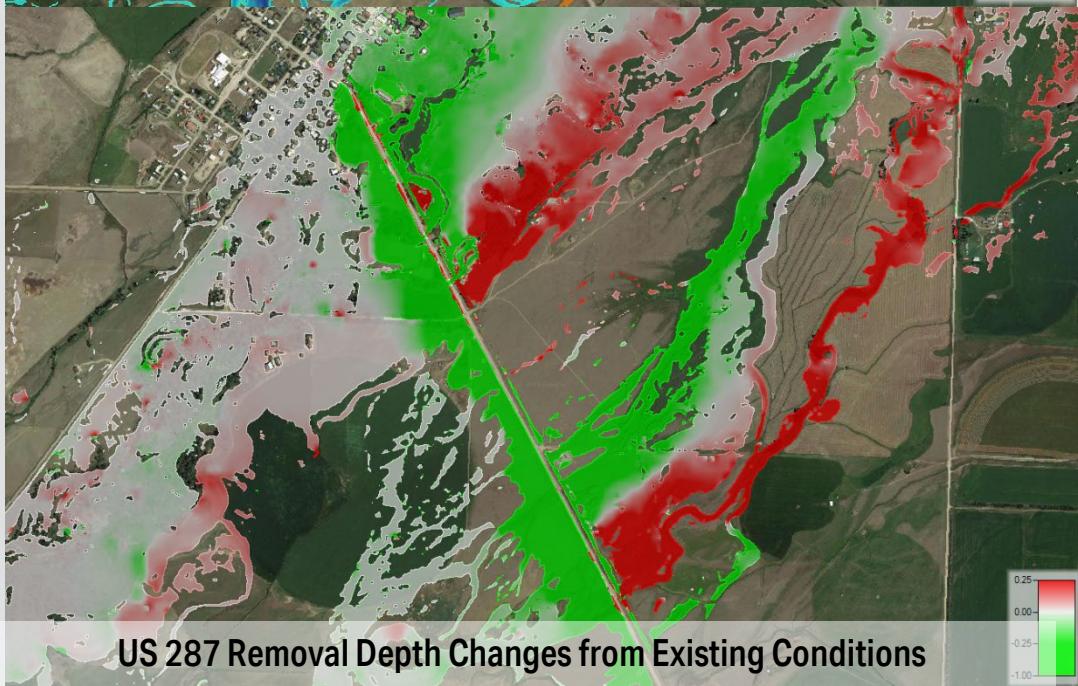
US 287 REMOVAL

- REMOVE HIGHWAY 287 AND STRUCTURES TO LIMIT BACKWATER FROM ROADWAY EMBANKMENT
- HIGH COST, SMALL FLOW REDUCTION THROUGH TOWN AND THE ELK CREEK OVERFLOW CHANNEL (~550 CFS)

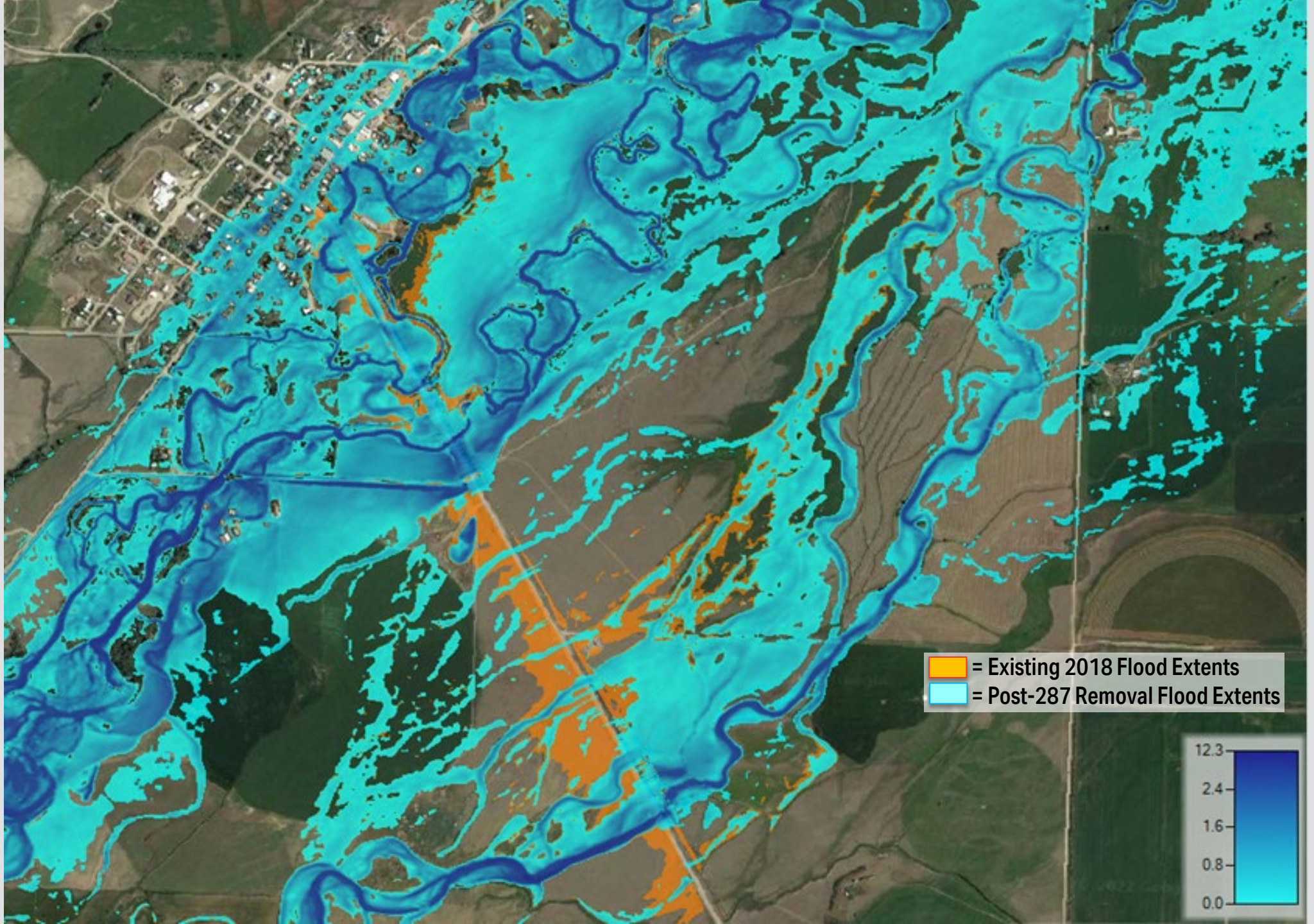
Model Results Percentage of Total Flow In Each Region Just Downstream of US 287

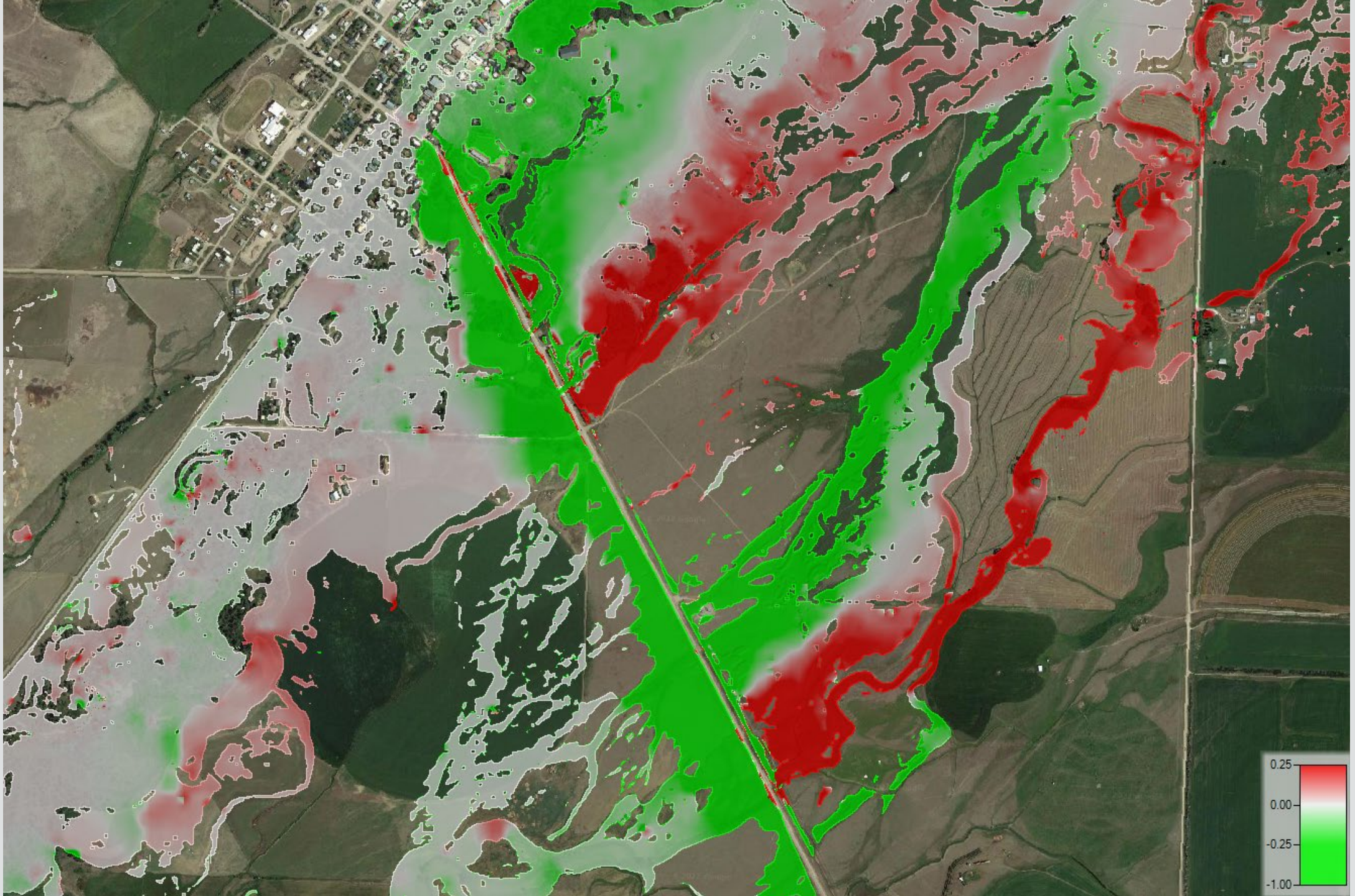
Scenario	Elk Creek Overflow + Floodplain	Elk Creek Main + Floodplain	Hogan Slough + Floodplain
2018 Flood	37.1%	42.9%	20.0%
US 287 Removal	28.7%	49.9%	21.4%





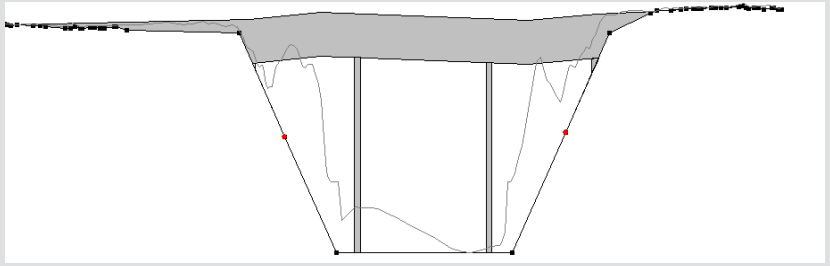
US 287 Removal Depth Changes from Existing Conditions


= Existing 2018 Flood Extents
= Post-287 Removal Flood Extents
12.3
2.4
1.6
0.8
0.0

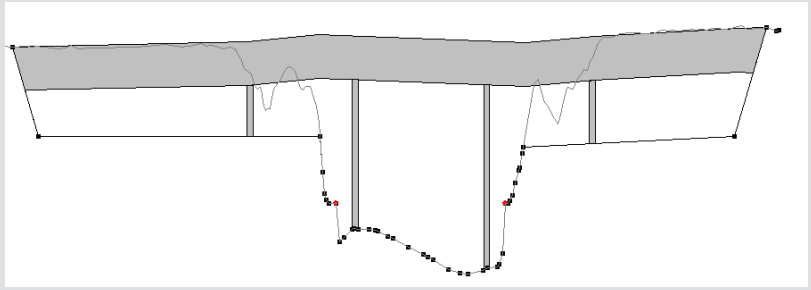

0.25
0.00
-0.25
-1.00

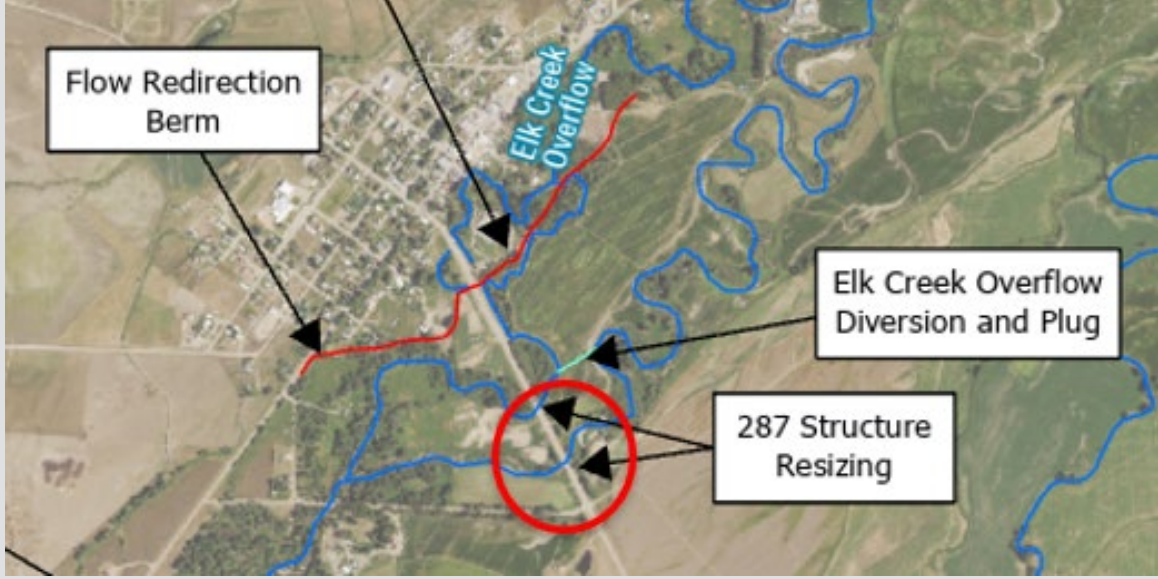
287 STRUCTURE RESIZING

a. Channel widening

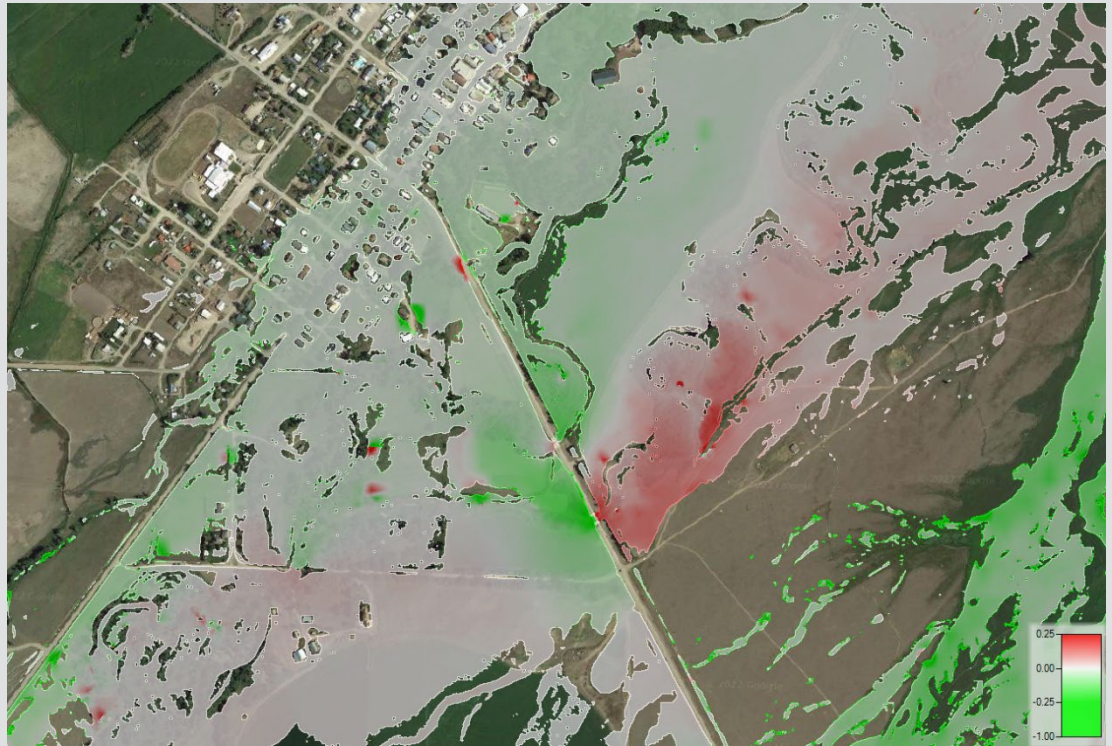


b. Addition of floodplain elevation level benches



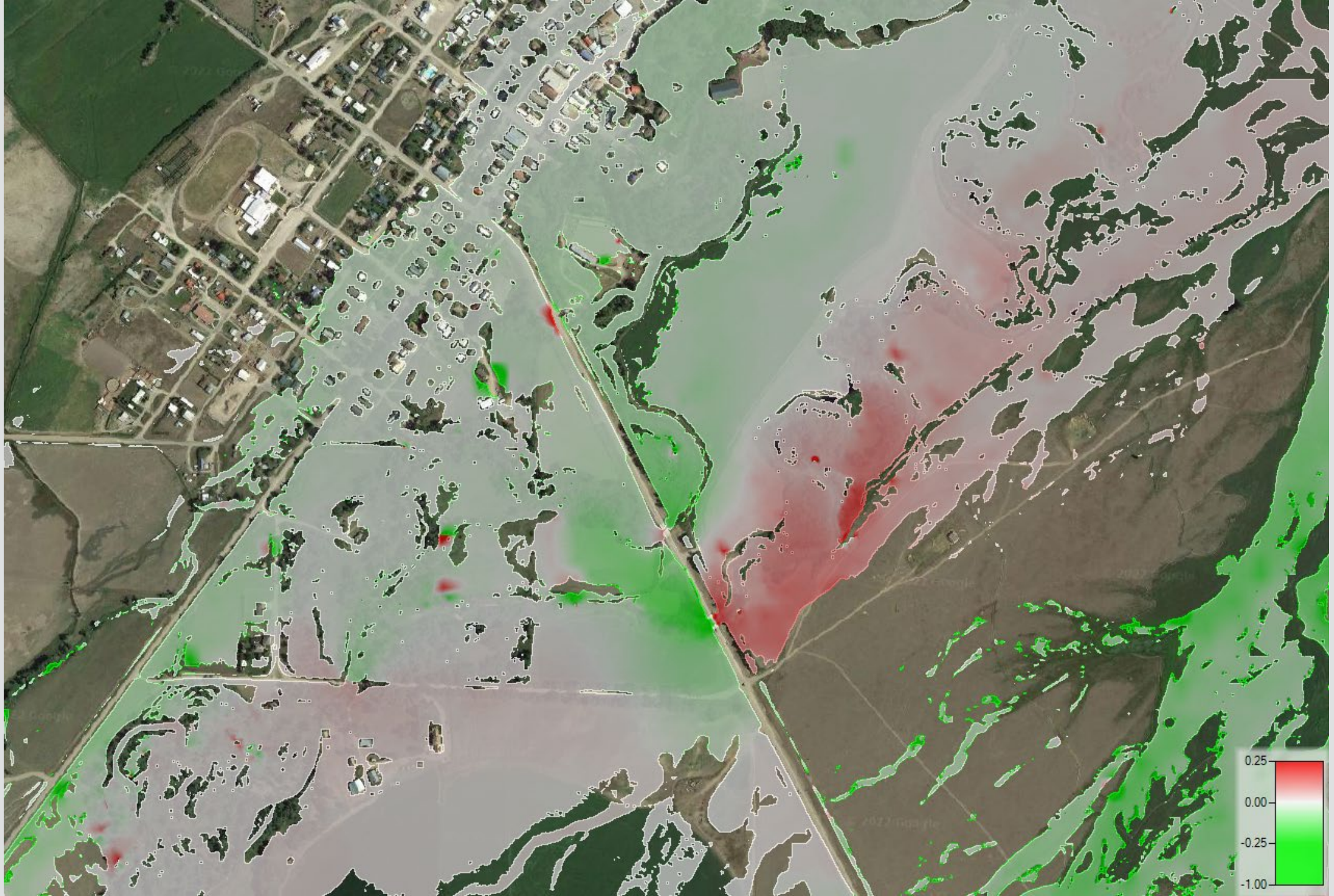


Structure Resizing Depth Changes from Existing Conditions



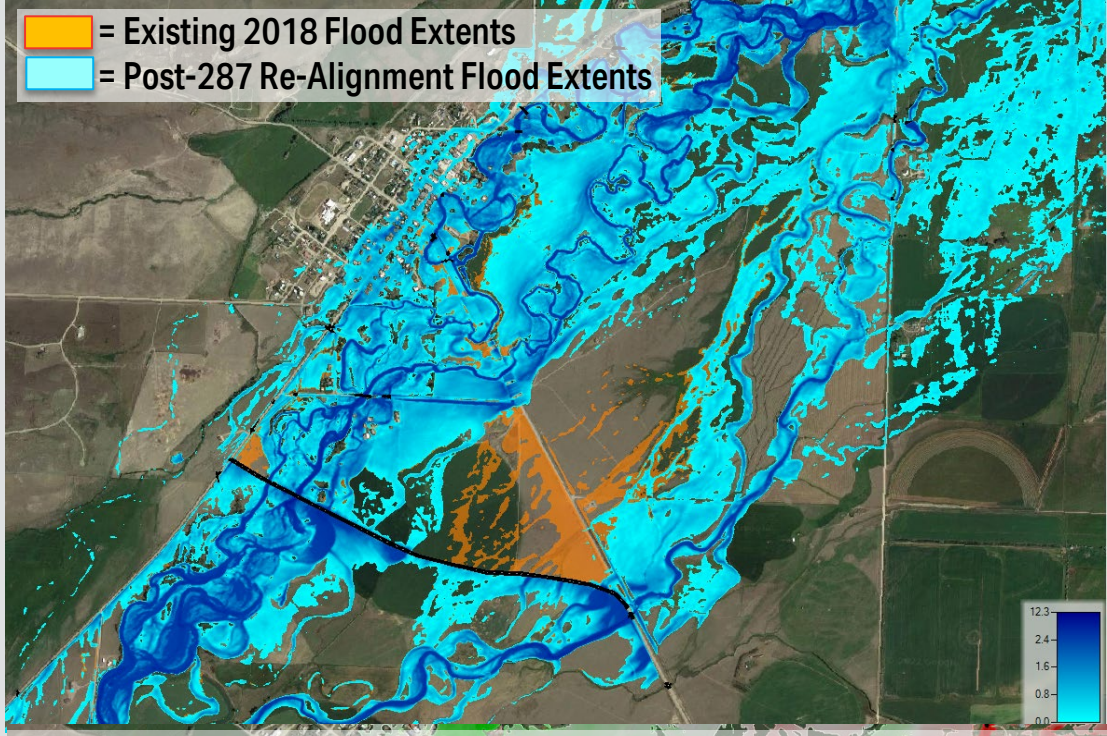
Model Results Percentage of Total Flow In Each Region Just Downstream of US 287

Scenario	Elk Creek Overflow + Floodplain	Elk Creek Main + Floodplain	Hogan Slough + Floodplain
2018 Flood	37.1%	42.9%	20%
Channel Widening	35.9%	44.1%	20.0%
Floodplain Level Benches	35.7%	44.4%	19.9%

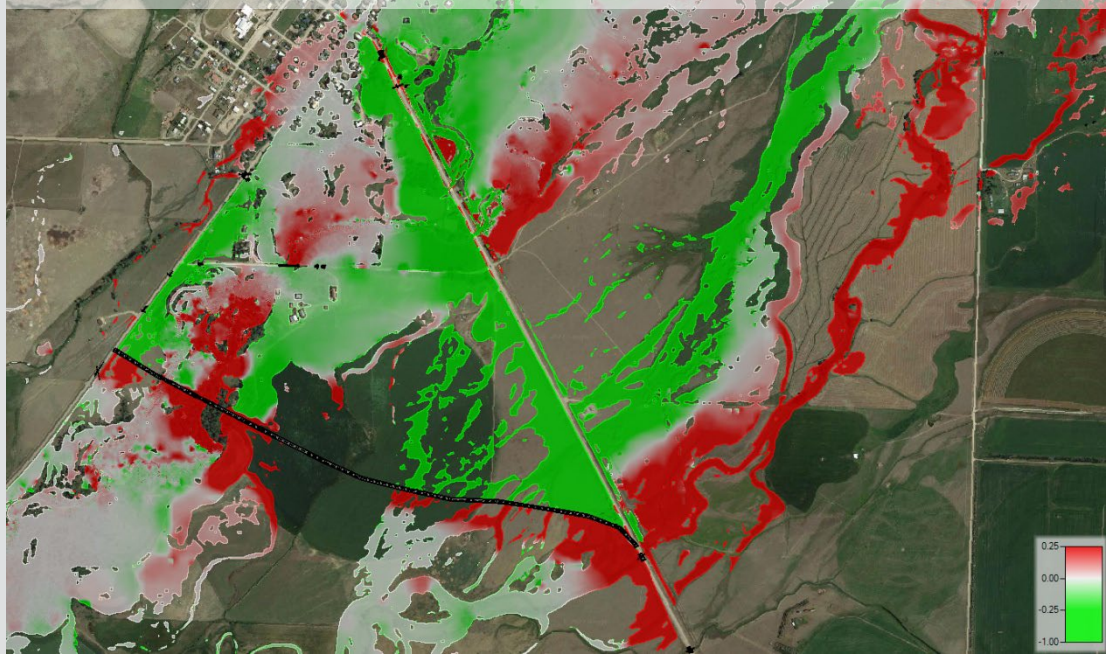

0.25
0.00
-0.25
-1.00

US 287 REMOVAL AND RE-ALIGNMENT

- RE-ALIGN 287 TO BE MORE PERPENDICULAR TO FLOODPLAIN
- HIGH COST, SMALL FLOW REDUCTION THROUGH TOWN AND THE ELK CREEK OVERFLOW CHANNEL (~450 CFS)

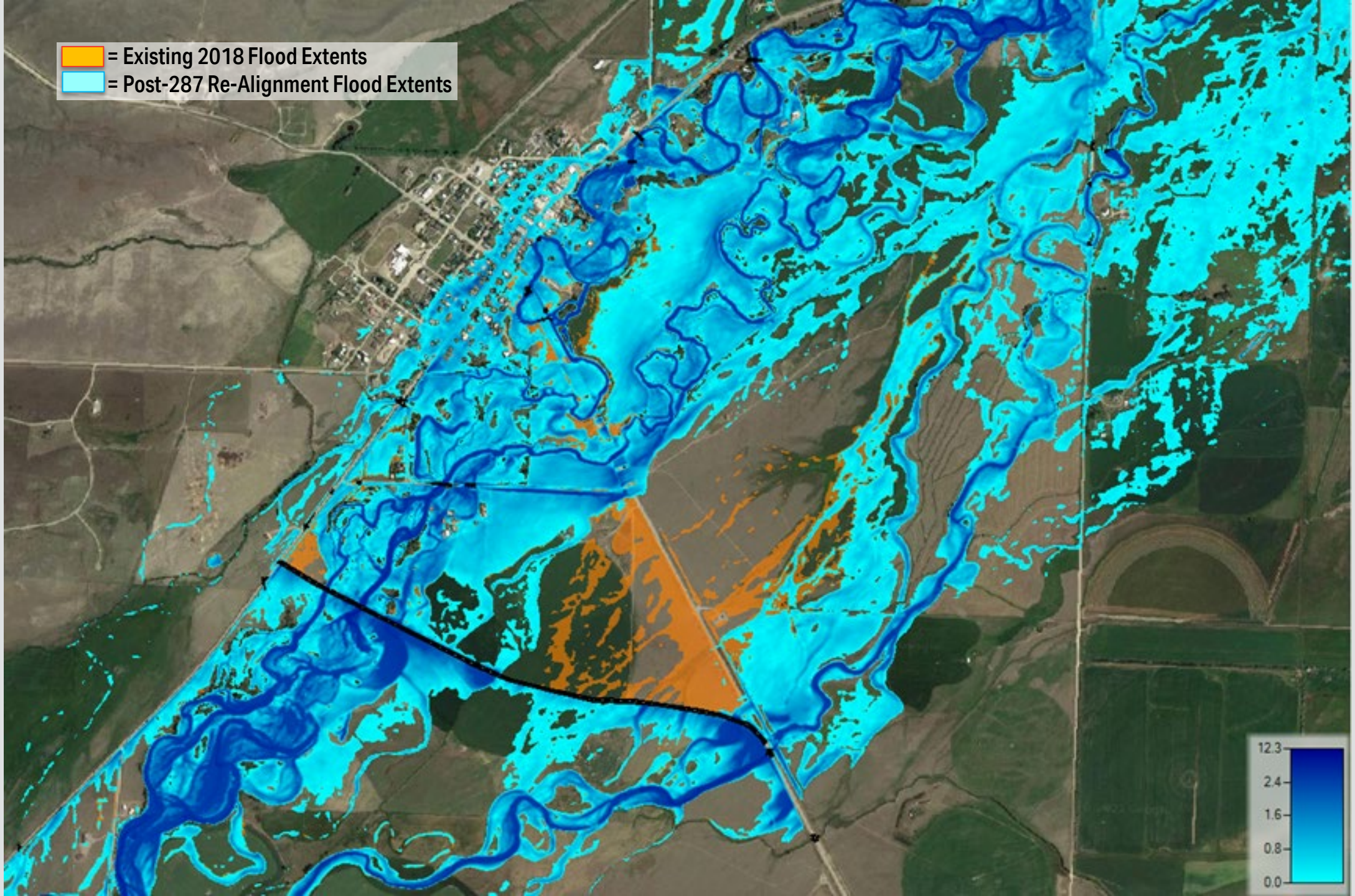


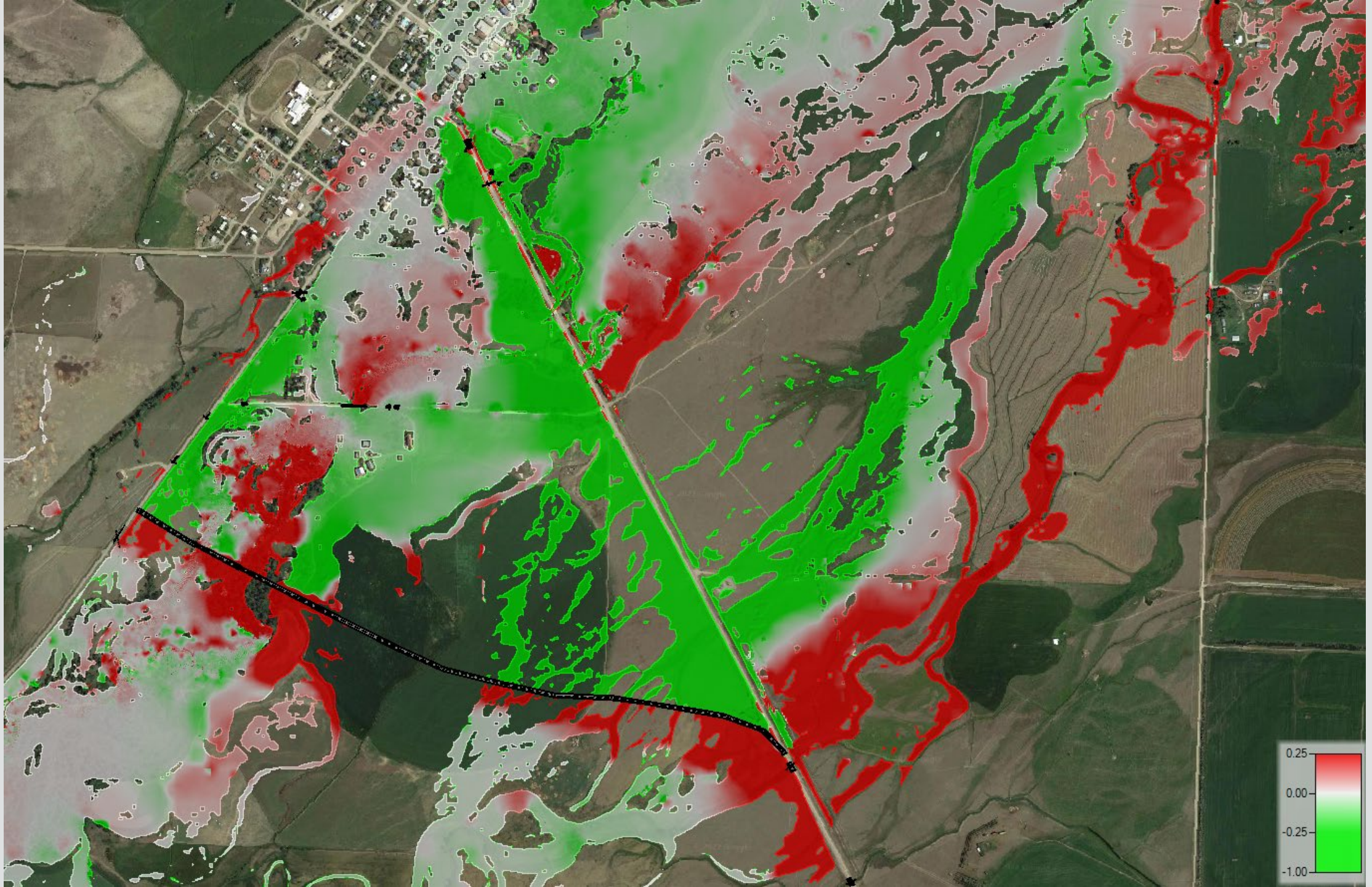
US 287 Re-Alignment Depth Changes from Existing Conditions



Model Results Percentage of Total Flow In Each Region Just Downstream of the existing US 287

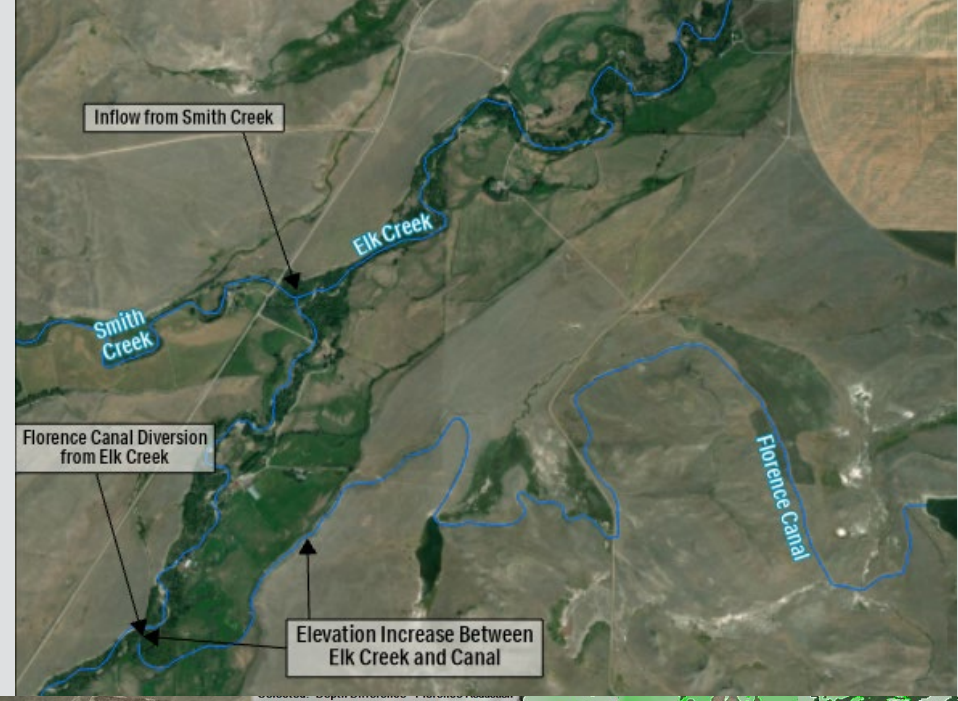
Scenario	Elk Creek Overflow + Floodplain	Elk Creek Main + Floodplain	Hogan Slough + Floodplain
2018 Flood	37.1%	42.9%	20%
US 287 Re-Alignment	30.3%	44.8%	24.9%

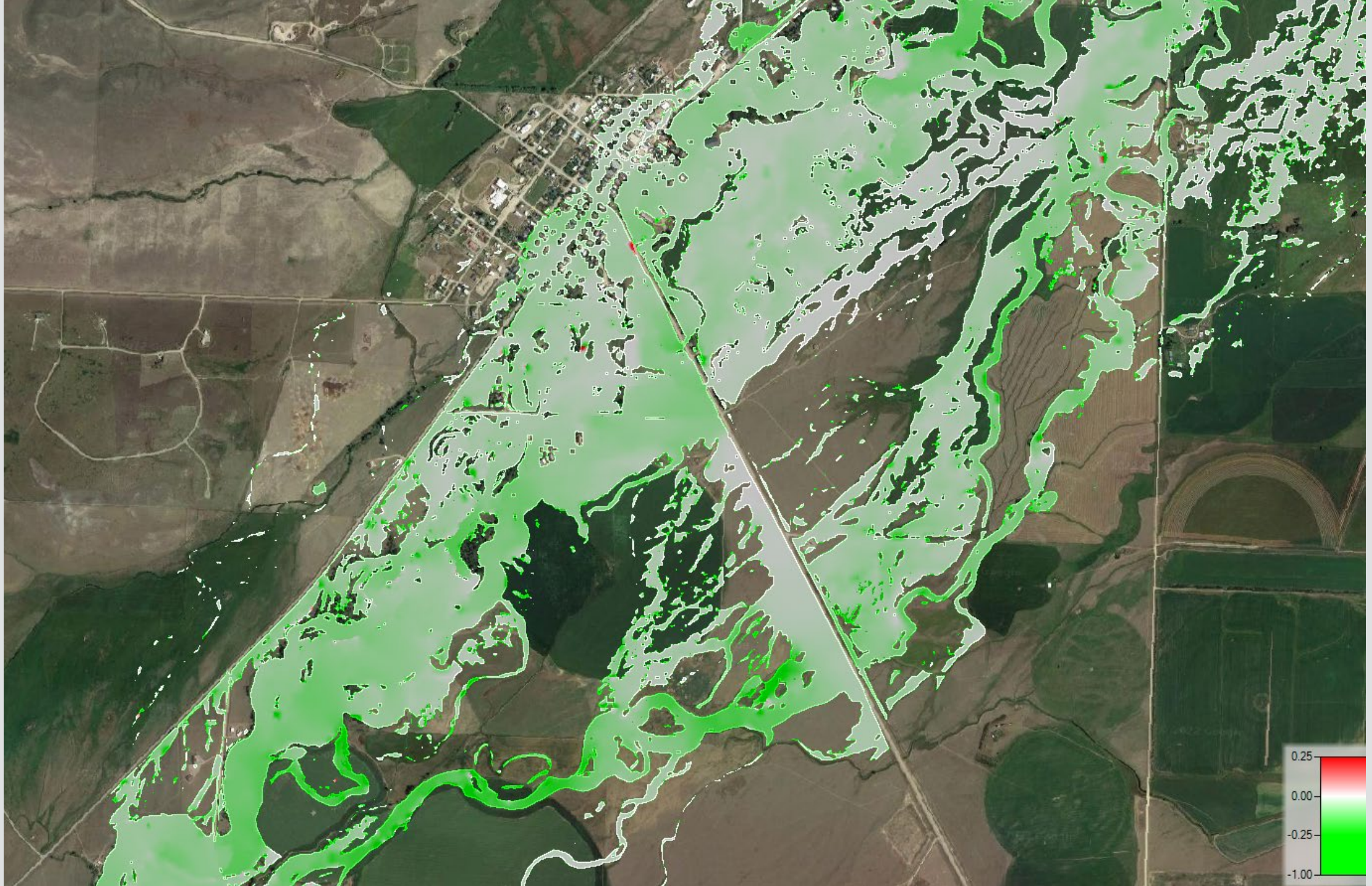

= Existing 2018 Flood Extents
= Post-287 Re-Alignment Flood Extents
12.3
2.4
1.6
0.8
0.0


0.25
0.00
-0.25
-1.00

FLORENCE CANAL DIVERSION

- LOW-CAPACITY CANAL (~500 CFS)
- PERCHED CANAL ABOVE FLOODPLAIN
- APPROXIMATELY A 0.05’ DECREASE OF DEPTH IN ELK CREEK OVERFLOW JUST DOWNSTREAM OF US 287
- SMALL DEPTH DECREASES



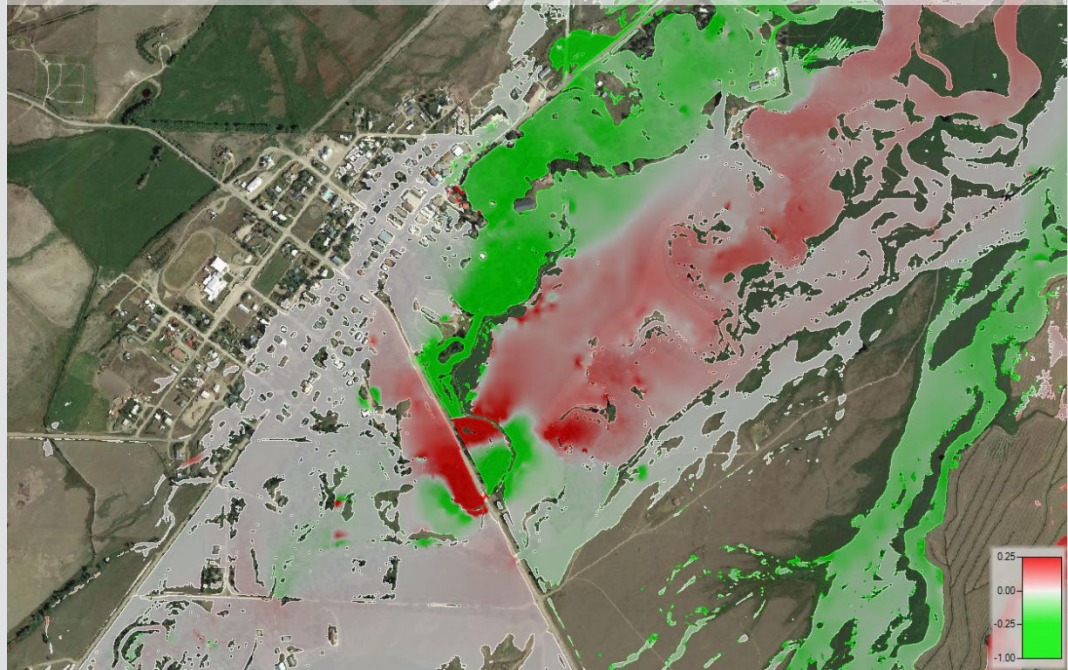

0.25
0.00
-0.25
-1.00

ELK CREEK OVERFLOW DIVERSION

DIVERT FLOW BACK INTO ELK CREEK MAIN AT FLOOD STAGES

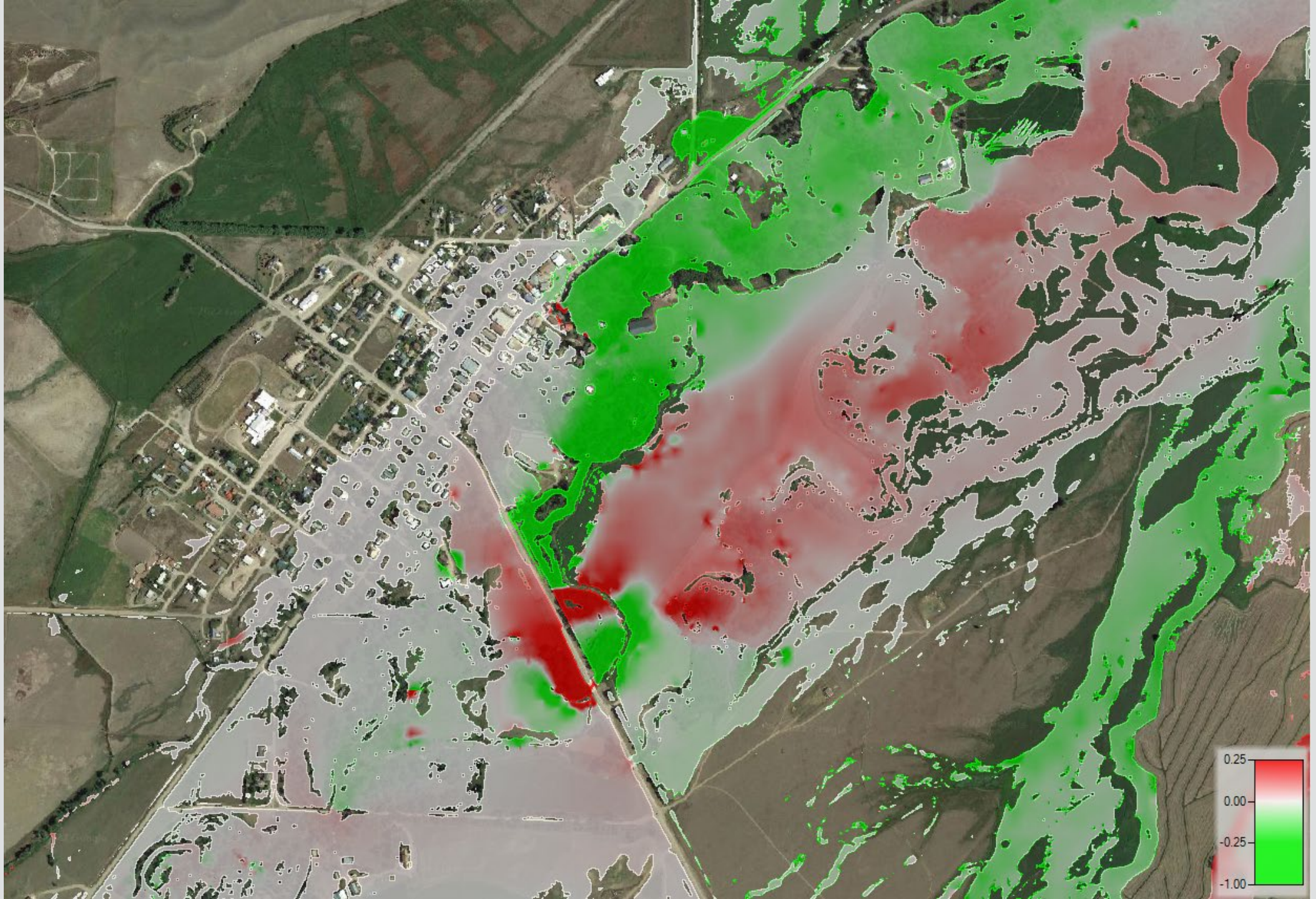
- Small channel creation connecting Elk Creek Overflow and Elk Creek Main
- Plug Elk Creek Overflow
- Downstream bank stabilization efforts
- Consider prevention of backwater into culverts to support

Elk Creek Overflow Diversion Depth Changes from Existing Conditions



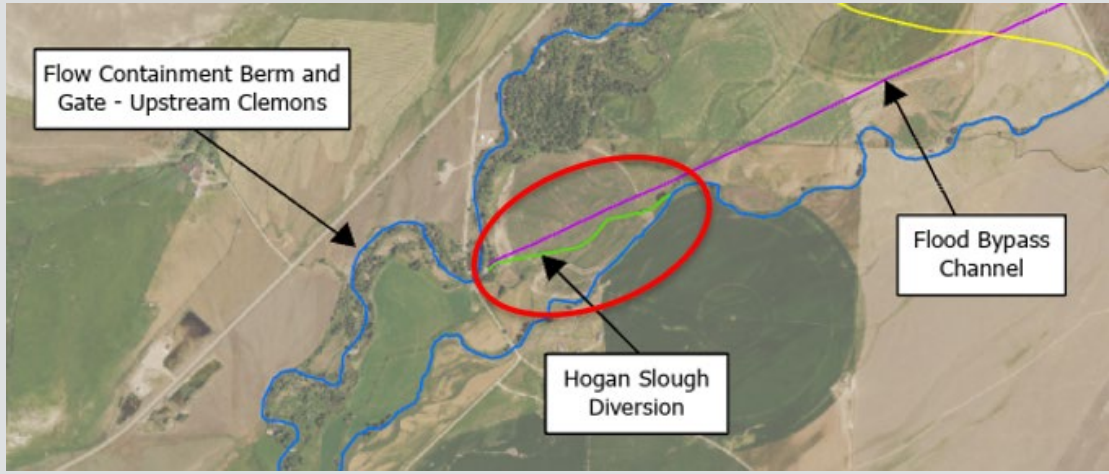
Model Results Percentage of Total Flow In Each Region Just Downstream of US 287

Scenario	Elk Creek Overflow + Floodplain	Elk Creek Main + Floodplain	Hogan Slough + Floodplain
2018 Flood	37.1%	42.9%	20%
Elk Creek Overflow Diversion	31.4%	48.7%	19.9%

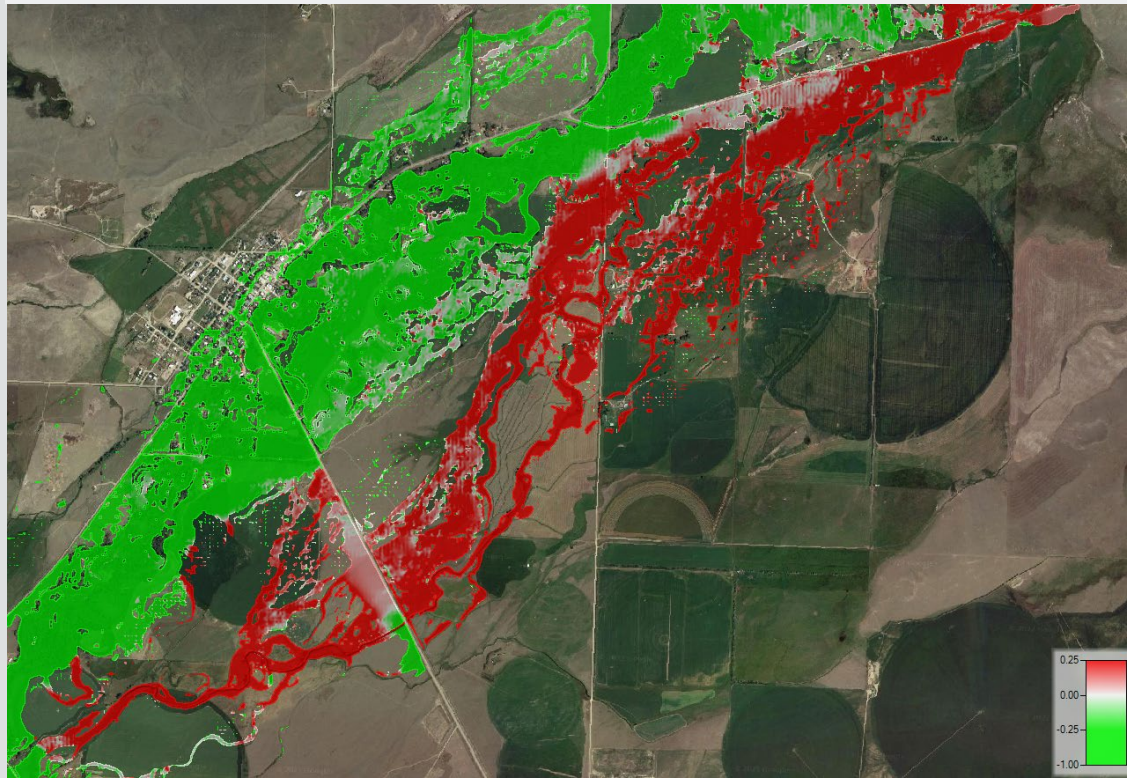

0.25
0.00
-0.25
-1.00

HOGAN SLOUGH DIVERSION

- DIVERT FLOW INTO HOGAN SLOUGH AT FLOOD STAGES
  - Small channel creation connecting Elk Creek and Hogan Slough
  - As currently modeled, diverts ~3000 cfs at flood stages
  - Extents
  - Includes resizing of US 287 crossing
    - Larger culvert
    - Bridge

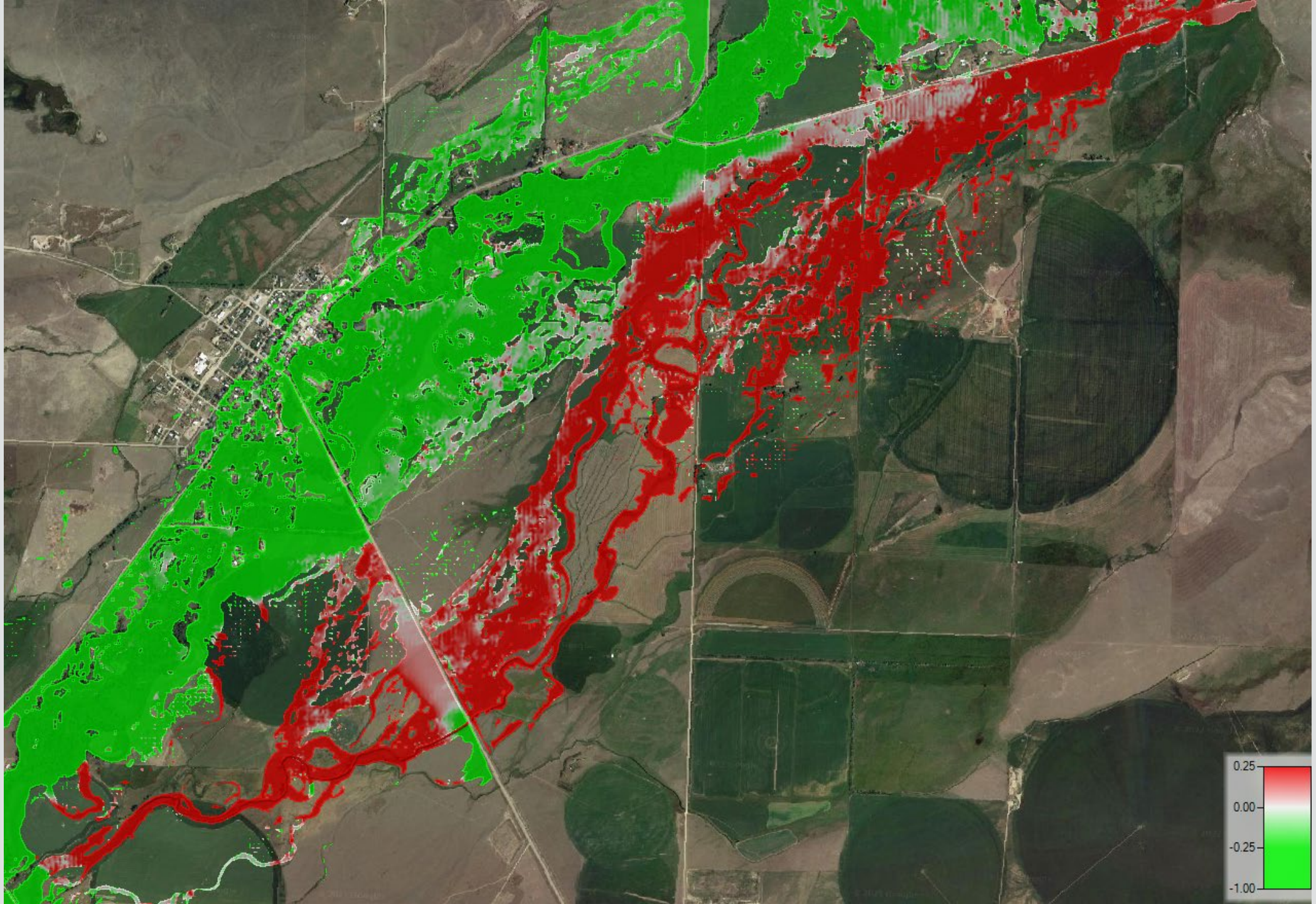


Hogan Slough Diversion Depth Changes from Existing Conditions



Model Results Percentage of Total Flow In Each Region Just Downstream of US 287

Scenario	Elk Creek Overflow + Floodplain	Elk Creek Main + Floodplain	Hogan Slough + Floodplain
2018 Flood	37.1%	42.9%	20.0%
Hogan Slough Diversion	17.3%	25.0%	57.7%

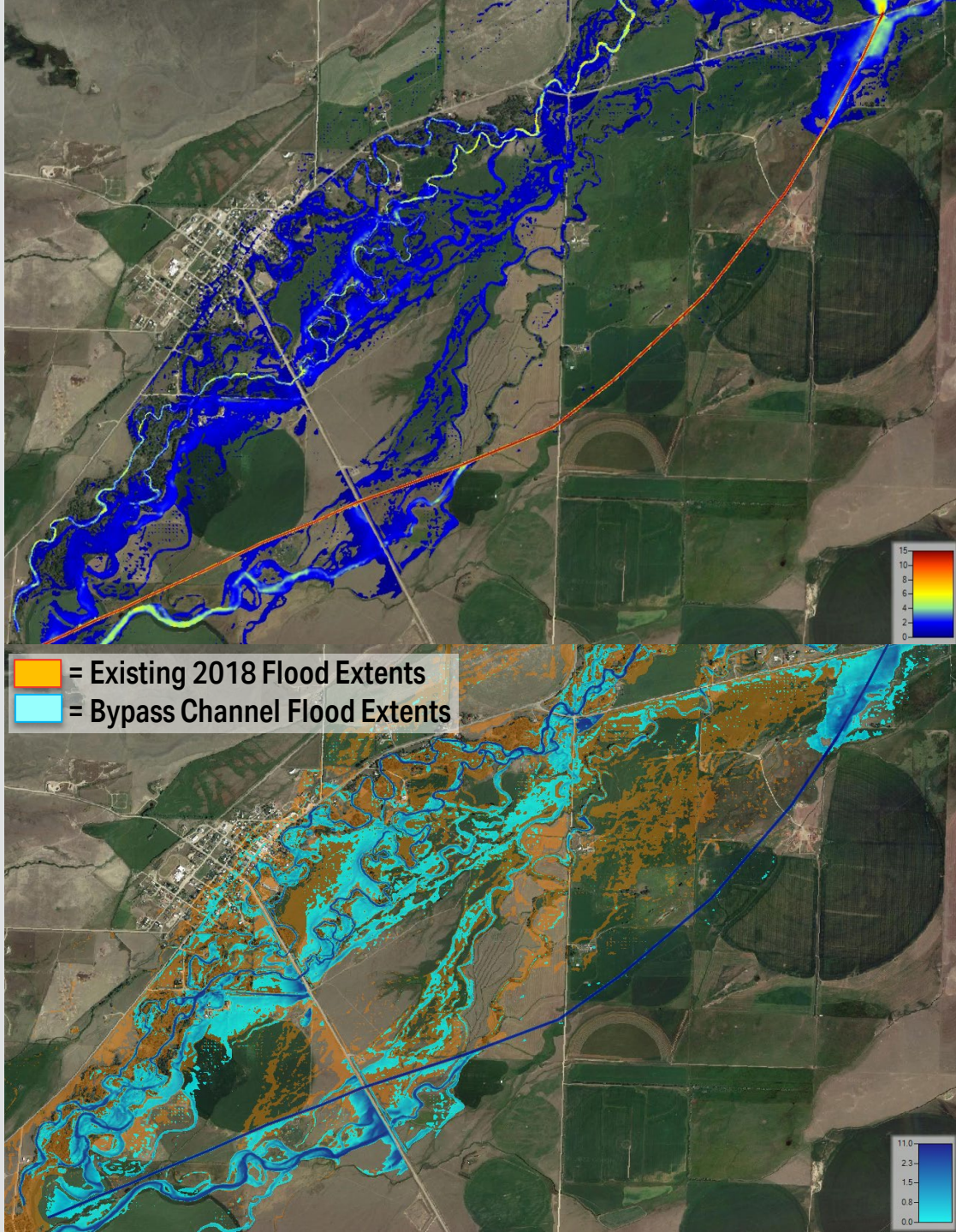

0.25
0.00
-0.25
-1.00

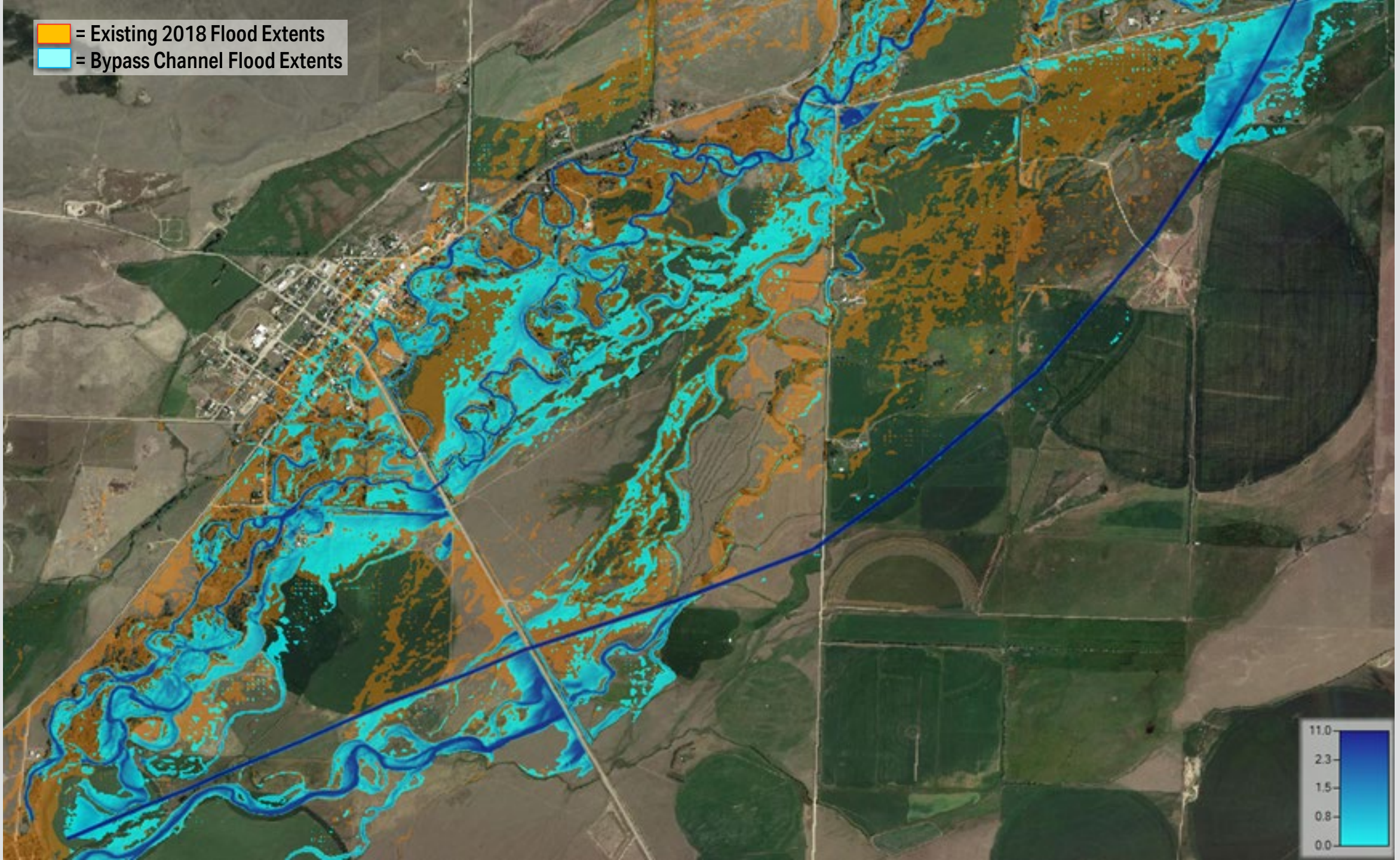
FLOOD BYPASS CHANNEL

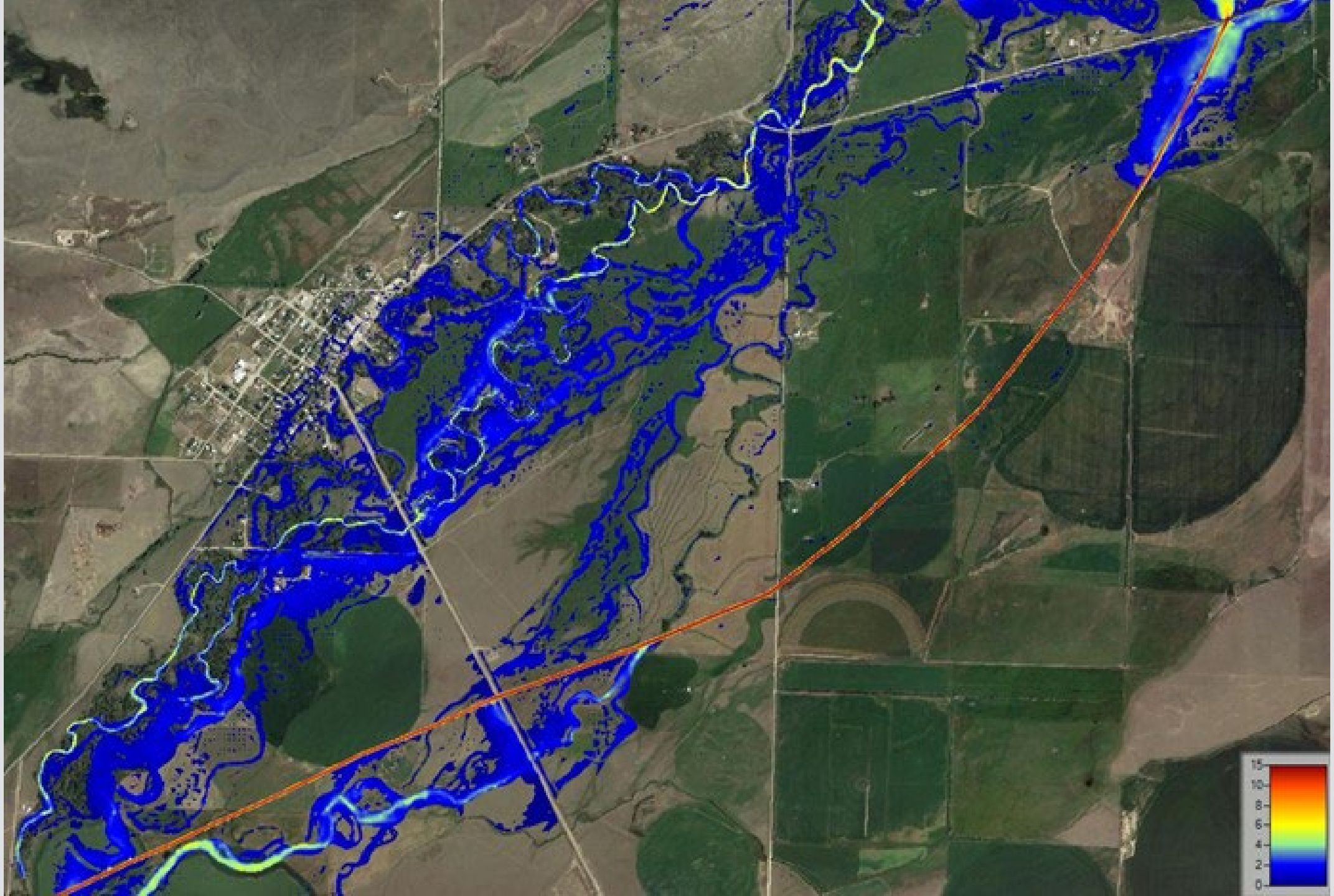
- EXAMPLE OF A FLOOD BYPASS CHANNEL
- CURRENT DESIGN CAPACITY OF 7000 CFS
- DIVERT MOST OF FLOWS INTO CHANNEL, MAINTAIN ~500 CFS IN ELK CREEK MAIN AT FLOOD STAGES
- HIGH VELOCITIES WITHIN CHANNEL (~12 FT/S IN THIS MODEL)
- OTHER ALTERNATIVES CAN STEM FROM THIS
  - Balance/optimize velocities, sediment transport, and cultivability
  - Example: Farmable swale

Model Results Percentage of Total Flow In Each Region Just Downstream of US 287

Scenario	Elk Creek Overflow + Floodplain	Elk Creek Main + Floodplain	Hogan Slough + Floodplain
2018 Flood	37.1%	42.9%	20%
Flow Redirection Berm Extension	4.4%	14.4%	81.2%

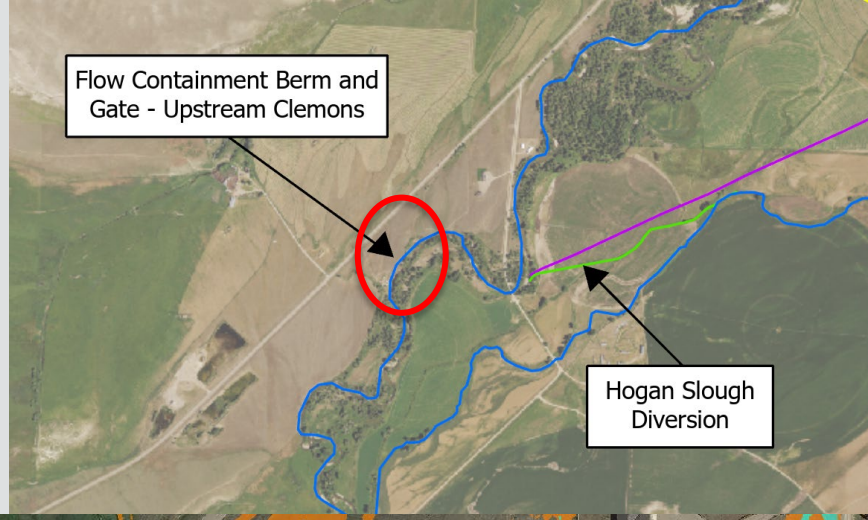


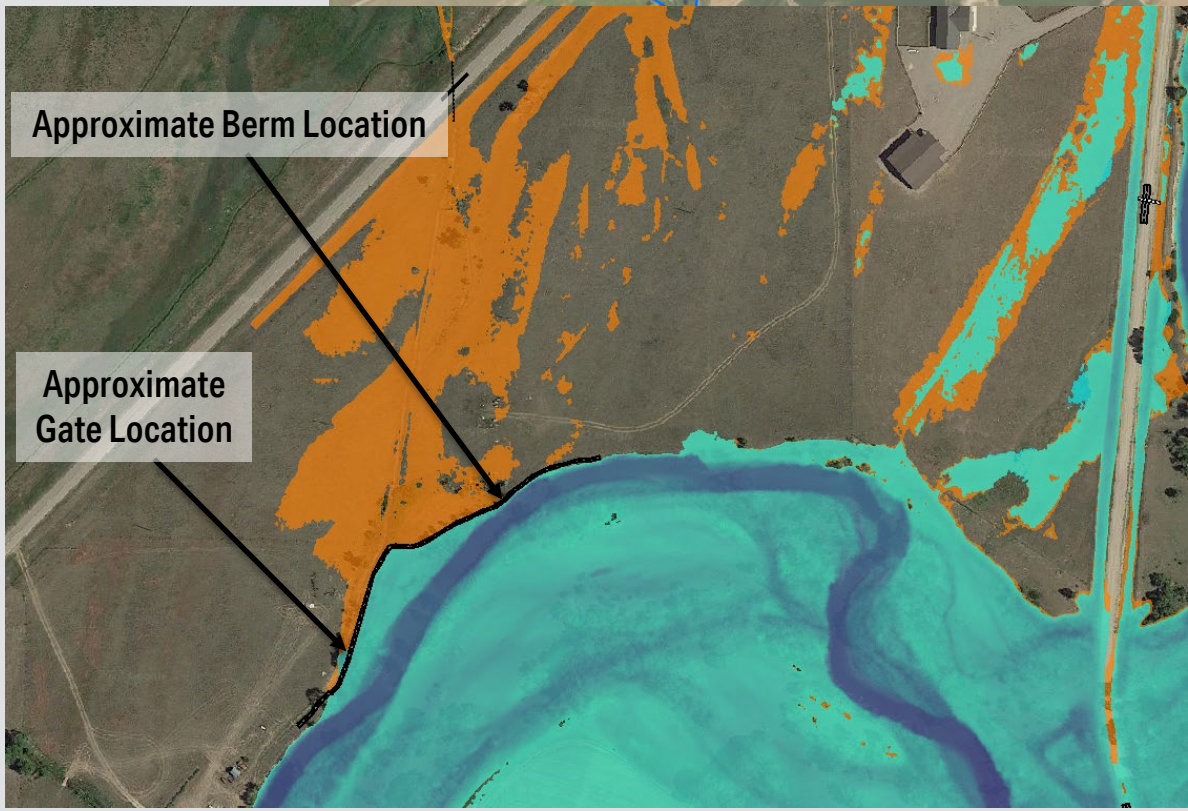

= Existing 2018 Flood Extents
= Bypass Channel Flood Extents
11.0
2.3
1.5
0.8
0.0


15
10
8
6
4
2
0

FLOW CONTAINMENT BERM AND GATE UPSTREAM OF AUGUSTA CLEMONS ROAD

- **BLOCK DIVERSION DITCH AT HIGH FLOOD STAGES**
  - Add berm to help with redirection into Elk Creek
  - Gate incorporated to allow flow at all other stages
  - Prevents water from entering highway ditches that deliver water to town
  - Decreases flood extents in select locations
  - Small flow reduction in Elk Creek Overflow Channel
  - Can be used as a low effort combination with other alternatives

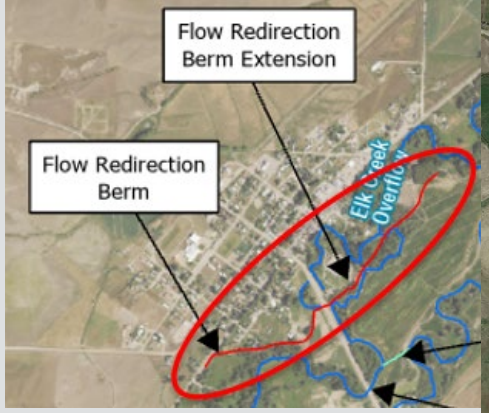


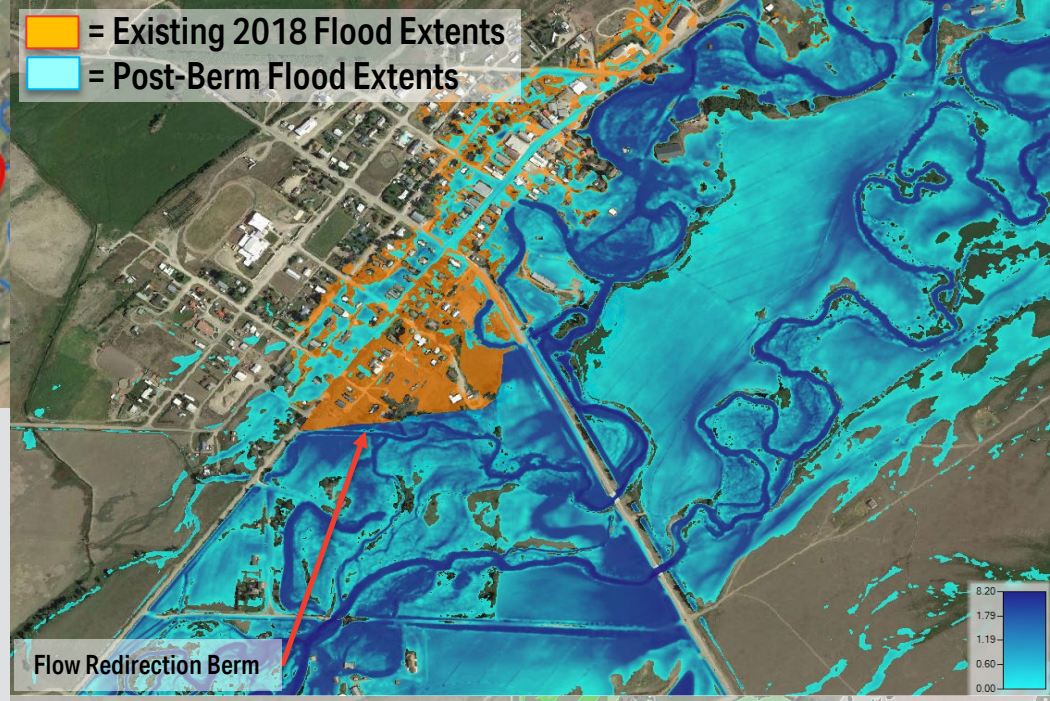


= Existing 2018 Flood Extents
= Post-Berm Flood Extents

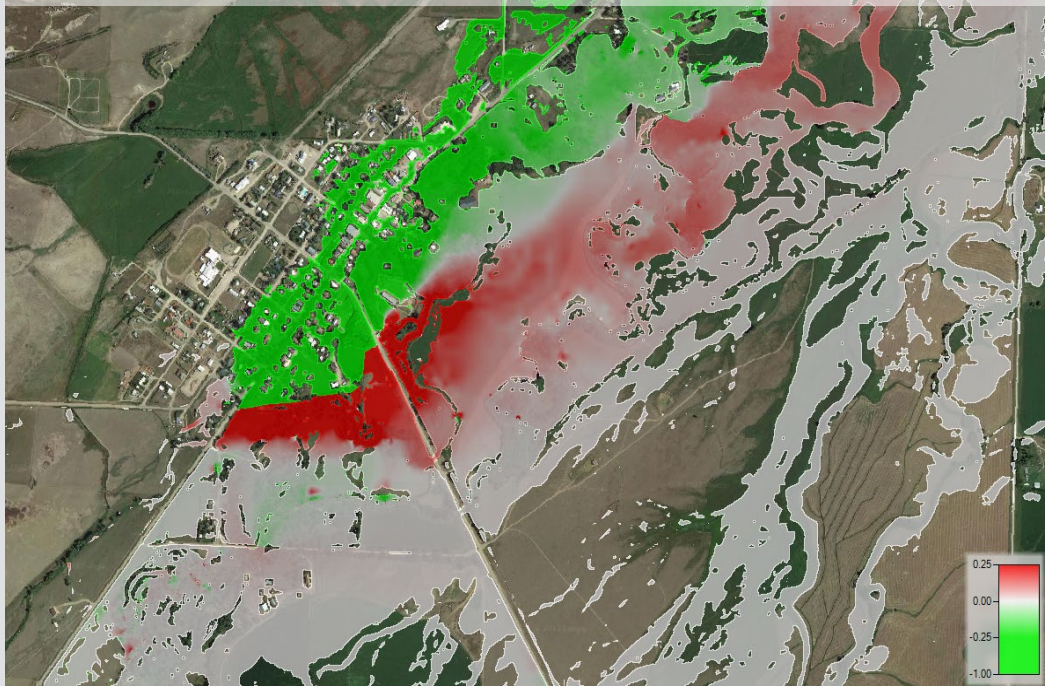
FLOW REDIRECTION BERM

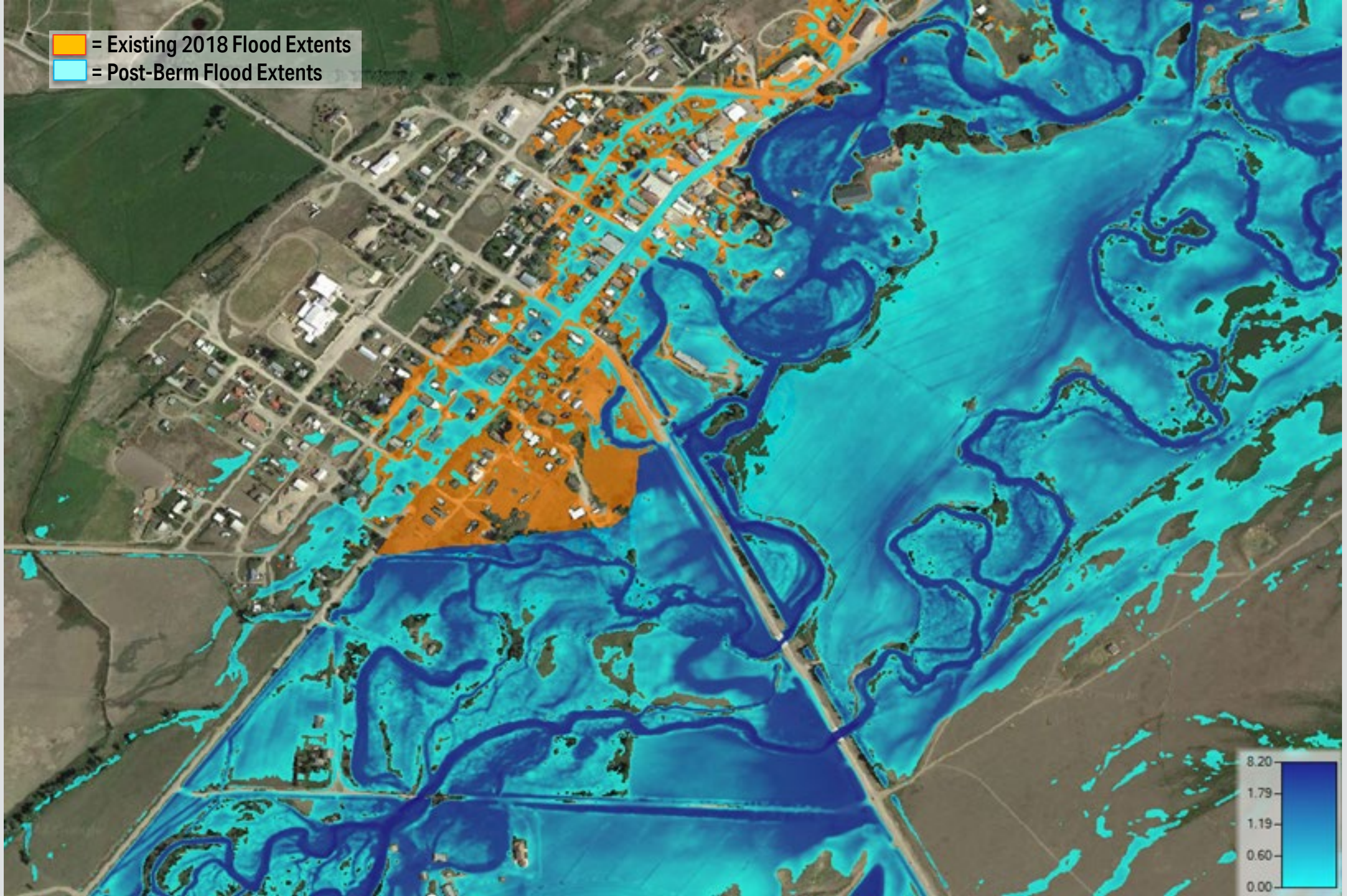
- NORTH OF LOVER'S LANE
- BERM TO BLOCK FLOOD WATERS FROM ENTERING TOWN
- DEPTH INCREASES ALONG BERM ARE 0.2-2 FEET
- DEPTHS ALONG BERM ARE 0.5 – 3 FEET
- CAN BE COMBINED WITH STRUCTURE RESIZING OR ELK CREEK OVERFLOW CHANNEL DIVERSION
- CONSIDER PREVENTION OF BACKWATER INTO CULVERTS TO SUPPORT

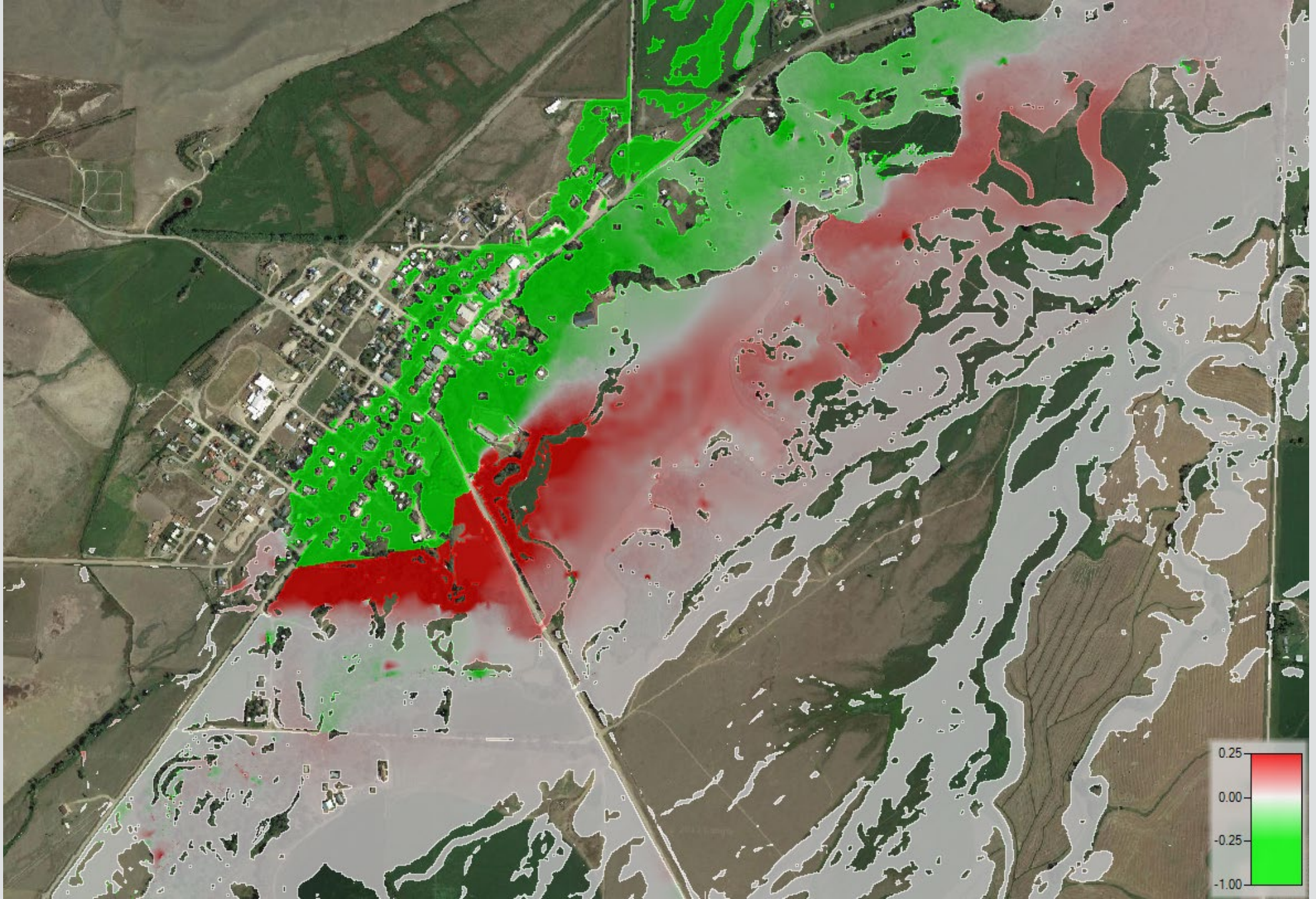




Flow Direction Berm Depth Changes from Existing Conditions

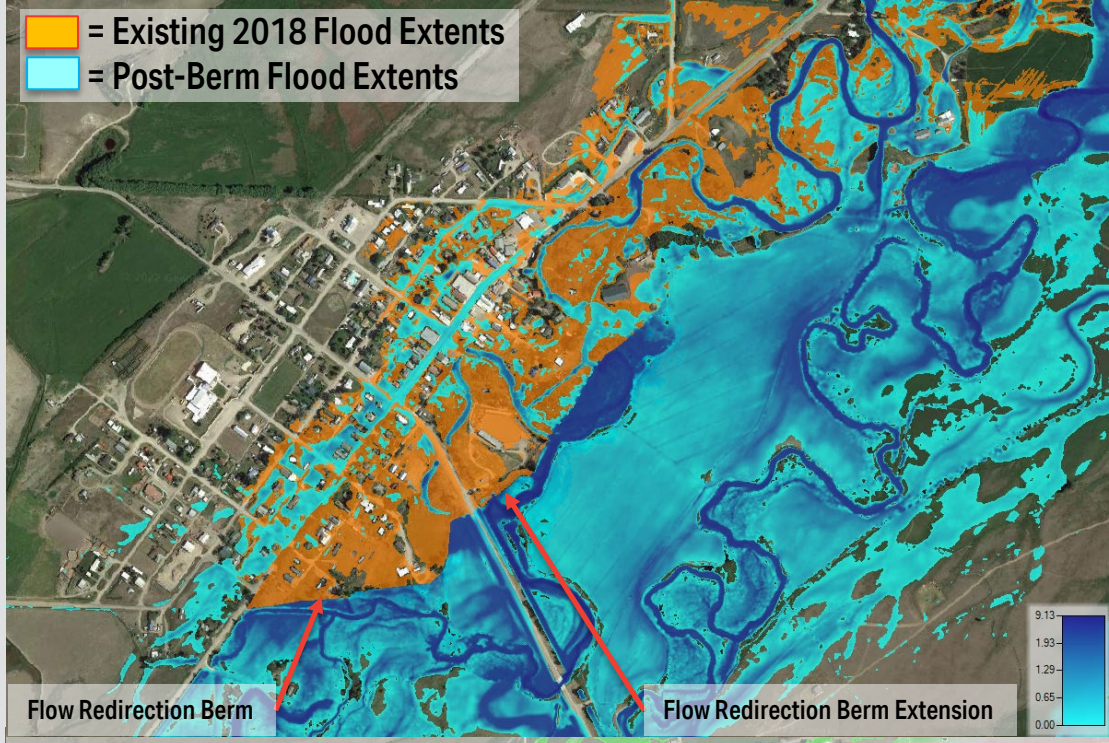



= Existing 2018 Flood Extents
= Post-Berm Flood Extents
8.20
1.79
1.19
0.60
0.00

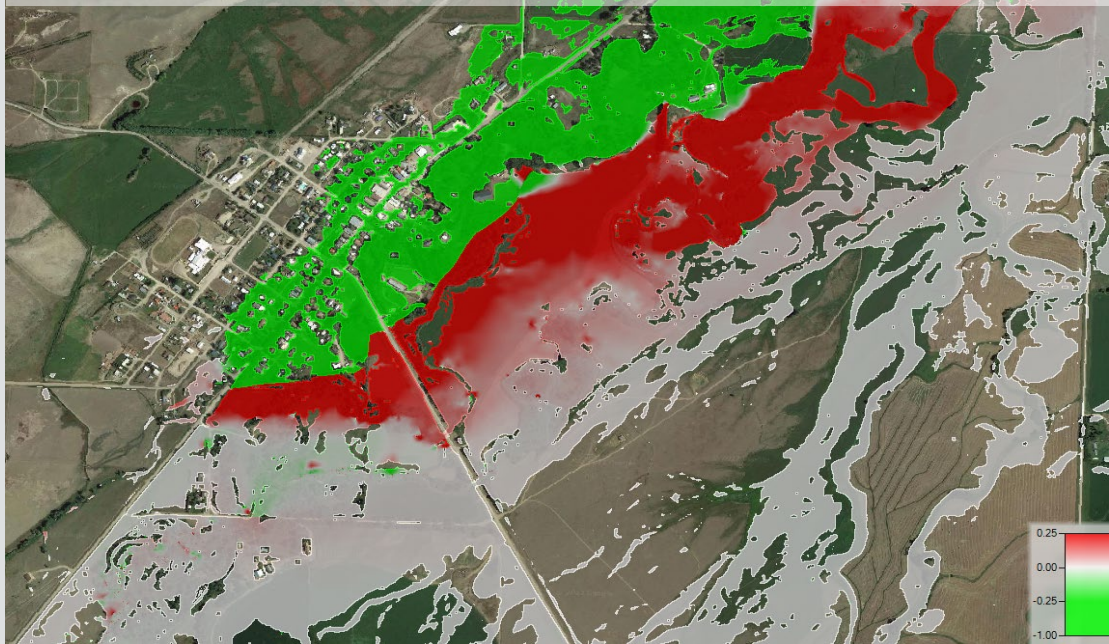

0.25
0.00
-0.25
-1.00

FLOW REDIRECTION BERM EXTENSION

- NORTHEAST OF US 287
- BERM TO BLOCK FLOOD WATERS FROM ENTERING TOWN
- DEPTHS ALONG EXTENSION BERM ARE 0.3 – 5 FEET
- DEPTH INCREASES ALONG EXTENSION BERM ARE 1-4 FEET
- DEPTH INCREASES IN FIELD ADJACENT EXTENSION BERM ARE 0.01 – 0.65 FEET

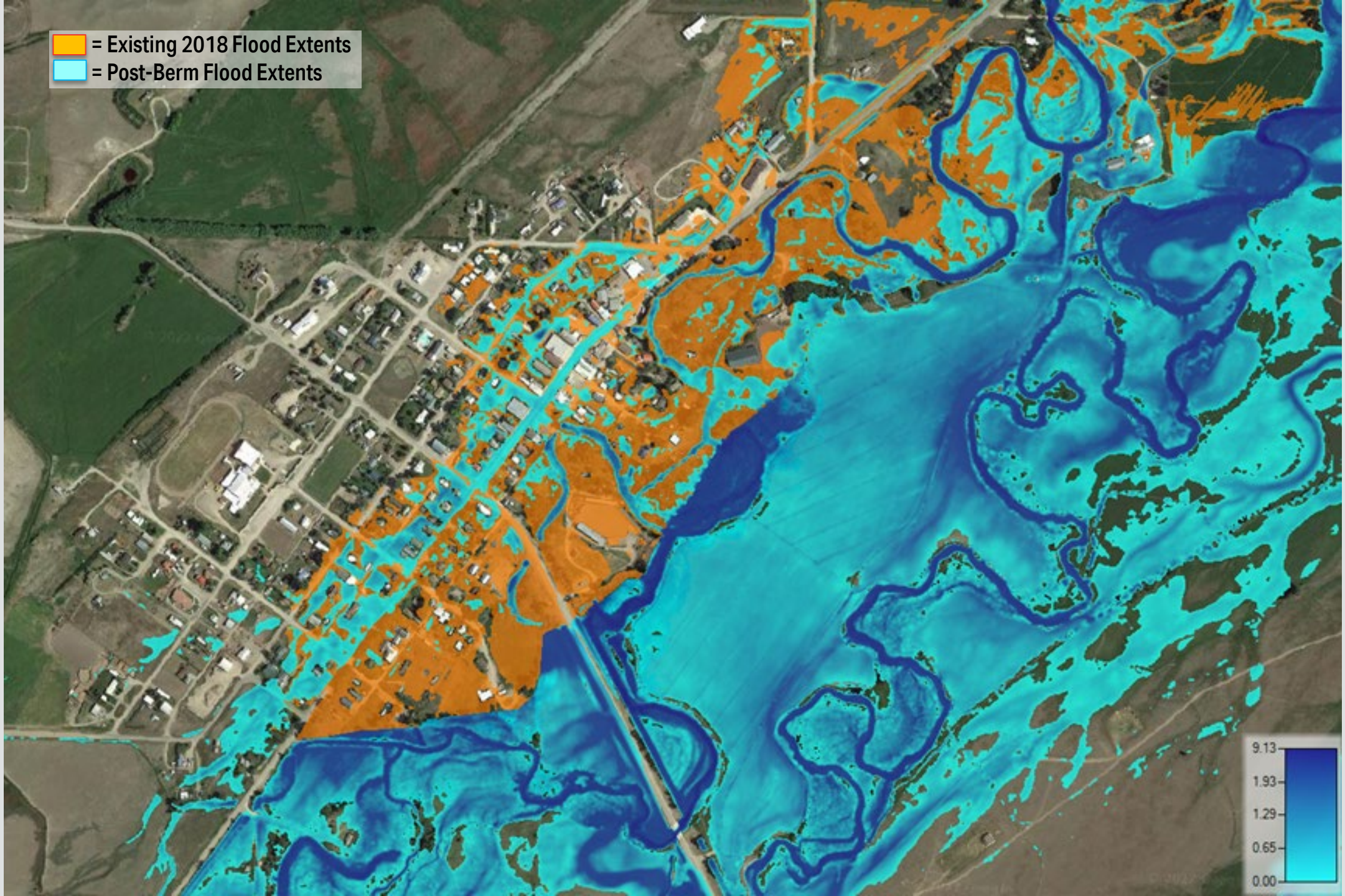


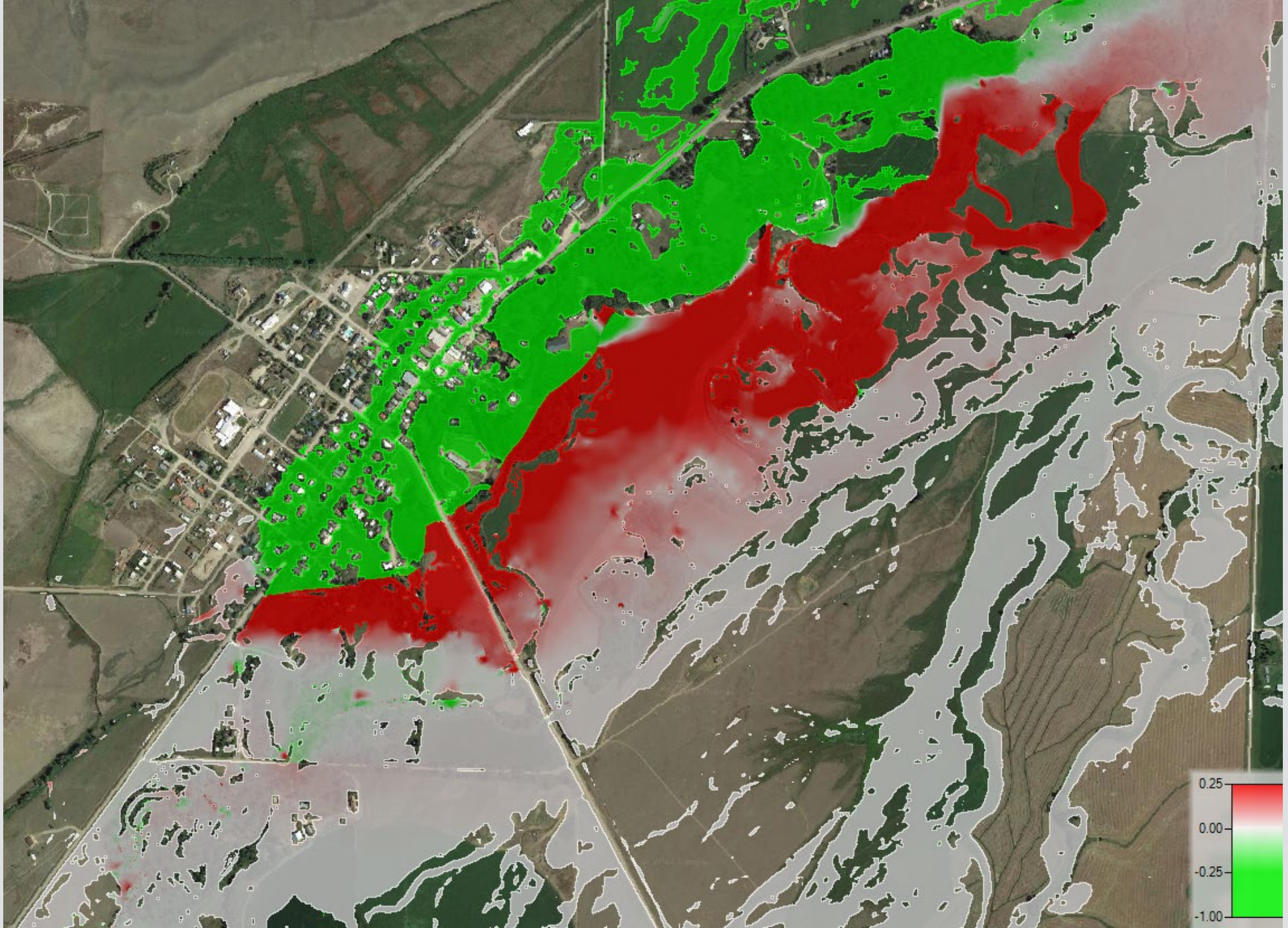
Flow Direction Berm Extension Depth Changes from Existing Conditions



Model Results Percentage of Total Flow In Each Region Just Downstream of US 287

Scenario	Elk Creek Overflow + Floodplain	Elk Creek Main + Floodplain	Hogan Slough + Floodplain
2018 Flood	37.1%	42.9%	20%
Flow Redirection Berm Extension	32.5%	47.6%	20%


= Existing 2018 Flood Extents
= Post-Berm Flood Extents
9.13
1.93
1.29
0.65
0.00


0.25
0.00
-0.25
-1.00

PERMITTING

- FEMA FLOODPLAIN STANDARDS/REGULATIONS
- PERMITTING FOR STATE AND COUNTY REGULATIONS
  - 310 – Lewis and Clark Conservation District
    - Work on bed or banks of perennial streams
  - 404 – U.S. Army Corps of Engineers
    - Placing fill or dredging in Waters of US
  - Floodplain – Local Floodplain Administrator
    - Work within the FEMA 100-year floodplain
    - Issued by Lewis and Clark County

COST-BENEFIT COMPARISON

Lower Cost, Lower Effort → **Higher Cost, Higher Effort**

Smallest Benefit

- Channel and Floodplain Debris Clearing
- Upstream of Clemons Road Berm and Canal Gate Addition
- Florence Canal Diversion
- 287 Bridge Resizing
  - Excavate aggregated materials
  - New bridges that have benches tied into the floodplain elevation
- Flow Redirection Berm Alone
- Elk Creek Overflow Diversion & Plug
- 287 Removal & Re-Alignment
- Hogan Slough Diversion Channel & US 287 Culvert Resizing
- Flow Redirection Berm with Extension
- Flow Redirection Berm Coupled with Elk Creek Overflow Diversion and Extension, & Overflow Channel Plug
- Flood Bypass Channel

Largest Benefit

RECOMMENDED ALTERNATIVES AND PHASING

ONLINE SURVEY FOR COMMENTS

- https://www.surveymonkey.com/r/augusta_pm2
- Comment on any flooding related topic
  - Emphasis on flood observations and mitigation alternatives
- Open until 5/22

NEXT STEPS

- COLLECT COMMENTS AND FEEDBACK FROM THIS MEETING
- MODIFY SIMULATIONS BASED ON COMMENT FEEDBACK
- FINAL REPORT – JUNE ’22

- LONGER TERM:
  - Monitor and pursue funding opportunities

AUGUSTA FLOOD MITIGATION – MAY 2022 MEETING

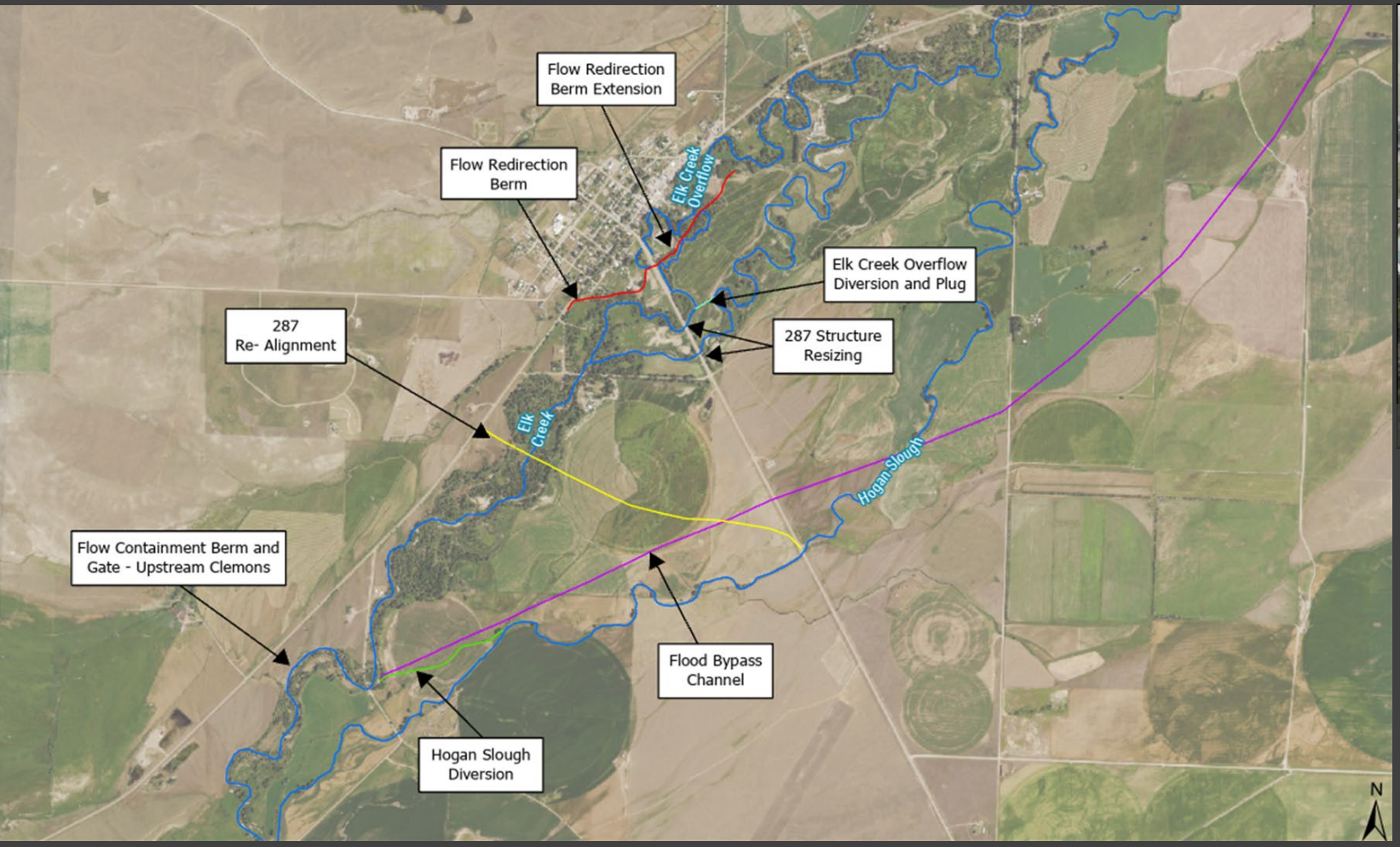


Photo by Mark Taylor

QUESTIONS AND DISCUSSION