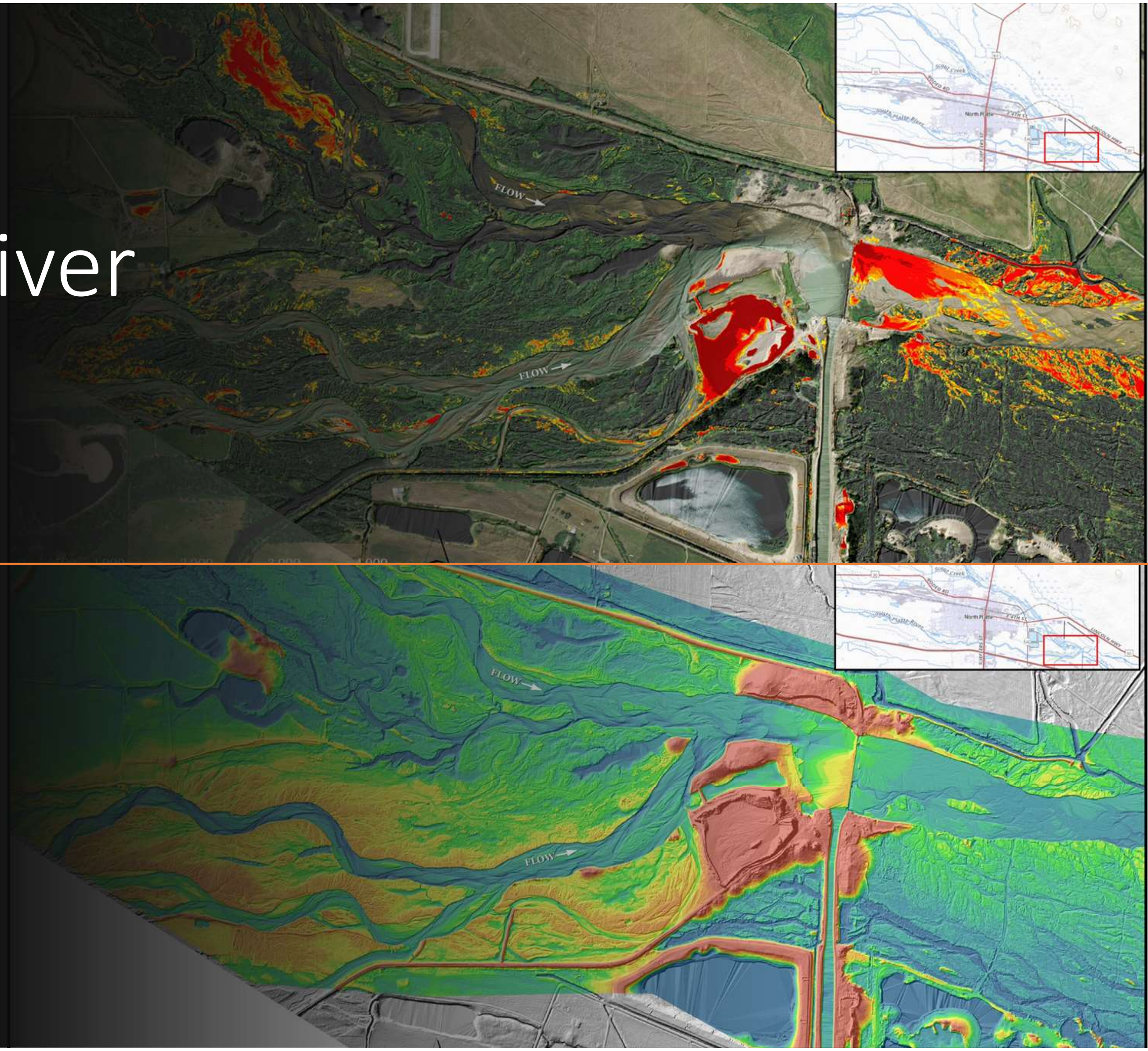
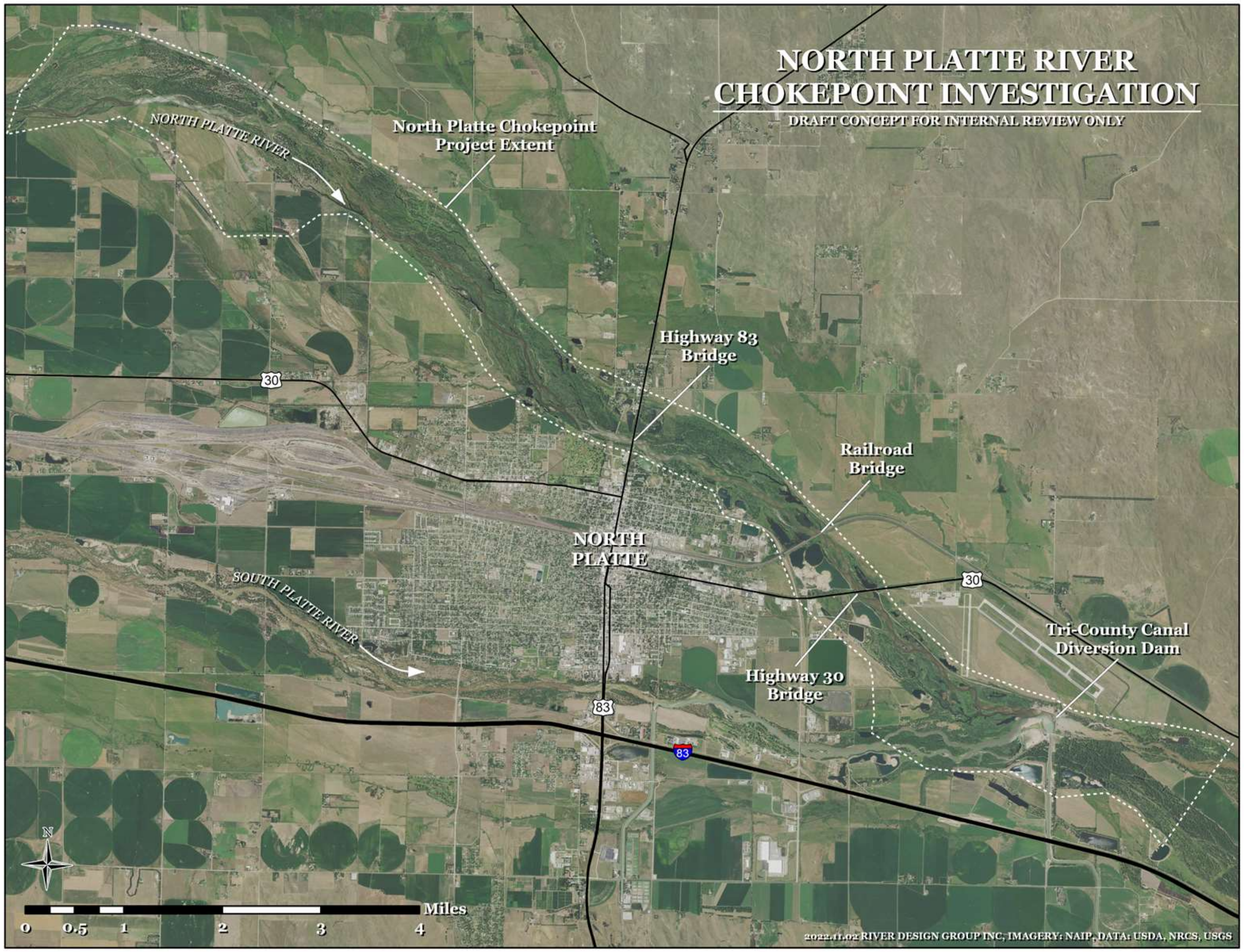
North Platte River Chokepoint Investigation



PRIP Planning Workgroup Meeting

February 1, 2023

North Platte Chokepoint Study Reach



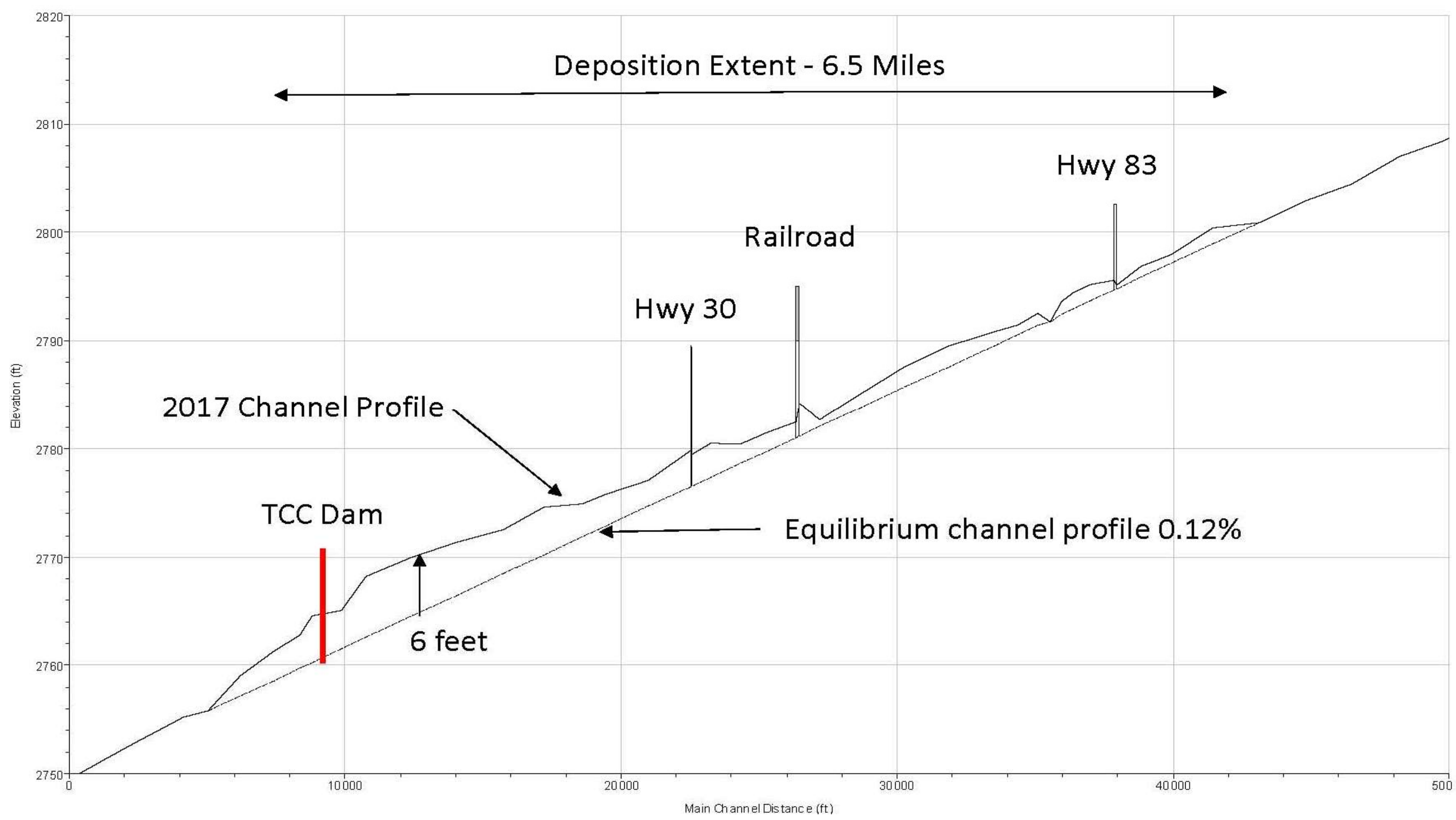
Key Questions

1. What are the major factors contributing to a loss of channel capacity at the North Platte Chokepoint Reach?
2. What is the flooding risk to the city of North Platte under various high flow conditions?
3. What is the projected future capacity at the North Platte Chokepoint under various management conditions?
4. What potential actions could increase capacity through the North Platte Chokepoint?

Tri County Canal Diversion Dam

- Built in 1940
- 11 feet high by 875 feet long
- Dredging operations occur 10 months per year
- More than 100,000 tons of sediment removed per year
- Sediment delivery to TCCDD on a nearly continuous basis
- Supply canal capacity ~ 2,000 cfs

North Platte River Channel Profile



Hydraulic Variables that Influence Channel Capacity

Manning's Formula

$Q = A * 1.486/n * R^{2/3} * S^{1/2}$

Q = Discharge (capacity cfs)

A = Cross-sectional Area of Flow (sq. ft.)

n = Coefficient of Roughness

R = Hydraulic Radius (depth ft.)

S = Slope (ft./ft.)

- ✓ Decrease in slope (TCCDD backwater)
- ✓ Decrease in area (sedimentation from TCCDD backwater)
- ✓ Decrease in width (bridges, levees, berms, roads, etc.)
- ✓ Increase in roughness (vegetation establishment)
- ✓ **All variables affected in a manner that decreases capacity**

Hydraulic Modeling Approach

Adapted existing HEC-RAS 1D model used for three prior modeling efforts (2011 HDR et al, 2013 USACE, 2018 USACE)

- Updated geometry with 2017 topo-bathymetric LiDAR
- Extended downstream of Tri County Canal Diversion Dam 1,000 feet

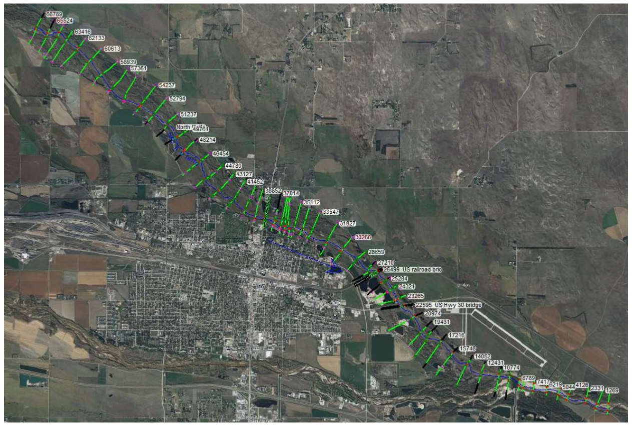


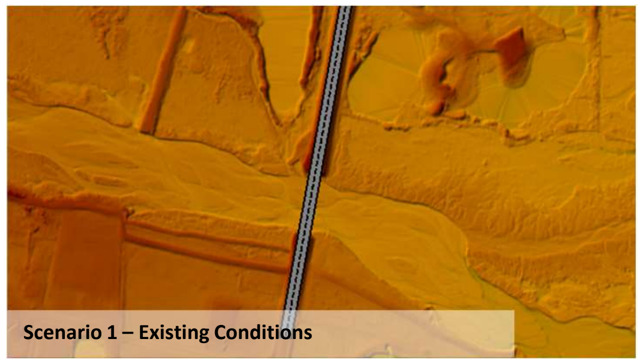
Table 3-2. Parameters for North Platte Chokepoint hydraulic model.

Software	HEC-RAS Version 6.2
Geometry	2017 topo-bathymetric LiDAR
Flows	1,000 to 12,000 cfs
Roughness	0.020 (channel) to 0.160 (floodplain)
Cross Sections	50
Calibration	Unchanged from USACE model
Infrastructure	Bridges, Tri-County Canal Diversion Dam, Levees
Ineffective Flow Areas	Bridges, borrow pits, vegetated islands

Hydraulic Modeling Scenarios

Developed 10 modeling scenarios aimed at evaluating sensitivity of channel capacity to key variables:

- Slope – TCCDD backwater
- Area - Sediment aggradation
- Area - bridge constrictions
- Roughness - vegetation



Scenario 1 – Existing Conditions

Scenario 2 – Bridge Structure Removed

Scenario 3 – Widen Opening to 500’

Scenario 4 – Widen Opening to 1000’

Modeling Results – Bridge Constrictions

- The bridges constrict the North Platte floodplain by as much as 85%.
- Modeling found that bridge constrictions contribute to ***localized*** effects on channel capacity and effects are relatively minor for moderate flows up to 3,000 cfs.
- Sedimentation effects from the TCCDD extend upstream through the three bridges.
- Increasing the width of the bridge openings is not a sustainable solution without addressing TCCDD operations and reach-scale aggradation.

Table 4-1. Increase in channel capacity at bridge locations for widening the openings to 1,000 feet.

Increase in capacity at Highway 83 (Existing width = 320 feet)	Increase in capacity at Union Pacific Railroad (Existing width = 250 feet)	Increase in capacity at Highway 30 (Existing width = 560 feet)
+ 96 (7%) at 1,334 cfs	+ 443 (30%) at 1,473 cfs	No increase
+ 551 (20%) at 2,773 cfs	+ 930 (33%) at 2,786 cfs	
+ 1,189 (24%) at 4,906 cfs	+ 1,886 (41%) at 4,626 cfs	
+ 2,042 (24%) at 8,362 cfs	+ 1,434 (18%) at 8,125 cfs	

Modeling Results – Vegetation Encroachment

- The current hydrologic regime supports vegetation establishment and vegetation encroachment on the channel contributes to reach-scale deposition.
- If vegetation was removed on a reach scale, channel capacity would increase by less than 10% for flows up to 7,000 cfs.
- Reach-scale vegetation removal may provide short-term benefits for habitat and capacity, but benefits would be temporary due to the lack of historical disturbance regimes such as floods and fires.
- Vegetation removal is not a sustainable solution without addressing TCCDD operations, reach-scale aggradation, and Kingsley Dam operations.

Table 4-2. Increase in channel capacity at bridge locations for vegetation removal within 1,000 feet of the active channel.

Increase in capacity at Highway 83	Increase in capacity at Union Pacific Railroad	Increase in capacity at Highway 30
+ 119 (10%) at 1,143 cfs	+ 106 (7%) at 1,473 cfs	+ 119 (10%) at 1,143 cfs
+ 153 (6%) at 2,576 cfs	+ 186 (7%) at 2,786 cfs	+ 153 (6%) at 2,576 cfs
+ 183 (4%) at 4,573 cfs	No increase	+ 183 (4%) at 4,573 cfs
+ 654 (9%) at 7,080 cfs	No increase	+ 654 (9%) at 7,080 cfs

Modeling Results – Dredging Scenarios

- Three dredging scenarios were simulated using the hydraulic model.
- Scenarios included dredging a channel seven miles through the Chokepoint Reach at the estimated equilibrium channel slope of 0.12% for widths of 200 feet, 500 feet and 1,000 feet.
- Dredging a channel 200 feet wide could increase flood stage capacity from approximately 1,500 cfs to 4,000 cfs and would require removal of ~1.5 million cubic yards of material.

Table 4-3. Modeled flood stage capacity at the Highway 83 Bridge for dredging scenarios.

Scenario	Flood Stage Capacity (cfs)	Dredge volume (cubic yards)
Existing Conditions	1,775	N/A
Dredge 200 feet wide	4,678	1,500,000
Dredge 500 feet wide	7,868	3,700,000
Dredge 1,000 feet wide	> 12,000	7,400,000

#2 - Flood Risk

A. What would be the spatial extent of flooding in the city of North Platte and adjacent communities considering a range of high flows including 3,000, 6,000, 9,000, and 12,000 cfs under current and projected future streamflow capacities?

B. In the absence of releases from Kingsley Dam, what is the probability that these flows will occur downstream of Lake McConaughey and upstream of the city of North Platte?

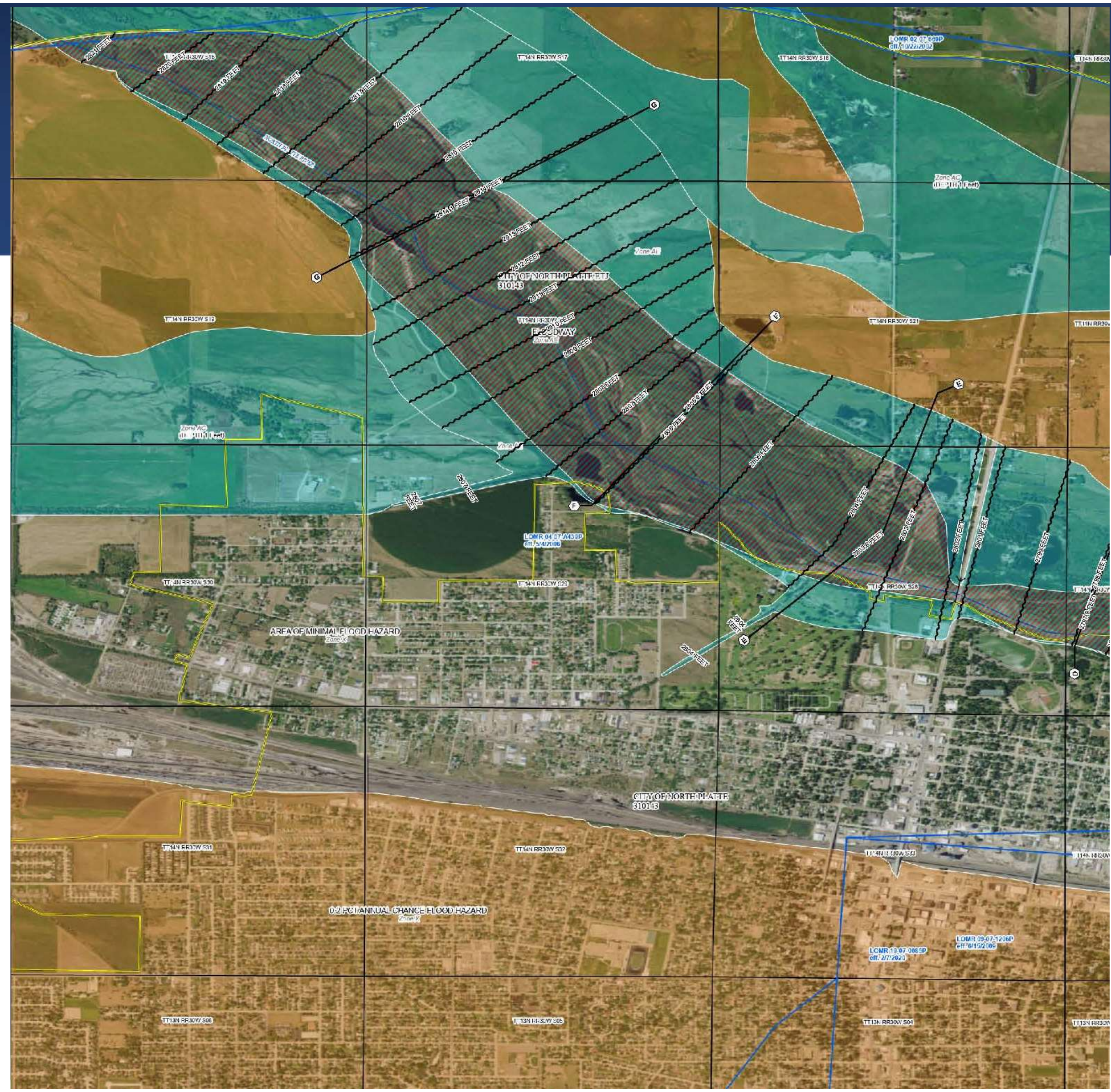
C. What level of rainfall needs to be observed locally for such flows to occur?

D. How do climate projections influence the probability of large rainfall events and therefore flooding risk from peak river flows?

#2 - Flood Risk

A.What would be the spatial extent of flooding in the city of North Platte and adjacent communities considering a range of high flows including 3,000, 6,000, 9,000, and 12,000 cfs under current and projected future streamflow capacities?

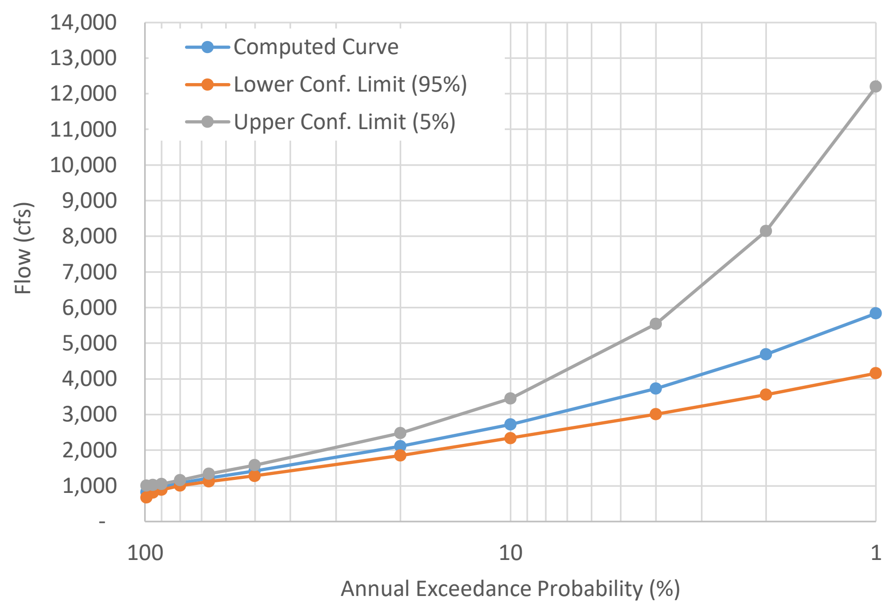
- Model limitations for higher flows
- Flow splits not built into model
- Differing value of Q100 between FEMA and USACE
- Does not account for flooding from groundwater



#2 - Flood Risk

B. In the absence of releases from Kingsley Dam, what is the probability that these flows will occur downstream of Lake McConaughey and upstream of the city of North Platte?

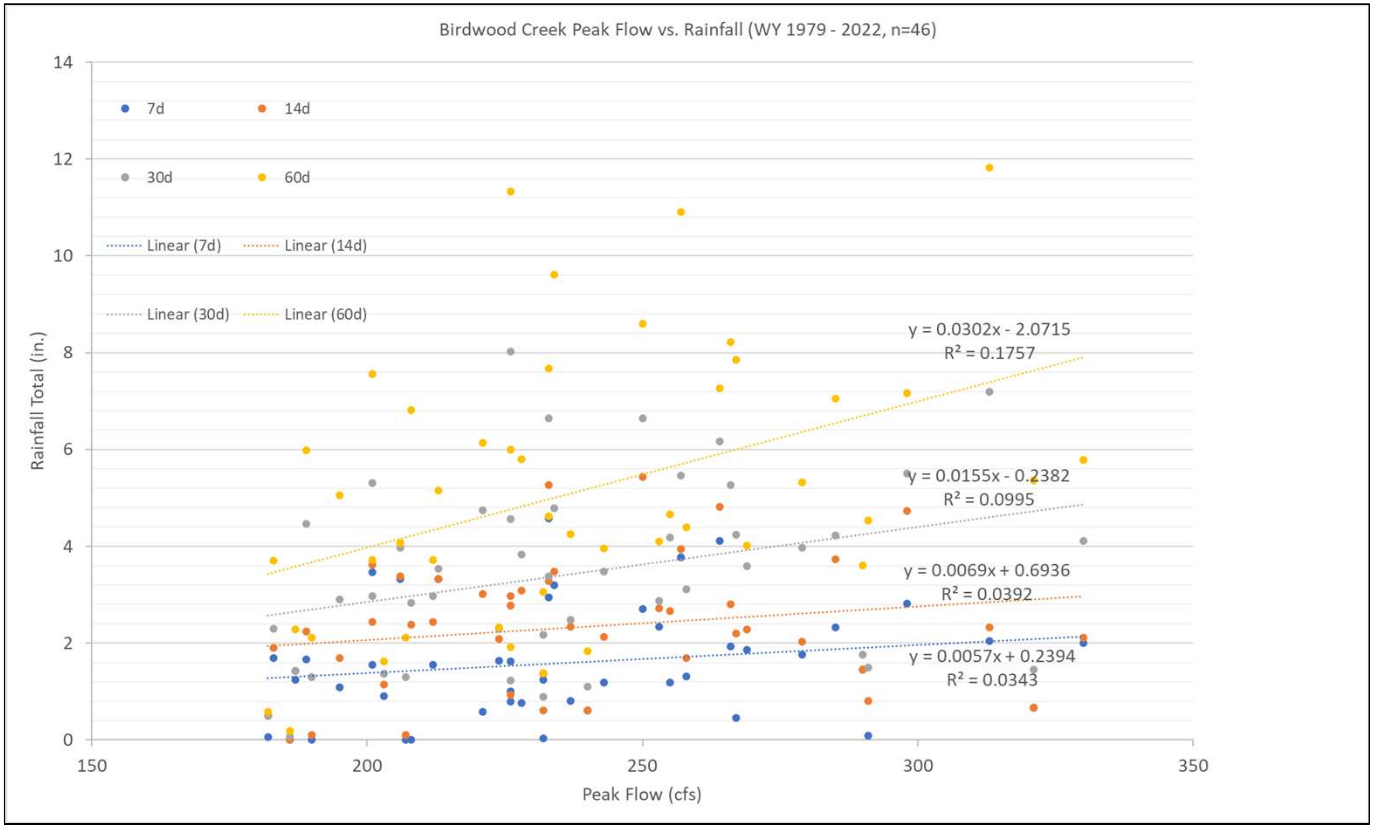
- Contributing drainage area 10-20% of total drainage area due to basin characteristics i.e., closed basins, highly permeable soils and irrigation withdrawals
- Only gaged tributary is Birdwood Creek (USGS reports 940 square miles total drainage area with only 80 square miles contributing)
- Contributing flows were interpolated from USGS period of record for Birdwood Creek (1932 – 1993) representing 25% of total area
- Result - flows of 3,000 cfs from tributaries have return interval of ~ 12 years (AEP of 8%)



#2 - Flood Risk

C. What level of rainfall needs to be observed locally for such flows to occur?

- Evaluated correlation between rainfall record at North Platte airport and gage on Birdwood Creek
- Poor correlation due to basin characteristics and spatial variations in precipitation
- Conclusions consistent with other studies (USGS, NDNR 2013)



#2 - Flood Risk

D. How do climate projections influence the probability of large rainfall events and therefore flooding risk from peak river flows?

- Climate projections suggest that the probability of large rainfall events and the flooding risk from peak river flows could increase or decrease. Given the uncertainty of climate model predictions, a range of possible outcomes is possible given the climate model's wide band of confidence limits.

#3 - Chokepoint Trends and Future Capacity

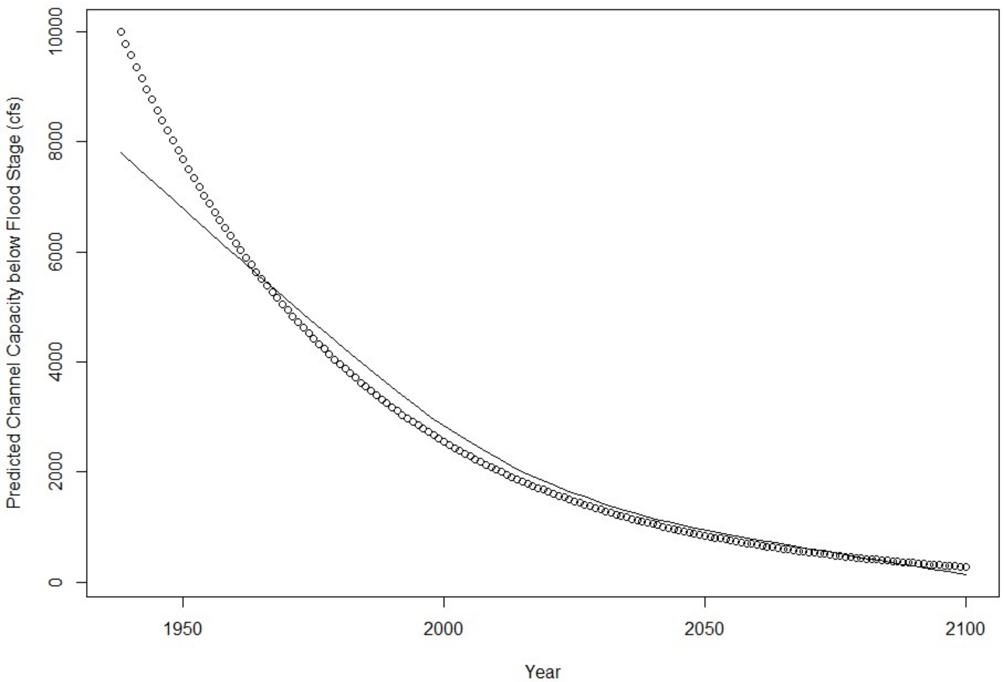
A. If nothing is done, at what rate will flow capacity in the North Platte River change?

B. What would be the projected change in capacity under various management scenarios (e.g., regular sediment removal, installation of a sediment bypass system at the Tri- County Canal Diversion Dam, regular in-channel vegetation control, etc.)?

#3 - Chokepoint Trends and Future Capacity

If nothing is done, at what rate will flow capacity in the North Platte River change?

- Loss of capacity ~85% in 80 years, or 2.2% per year (10,000 cfs to 1,800 cfs)
- Trend will continue with diminishing loss of capacity (stage is 3 feet higher for flow of 2,000 cfs)
- Hydrologic conditions favor vegetation establishment
- Increased flood risk
- Habitat conversion from sand bars and grasses to riparian forest
- Decrease in bridge conveyance
- Decreased ability to deliver water to Tri-County Canal
- Increased costs for operations, maintenance and flood control



#4 - Potential Actions to Increase Capacity

Prior Studies

- Common theme is that recommendations were not sustainable
- Structural remedies (berms, overflow channels, etc.) found to transfer flooding and sediment problems elsewhere
- Tri-County Canal Diversion Dam not addressed
- None of the cost analyses accounted for impacts to habitat, recreation or local economies
- Most studies completed prior to 2017 Topobathy LiDAR

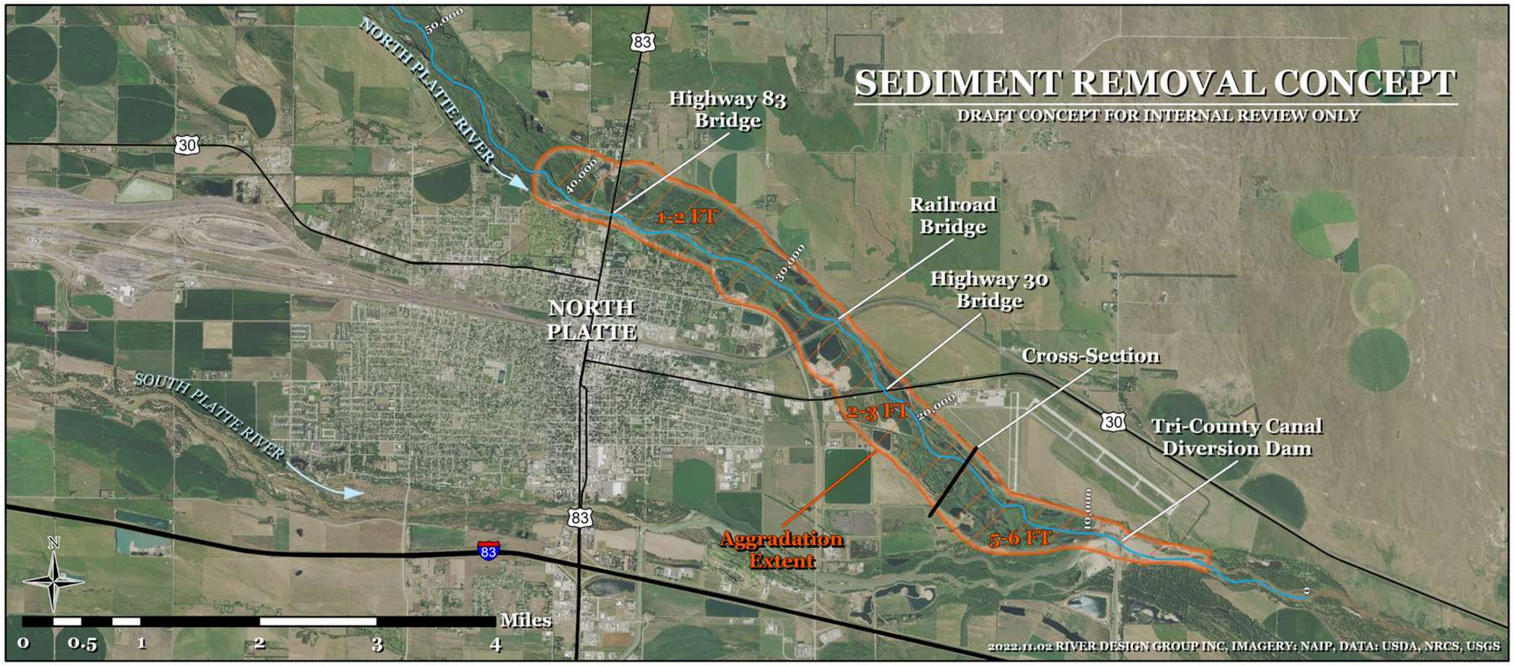
#4 - Potential Actions to Increase Capacity

A. Is it essential to modify the Tri-County Canal diversion dam system to increase flow and sediment conveyance capacity locally? **Yes.**

B. Could widening bridges significantly increase discharge capacity and sediment transport? **No, benefits are local (within one half-mile of bridges) and temporary given reach-scale constraints.**

C. What impact could river disking and vegetation removal have on North Platte River flow conveyance capacity? **Extensive effort to achieve less than 10% gain in capacity and improvements would be temporary given constraints of current hydrologic and sediment regimes.**

D. Is it necessary to actively remove sediment from the channel bed to increase local flow conveyance? What methods could be used (e.g., dredging)? **Yes, a combination of active (dredging) and passive (river erosion) methods could be used. Modeling needed to confirm.**


SEDIMENT REMOVAL CONCEPT
DRAFT CONCEPT FOR INTERNAL REVIEW ONLY
NORTH PLATTE RIVER
SOUTH PLATTE RIVER
NORTH PLATTE
Highway 83 Bridge
Railroad Bridge
Highway 30 Bridge
Cross-Section
Tri-County Canal Diversion Dam
Aggradation Extent
1-2 FT
2-3 FT
5-6 FT
50,000
40,000
30,000
20,000
10,000
0
83
30
Miles
0 0.5 1 2 3 4
N
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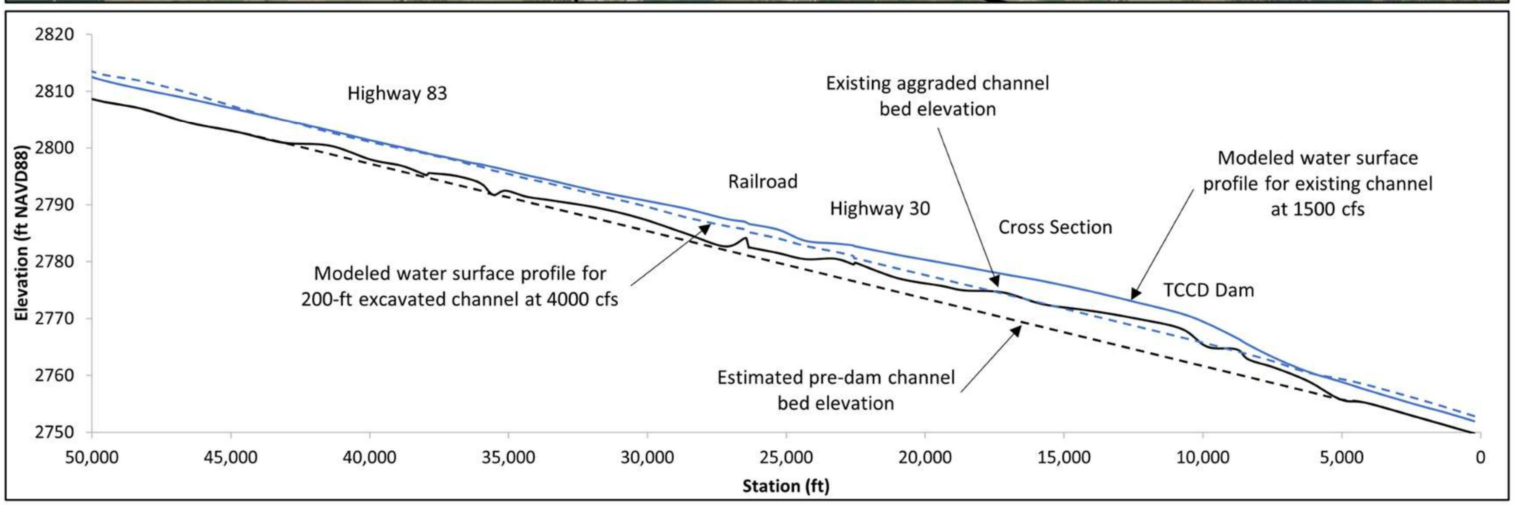
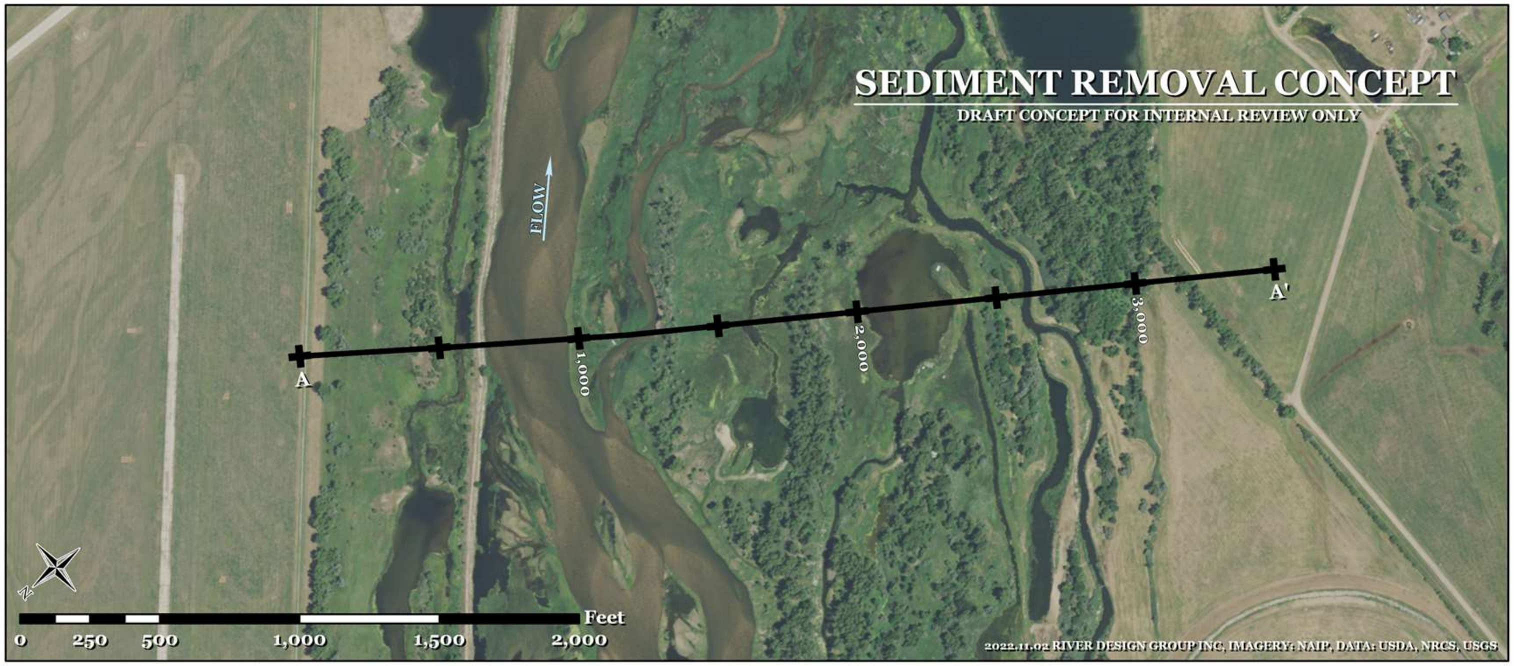

Elevation (ft NAVD88)
Station (ft)
2820
2810
2800
2790
2780
2770
2760
2750
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
Highway 83
Railroad
Highway 30
Cross Section
TCCD Dam
Existing aggraded channel bed elevation
Modeled water surface profile for existing channel at 1500 cfs
Modeled water surface profile for 200-ft excavated channel at 4000 cfs
Estimated pre-dam channel bed elevation



SEDIMENT REMOVAL CONCEPT
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FLOW
A
1,000
2,000
3,000
A'
0
250
500
1,000
1,500
2,000
Feet
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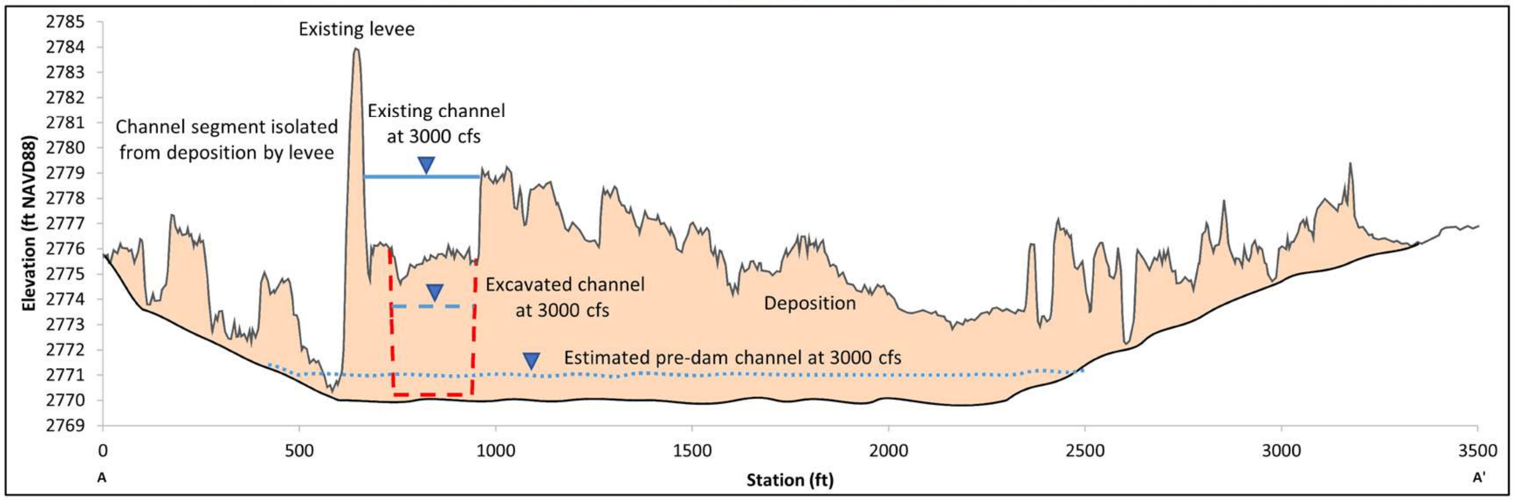


Existing levee
Channel segment isolated from deposition by levee
Existing channel at 3000 cfs
Excavated channel at 3000 cfs
Deposition
Estimated pre-dam channel at 3000 cfs
Elevation (ft NAVD88)
2785
2784
2783
2782
2781
2780
2779
2778
2777
2776
2775
2774
2773
2772
2771
2770
2769
0
500
1000
1500
2000
2500
3000
3500
A
A'
Station (ft)

Sediment Removal Pros/Cons

Benefits

- Addresses the primary cause of sedimentation by restoring equilibrium channel slope to the reach
- Increase in capacity from 1800 cfs to 4600 cfs at Highway 83 (North Platte Gage)
- Reduced flood risk
- Reduced dredging operations at Tri-County Canal Dam
- Lower water table limits vegetation establishment
- Continued channel erosion removes existing vegetation
- Sediment delivery to downstream reaches
- Formation of new sand bards creates habitat for focal speces

Sediment Removal Pros/Cons

Feasibility Concerns

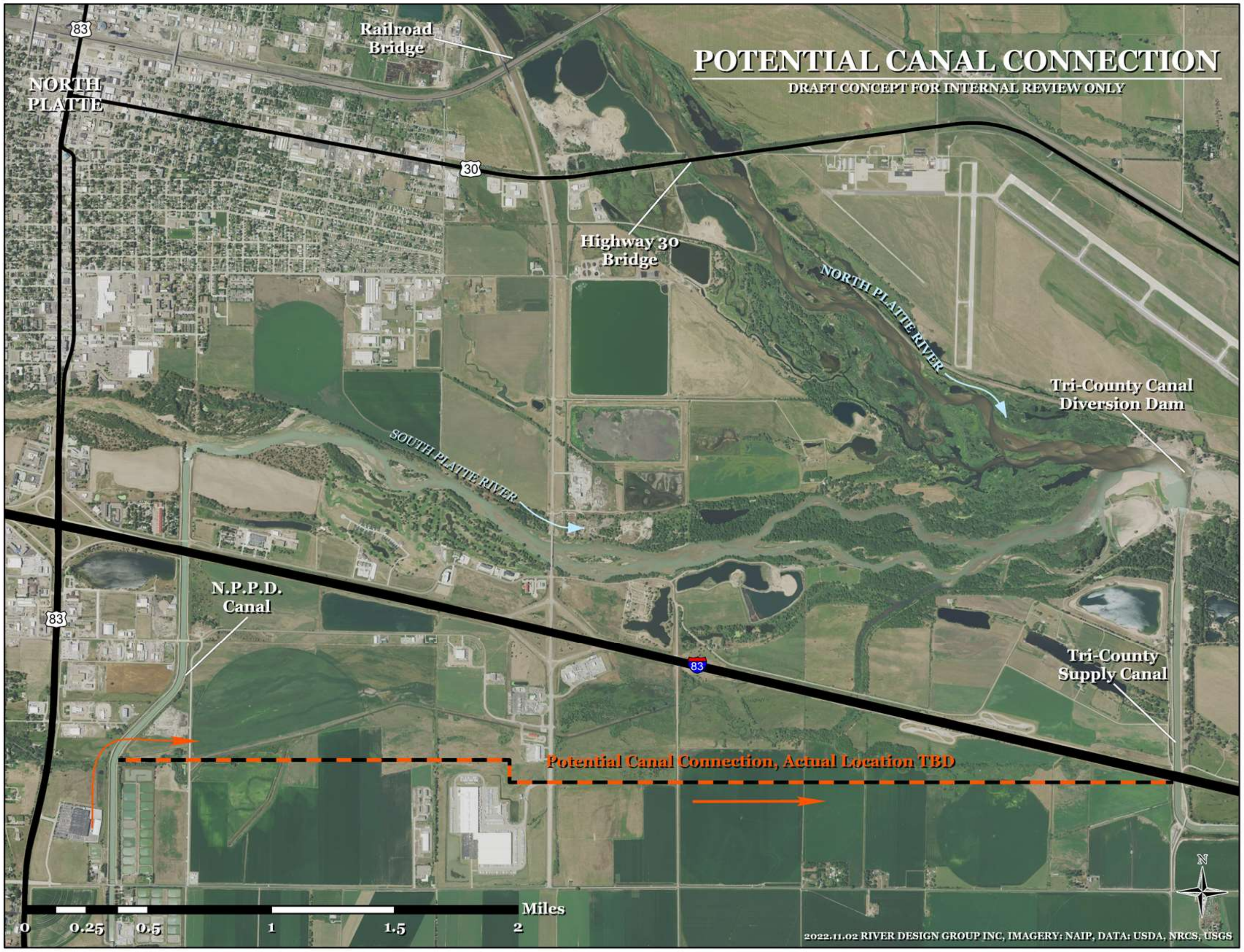
- Modifications to Tri-County Canal Dam and irrigation/hydropower operations
- Extent of channel erosion in response to dredging
- Impacts of channel erosion on private property and infrastructure
- Impacts of sediment delivery to downstream reaches
- Sustainability of dredged channel
- Ability to manage flows from Kingsley Dam to sustain channel capacity
- Vegetation re-establishment at lower elevations
- Permitting, outreach and coordination with stakeholders
- Cost

Sediment Removal Feasibility

Develop sediment transport model to address questions:

- How much dredging is required to allow the river to do the remaining work?
- What magnitude and duration of flows are needed?
- How much lateral erosion could occur?
- Which areas could be affected by erosion?
- How much flow and sediment can bypass the TCCDD via the existing spillway and radial gates?
- Where does the sediment go that bypasses the TCCDD?

Answers will inform how much active and passive removal can be accomplished



POTENTIAL CANAL CONNECTION
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NORTH PLATTE
Railroad Bridge
83
30
Highway 30 Bridge
NORTH PLATTE RIVER
SOUTH PLATTE RIVER
Tri-County Canal Diversion Dam
N.P.P.D. Canal
83
Tri-County Supply Canal
Potential Canal Connection, Actual Location TBD
0
0.25
0.5
1
1.5
2
Miles
N
2022.11.02 RIVER DESIGN GROUP INC, IMAGERY: NAIP, DATA: USDA, NRCS, USGS

Canal Modification Pros/Cons

Benefits

- Reduces or eliminates need for Tri-County Canal Diversion Dam
- Dam modification could allow for passive sediment evacuation
- Addresses the primary cause of sedimentation by restoring equilibrium channel slope to the reach
- Increase in channel capacity
- Reduced flood risk
- Lower water table limits vegetation establishment
- Continued channel erosion removes existing vegetation
- Sediment delivery to downstream reaches
- Formation of new sand bars creates habitat for focal species

Canal Modifications Pros/Cons

Feasibility Concerns

- Land acquisition for new canal
- Modifications to irrigation/hydropower operations
- Instream flow requirements for lower South Platte River
- Ecological, hydrologic and geomorphic impacts to the lower South Platte River
- Extent of channel erosion in response to passive sediment removal
- Impacts of channel erosion on private property and infrastructure
- Impacts of sediment delivery to downstream reaches
- Sustainability of new channel
- Permitting, outreach and coordination with stakeholders
- Cost

Closing Thoughts

- North Platte River has many uses and recommendations must accommodate a broad audience to achieve solutions to the problem.
- VESPR provided criteria to guide the recommendations of this study including reduce flood risk, maintain irrigation canal operations, improve habitat for native species, decrease infrastructure maintenance, and promote opportunities for recreation.
- Removal of accumulated sediment from the Chokepoint Reach will require a combination of dredging and modifications to TCCDD operations to allow sediment to bypass the dam.
- Dredging could be employed to excavate a pilot channel down to the estimated pre-dam profile that would allow river flows to perform additional sediment removal via lateral erosion.
- The amount of energy available for flow to remove sediment would depend on how much flow can bypass the TCCDD.
- A sediment transport model would be needed to evaluate potential combinations of dredging and flow releases that would be feasible.
- The current FERC license was issued in 1998 for a term of 40 years and the next renewal is scheduled for 2038.