MEMORANDUM

Anderson Consulting Engineers, Inc.
Civil • Water Resources • Environmental

DATE: September 2, 2016 **ACE PROJECT NO.:** NEHEADWATERS04-04

TO: Jerry Kenny, PhD, P.E., Headwaters Corporation

FROM: Brad Anderson, P.E., Anderson Consulting Engineers, Inc.
Michelle Martin, P.E., Anderson Consulting Engineers, Inc.

SUBJECT: North Platte Chokepoint: Feasibility Assessment of Recommended Alternatives

The Executive Director's Office (EDO) of the Platte River Recovery Implementation Program (PRRIP) requested assistance from Anderson Consulting Engineers, Inc. (ACE) as special advisor to the EDO, to evaluate methods to improve flood conveyance through the Chokepoint on the North Platte River in order to accommodate short duration high flows. Specifically, the objective of the evaluation was to identify alternatives that would achieve a flow of 3,000 cfs downstream of Highway 83 during a short duration high flow (SDHF) and to accommodate environmental account (EA) releases along with irrigation releases without exceeding flood stage. This work was initiated in 2012 with a preliminary analyses of alternatives, supported by sediment transport analyses and modeling. Additional work was completed and the results provided in a memorandum completed by ACE (May 2015). The results of the May 2015 memorandum identified an improvement alternative that satisfied the objective identified above. Furthermore, the memorandum recommended that additional analyses be completed to: (a) determine the feasibility and practical implementation of the recommended alternative improvement, and (b) compare the feasibility of the recommended alternative improvement with the feasibility of an alternative associated with compensation for inundation of property.

In recent weeks, an additional alternative was formulated that involved the diversion of a portion of the SDHF of 3,000 cfs from the North Platte River to the South Platte River via existing irrigation diversion structures and conveyance facilities. The purpose of the alternative is to divert as much as 1,500 cfs to the South Platte River thereby reducing the impact of flooding associated with flows of 3,000 cfs on property owners adjacent to the Chokepoint near Highway 83.

This memo summarizes the results of a feasibility study to divert a portion of the SDHF to the South Platte River. In addition, a comparative assessment of the results of the feasibility investigation all three alternatives is also provided. In summary, this memo provides information related to the feasibility of implementing the following alternatives to improve flood conveyance through the Chokepoint on the North Platte River in order to accommodate short duration high flows.

> ***Diversion Alternative:*** Diversion of 1,500 cfs from the North Platte River to the South Platte River via existing irrigation diversion structures and conveyance facilities.
>
> ***Recommended Construction Alternative:*** Channel Widening Upstream of Highway 83 and channel dredging along with construction of jetties/bendway weirs downstream of Highway 83.
>
> ***Property Inundation Compensation Alternative***: The parcels impacted by the SDHF of 3,000 cfs are identified along with specific information related to land or structure impact fees.

Diversion Alternative: Diversion of 1,500 cfs from the North Platte River to the South Platte River via existing irrigation diversion structures and conveyance facilities

A preliminary investigation of the capacity of three irrigation canals (Keith-Lincoln Canal, Suburban Irrigation Canal, and Platte Valley Irrigation Canal) was initiated by the Executive Director's Office (EDO) in the spring of 2013. The investigation focused on the capability of the existing facilities to convey water from the North Platte River and utilize existing wasteways to deliver water to the South Platte River. The goal of this effort was to determine the potential for reducing the flooding impact of the SDHF at the Chokepoint through diversion of a portion of the SDHF to the South Platte River. The results of the investigation indicated less than 100 cfs could be delivered to the South Platte River. Based on the costs of improvements and the minimal benefit realized at the Chokepoint, the EDO decided to pursue other alternatives to achieve the goal of 3,000 cfs at the Chokepoint.

Subsequent to the completion of the EDO investigation, ACE was contacted to conduct an evaluation of diverting as much as 1,500 cfs of the 3,000 cfs SDHF from the North Platte River to the South Platte River. The remaining 1,500 cfs within the North Platte River can presently be conveyed and meet the 6-foot flood stage requirement at the gage located downstream of Highway 83.

Existing irrigation diversion and conveyance facilities were earmarked for the evaluation and included the facilities noted below and indicated on Figure 1:

- Keith-Lincoln Irrigation District (KLID) Canal
- Platte Valley Irrigation District (PVID) Canal
- Suburban Irrigation District (SID) Canal

A preliminary feasibility investigation of each canal was conducted to identify alternatives that warrant additional investigation. This work included identification of the maximum capacity of each canal as well as an evaluation of the potential length of improvements necessary to convey the flow diversion. The maximum capacity of each canal was determined to be:

- 80 cfs (KLID Canal)
- 200 cfs (PVID Canal)
- 80 cfs (SID Canal)

Considering the limitations in capacity noted above, it is apparent that enlargement of the existing canals is required to convey as much as 1,500 cfs to the South Platte River. Given the operational needs for delivery of irrigation water (i.e., the need to check/raise water levels to ensure deliver to existing headgates), a separate conveyance canal for diversion of 1,500 cfs is assumed and will generally follow the alignment of the existing canal facilities unless noted otherwise.

The initial review of the alignment for each canal was conducted through an evaluation of existing aerial photography and topographic mapping. The results of this review are summarized in the items below:

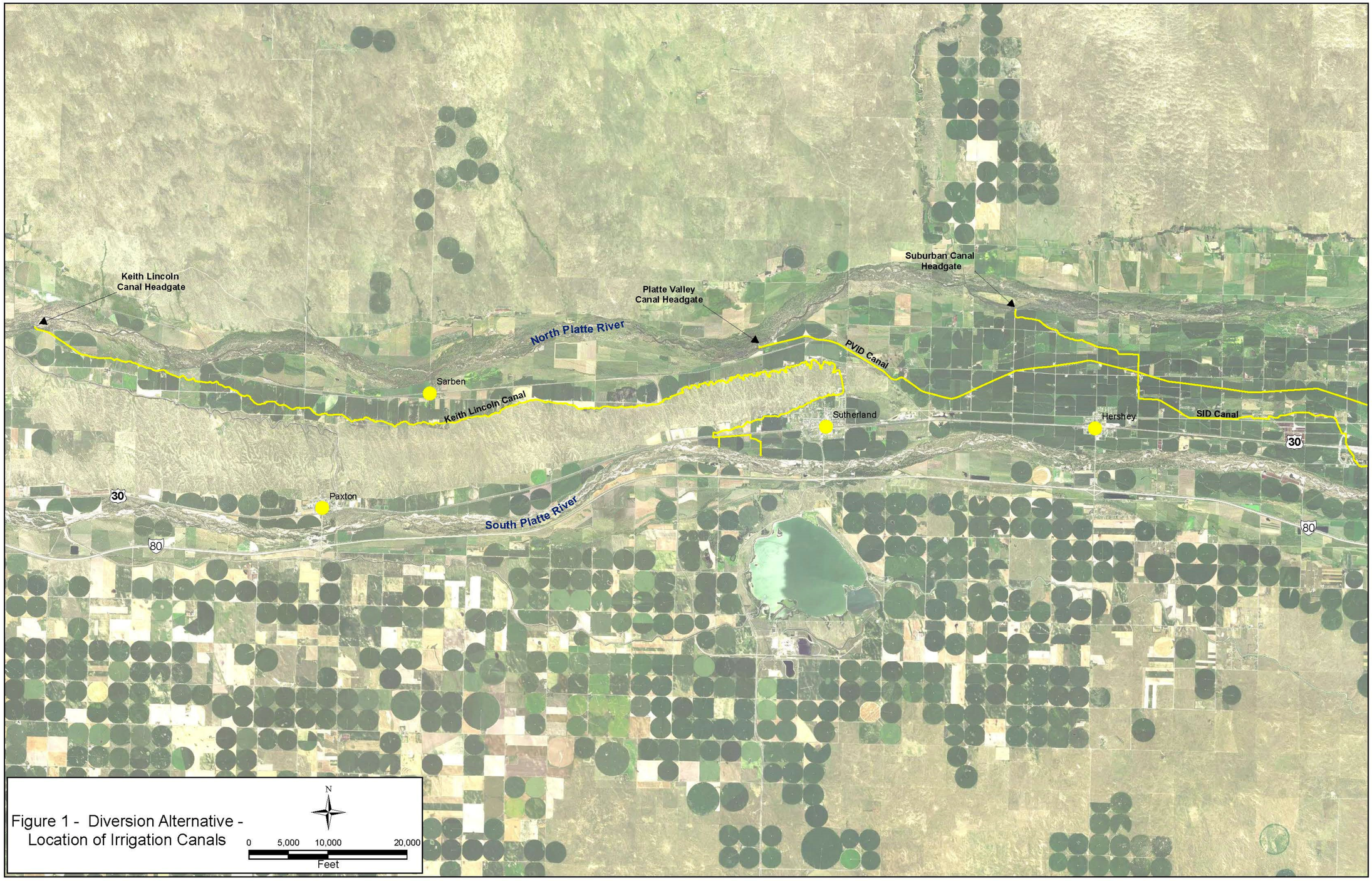

Figure 1 - Diversion Alternative - Location of Irrigation Canals

1. The elevation of the South Platte River channel is generally 15 to 20 feet higher than the North Platte River channel along an axis consistent with the north-south section boundary.
2. A significant ridge exists between the North Platte River and South Platte River north and west of Sutherland, Nebraska.
3. For each of the irrigation districts, the length of the main delivery canal from the North Platte River to a location in close proximity to the South Platte River was ascertained. The length was determined to be approximately 20 miles (KLID Canal), 5 miles (PVID Canal), and 5.7 miles (SID Canal).

Based on the information provided in Items 2 and 3, the alternative improvements associated with the KLID Canal do not warrant further consideration. The KLID Canal would require improvements along a length of canal that is estimated to be 20 miles. However, evaluation of improvements to the PVID Canal and SID Canal is worthy of consideration. Alternative alignments associated with the PVID Canal and SID Canal were developed and are illustrated on Figure 2. Given the ridge along a portion of the PVID Canal, the PVID Alternative 1 alignment follows the existing canal it is directed south along the country road located 1 mile east of Sutherland, Nebraska. The total length of the PVID Alternative 1 alignment is estimated to be 5.3 miles. For the SID Canal, the constraint associated with the ridge does not exist and provided an opportunity for two alternatives for consideration. The SID Alternative 1 alignment directs flow diverted from the North Platte River south along the county road for a distance of 3 miles where the outfall to the South Platte River is located. SID Alternative 2 utilizes the existing canal alignment for approximately 2.9 miles where it is directed south 2.6 miles to the South Platte River for a total length of 5.5 miles.

The alignment for SID Alternative 1 provided the shortest path for any of the considered alternatives. Following a preliminary evaluation of the alignment and profile necessary to convey the flow diversion, it was noted that the most direct alignment is not feasible given the elevation difference between the North Platte River and the South Platte River. The ground elevation in the vicinity of the SID Alternative 1 diversion canal from the North Platte River was determined to be approximately 2905 ft. The existing elevation of the diversion canal near the South Platte River was estimated to be 2915 ft. Assuming a canal slope of 0.0005 ft/ft, the elevation of the canal near the South Platte River would become 2897 ft which is much lower than the invert of the South Platte River channel. Consequently, the SID Alternative 1 was removed from further consideration.

To facilitate the selection of an alternative for development of conceptual construction costs, the two remaining alternatives were evaluated based on the following:

- Number of road crossings and railroad crossings
- Number of siphon crossings of the canal (typically associated with existing canals, laterals, ditches, etc.)
- Acreage and land use identified for acquisition. Land acquisition will vary depending on non-irrigated lands versus irrigated land (flood versus sprinkler irrigation) or dry land.

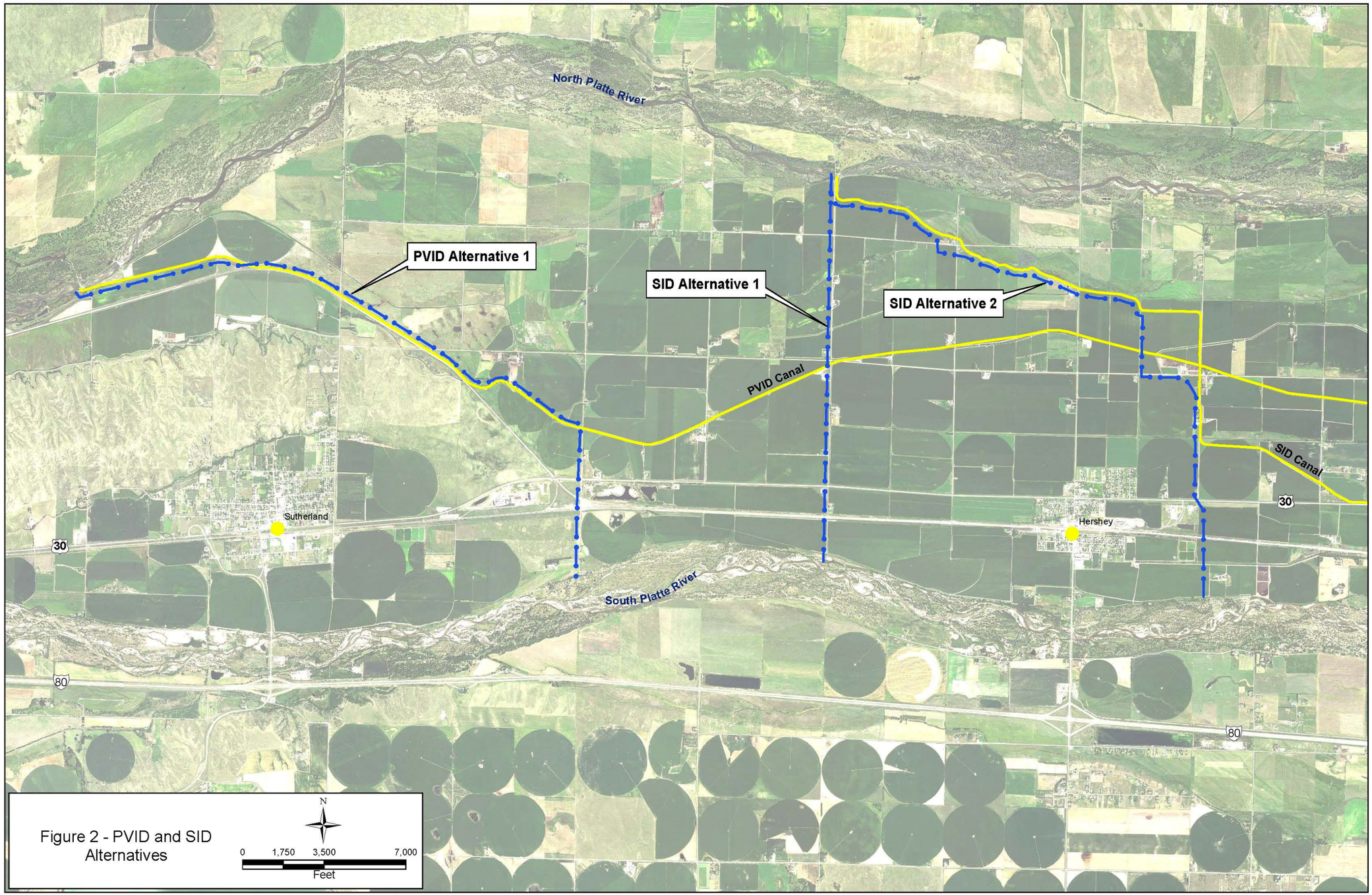

Figure 2 - PVID and SID Alternatives

- Estimates of the excavation to construct the canal

Using existing aerial photography, a review of the canal alignments for PVID Alternative 1 and SID Alternative 2 was conducted to determine the number of road and siphon crossings and land use along the canal alignment. The acreage and excavation quantities associated with each alternative alignment were based on the concept design for the diversion canal presented in Figure 3. The concept illustrated in Figure 3 will convey 1,500 cfs at a canal slope of 0.0005 ft/ft. With the concept design information, Table 1 presents the results of the alternative evaluation in consideration of the factors noted above.

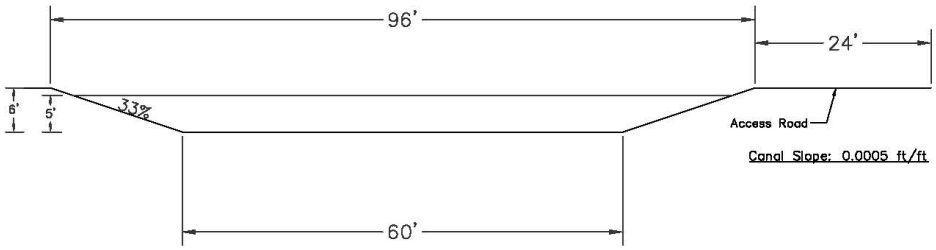

Figure 3 - Diversion Canal Section

Table 1. Alternative Evaluation

Alternative	Length (mile)	Road Crossings	RR Crossings	Siphon Crossings	Excavation (CY)	Land Acquisition	
						Irrigated (AC)	Dry Land (AC)
PVID Alternative 1	5.3	5	2	2	448,000	43	28
SID Alternative 2	5.5	7	1	6	470,000	75	0

As indicated in Table 1, both alternatives are similar in length and in the quantity of excavation required for construction of the canal improvements. Road, railroad and siphon crossings will incur significant costs. The number and nature of the crossings suggests the selection of PVID Alternative 1. In addition, the land acquisition necessary to construct the canal improvements favors PVID Alternative 1 based on the number of irrigated acres adjacent to the canal alignment. In consideration of this information, PVID Alternative 1 was selected for development of conceptual design detail as indicated on Figures 4 and 5. Figure 4 presents the location of the diversion canal alignment and the major structures associated with the PVID Alternative 1. Figure 5 illustrates a typical plan view and cross section associated with the roadway and railroad crossings.

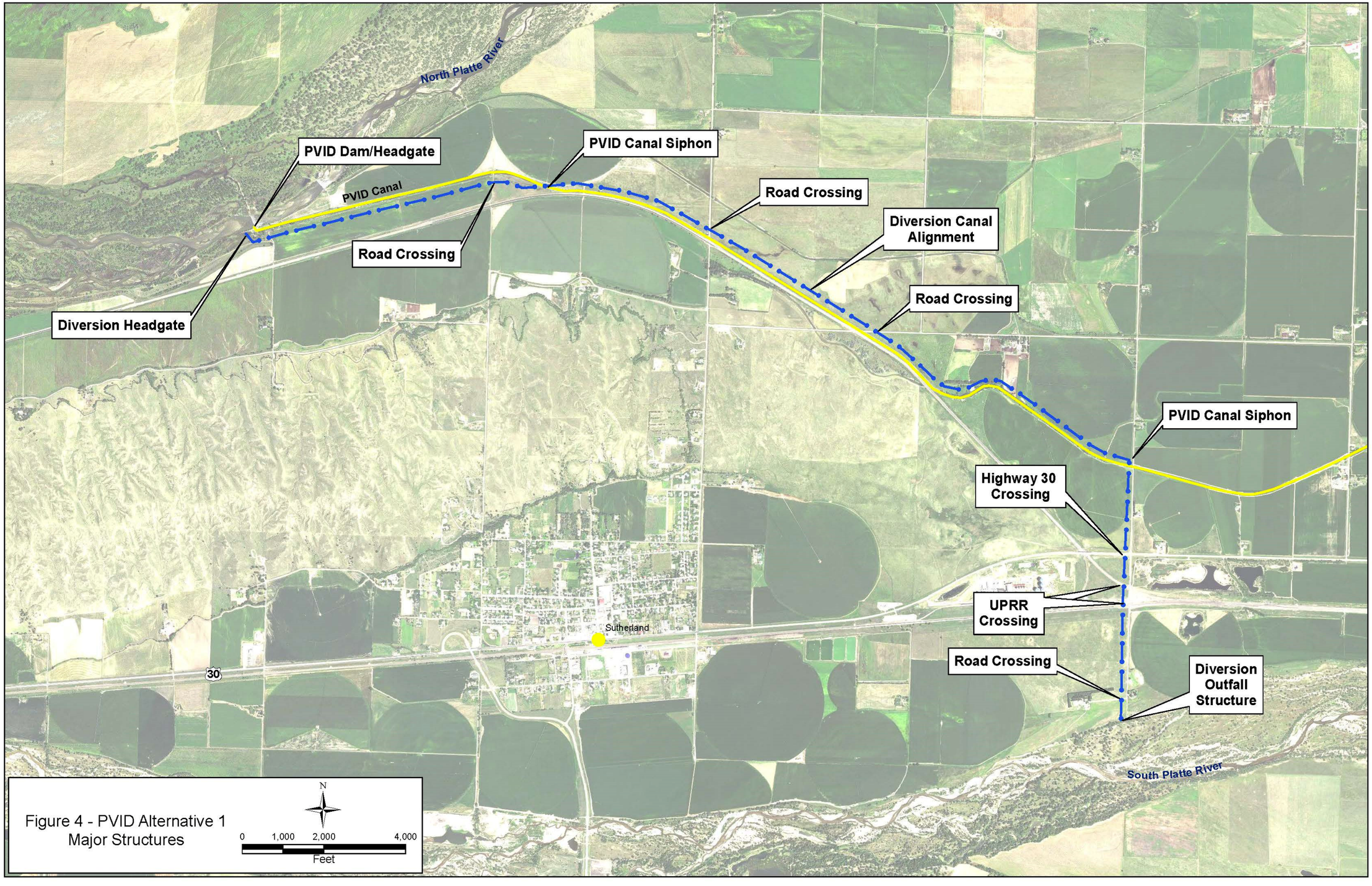

Figure 4 - PVID Alternative 1
Major Structures

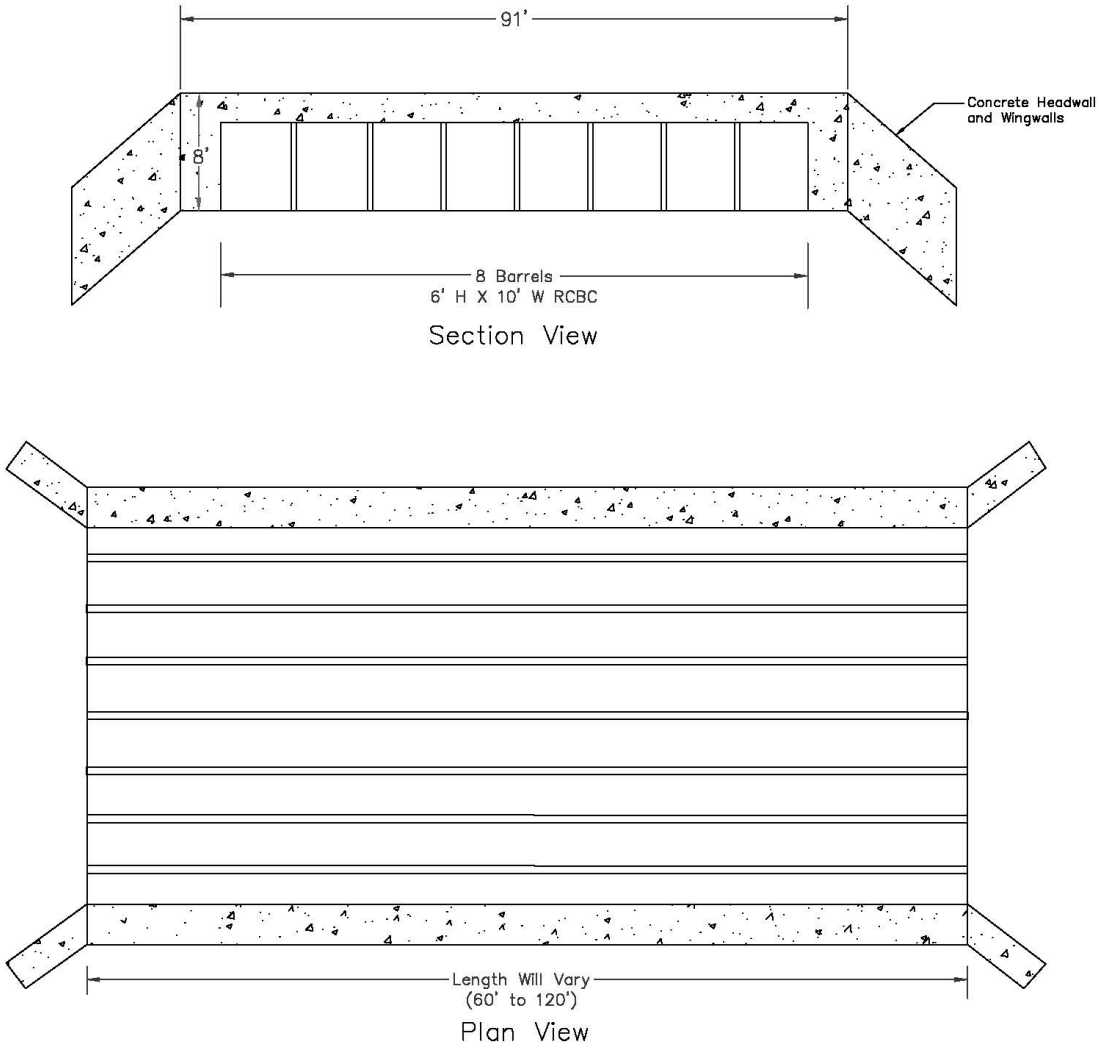

Figure 5 - Typical Diversion Canal Road Crossing

Implementation Costs for Diversion Alternative

For the Diversion Alternative, construction quantities, unit costs, and total construction costs were developed for construction of the improvements associated with PVID Alternative 1. Pertinent information regarding the implementation costs is provided in Table 2. As indicated in Table 2, the total cost estimated for the Diversion Alternative is $13,051,200.

Table 2. Diversion Alternative-PVID Alternative 1 Implementation Cost

Item Number	Description	Unit	Estimated Quantity	Unit Cost ($)	Item Cost ($)
1	Diversion Headgate Structure (see Note 1)	LS	1	$1,400,000.00	$1,400,000
2	Excavation (see Note 2)	CY	448000	$4.00	$1,792,000
3	Road Crossing #1 (see Note 3)	LS	1	$500,000.00	$500,000
4	Road Crossing #2 (see Note 4)	LS	1	$852,000.00	$852,000
5	Road Crossing #3 (see Note 5)	LS	1	$852,000.00	$852,000
6	Road Crossing #4 (see Note 6)	LS	1	$500,000.00	$500,000
7	PVID Siphon Crossing #1 (see Note 7)	LS	1	$212,000.00	$212,000
8	PVID Siphon Crossing #2 (see Note 8)	LS	1	$190,000.00	$190,000
9	Highway 30 Crossing (see Note 9)	LS	1	$852,000.00	$852,000
10	UPRR Crossing #1 (see Note 10)	LS	1	$1,380,000.00	$1,380,000
11	UPRR Crossing #2 (see Note 11)	LS	1	$764,000.00	$764,000
12	Diversion Outfall Structure	LS	1	$350,000.00	$350,000
	Land Acquisition				
13	Irrigation (sprinkler)	AC	16	$9,000.00	$144,000
14	Irrigation (flood)	AC	22	$6,000.00	$132,000
15	Dry land	AC	34	$2,000.00	$68,000
	Subtotal				$9,988,000
7	Mobilization/Demobilization	LS	1		$500,000
	Cost of Project Components				$10,488,000
	Engineering Costs	LS	1		$600,000
	Subtotal				$11,088,000
	Contingency (15%)	LS	1		$1,663,200
	Total Project Construction Costs				$12,751,200
	Permitting-Section 404/401 Certification/UPRR (See Note ??	LS	1	$300,000.00	$300,000
	Easements/Management Agreements	LS	1	$0.00	$0
	TOTAL PROJECT COSTS				$13,051,200

Note 1 8-6'Hx8'W gates, concrete headwall, wingwalls, apron
Note 2 Canal, 60' BW/96'TW, 6' high, 3:1 SS
Note 3 50 ft xsing, 400 ft of 6'Hx10W RCBC, Headwall/wingwalls
Note 4 90 ft xsing, 720 ft of 6'Hx10W RCBC, Headwall/wingwalls
Note 5 90 ft xsing, 720 ft of 6'Hx10W RCBC, Headwall/wingwalls
Note 6 50 ft xsing, 400 ft of 6'Hx10W RCBC, Headwall/wingwalls
Note 7 120 ft xsing, 6'Hx10"W RCBC, concrete inlet/outlet
Note 8 100 ft xsing, 6'Hx10"W RCBC, concrete inlet/outlet
Note 9 90 ft xsing, 720 ft of 6'Hx10W RCBC, Headwall/wingwalls
Note 10 150 ft xsing, 720 ft of 6'Hx10W RCBC, Headwall/wingwalls
Note 11 80 ft xsing, 720 ft of 6'Hx10W RCBC, Headwall/wingwalls
Note 12 Assumes Nationwide Permit, UPRR permit, and 401 permit

Recommended Construction Alternative: Channel Widening Upstream of Highway 83 and channel dredging along with construction of jetties/bendway weirs downstream of Highway 83

An overview of the construction limits associated with the Recommended Improvement Alternative is presented on Figures 6, 7 and 8. As indicated previously and on Figure 6, this alternative includes construction both upstream and downstream of Highway 83. The construction upstream of Highway 83 is intended to achieve a braided channel condition to promote deposition of sediment within the limits of construction (see Figure 7). The details associated with the construction upstream of Highway 83 include the following:

- Limits of the channel construction encompass length and width of approximately 16,200 feet and 350 feet, respectively resulting in an area of approximately 130 acres.
- Treatment for vegetation removal of approximately 31 acres (reflects the area of the mid-channel bar)
- Channel widening, material movement and slope grading (130 acres).
- Mobilization and demobilization of equipment.
- Access and management easements.

Downstream of Highway 83, construction of the improvements is intended to: (a) create a wider channel to promote additional transport during the high flow events, and (b) integrate a constricted low-flow channel that increases the sediment transport during relatively low flows (see Figure 8). The specific details of the proposed improvements are listed below:

- Limits of the channel improvements encompass a length of approximately 6,000 feet.
- Creation of a compound channel through channel widening/dredging and placement of jetties/bendway weirs
- Channel widening to increase the average channel width from 270 feet to a minimum of 300 feet; channel dredging to lower the channel thalweg 1.25 feet to 3 feet.
- Placement of 19 jetties/bendway weirs to constrict the dredged channel to a width of 150 feet. Maximum height of the jetties/bendway weirs not to exceed 2 feet above the channel thalweg. Length varies from 50 feet to 215 feet (reference Figure 3). Typical channel cross section and detail of a typical jetty/bendway weir are provided in Figure 9.
- Mobilization and demobilization of equipment.
- Access and management easements.

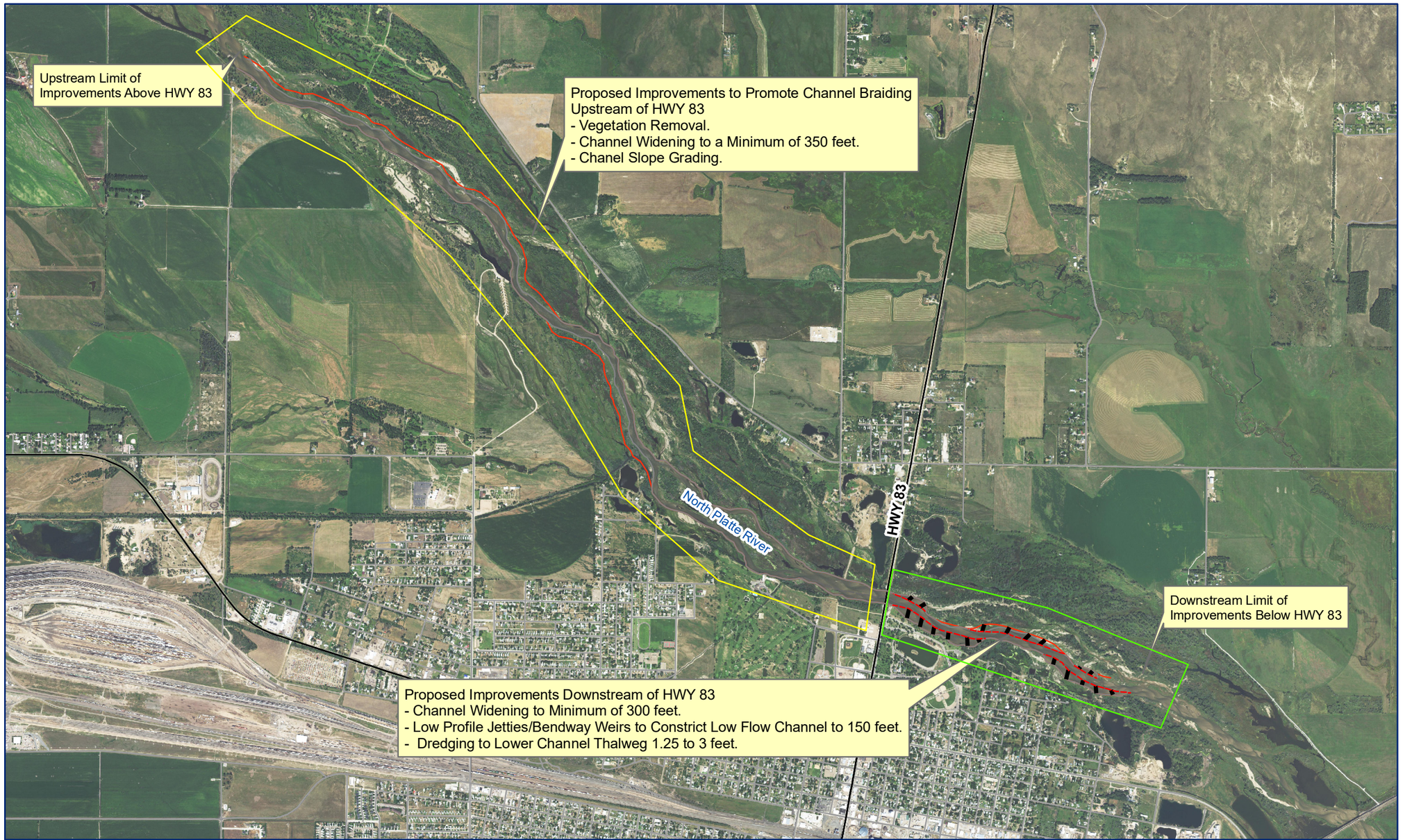

Figure 6 - Overview of Construction Alternative

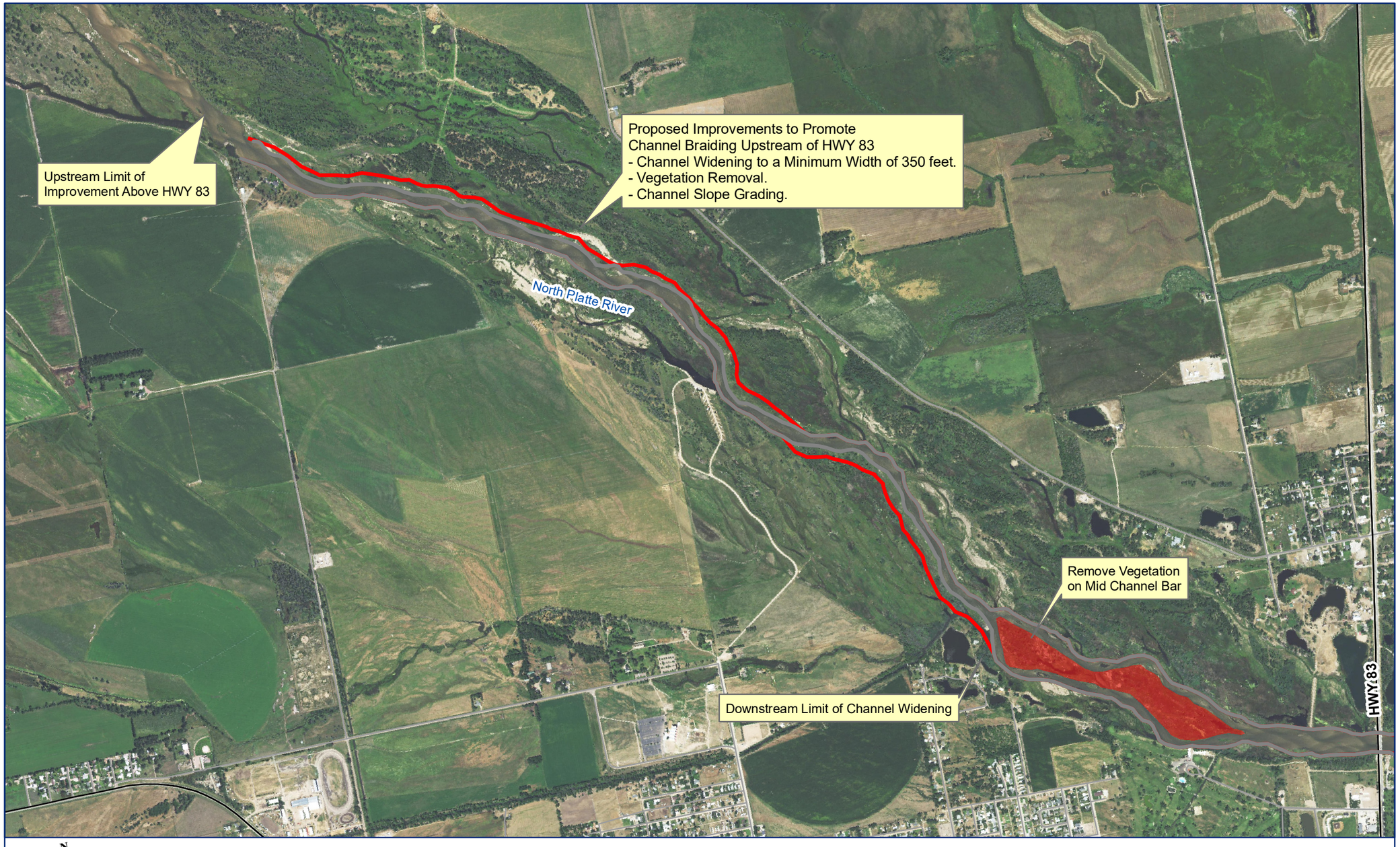

Figure 7 - Proposed Construction Alternative Upstream of HWY 83

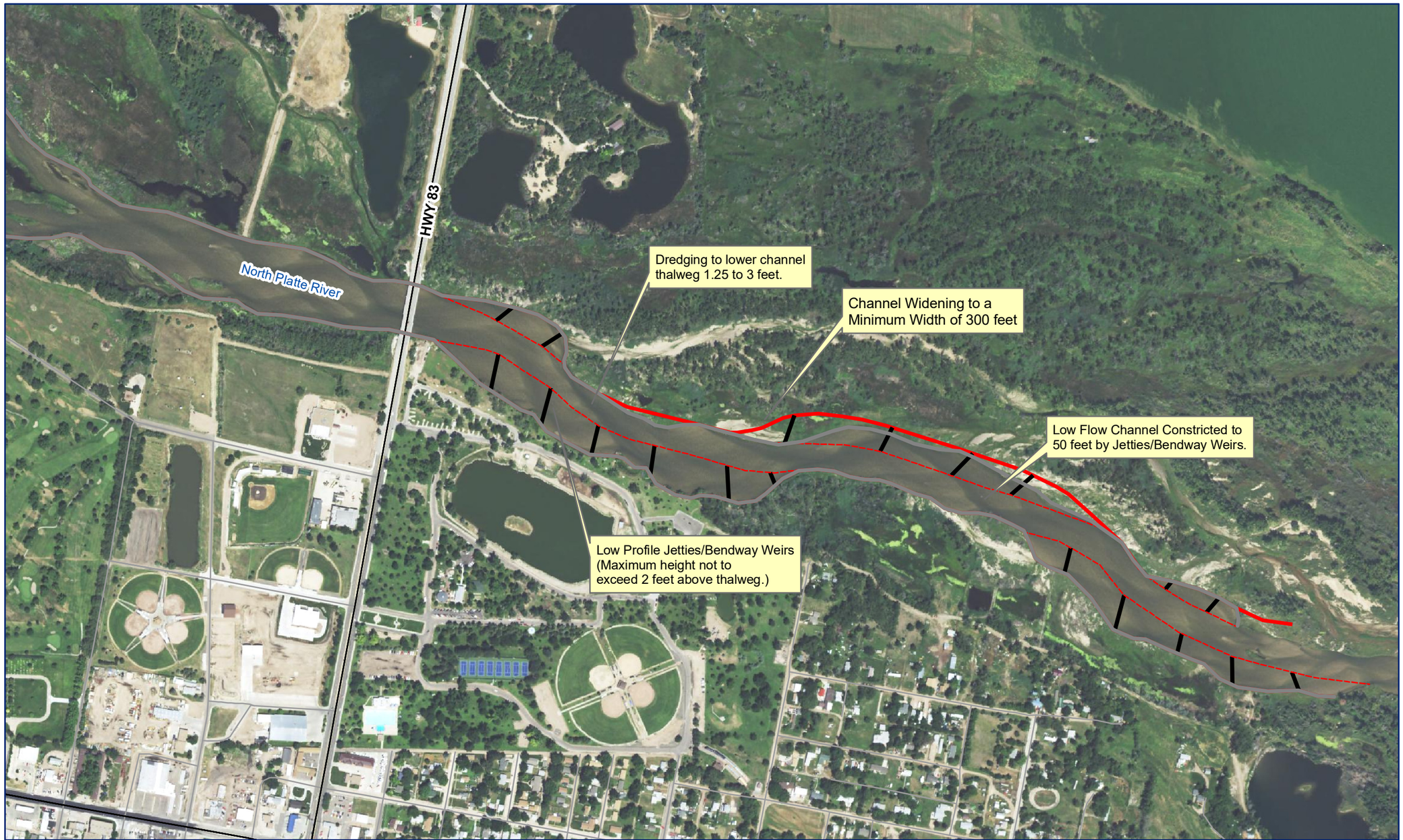

Figure 8 - Proposed Construction Alternative Downstream of HWY 83

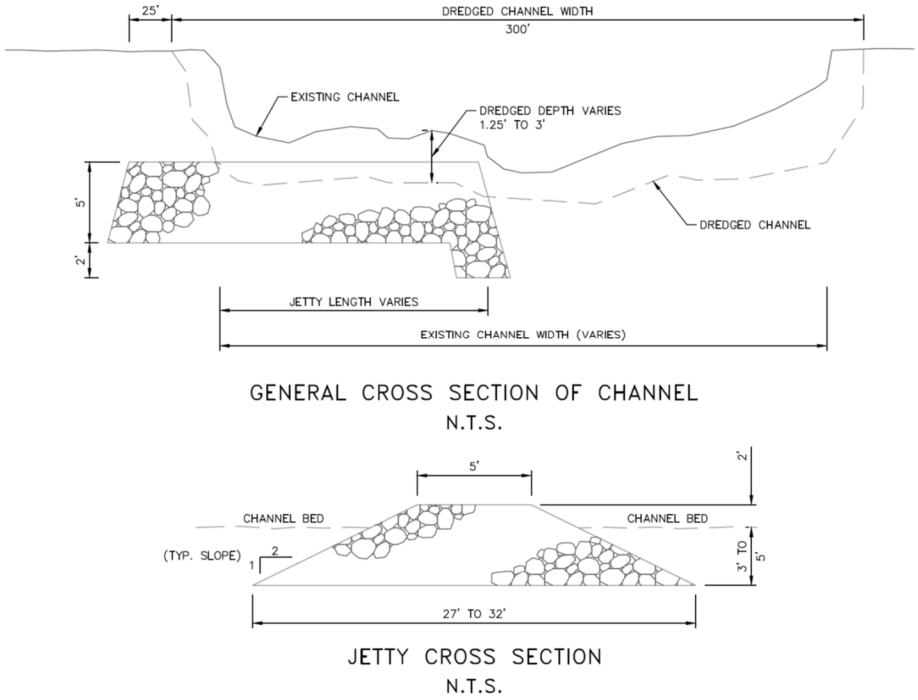

Figure 9 - Jetty/Bendway Weir Detail

Implementation Costs

For the Recommended Construction Alternative, construction quantities, unit costs, and total construction costs were developed for construction of the improvements upstream of Highway 83 as well as downstream of Highway 83. Pertinent information regarding the implementation costs for these two components is provided in Table 3. It should be noted that no costs have been assumed for access easements or management agreements. Based on previous channel widening projects, an access easement and management agreement has been obtained from the landowner at no cost. As indicated in Table 3, the total cost estimated for the Recommended Construction Alternative is $3,334,016.

Property Inundation Compensation Alternative

This intent of this alternative is to identify the costs to compensate for repetitive inundation of parcels/structures related to an increase in the frequency of SDHFs of 3,000 cfs. The following tasks were completed to support the feasibility assessment of the alternative:

- A hydraulic model of the North Platte River was utilized to determine the limits of flooding associated with a SDHF of 3,000 cfs. *The hydraulic model assumed improvements associated with the State Channel (east of Highway 83) were installed*.
- The hydraulic model was also utilized to determine the limits of flooding associated with a flood discharge of 1,560 cfs. The water surface elevation associated with a peak discharge of 1,560 cfs

Table 3. Recommended Construction Alternative Implementation Costs

Item Number	Description	Unit	Estimated Quantity	Unit Cost ($)	Item Cost ($)
Upstream of HWY 83					
1	Vegetation Treatment (see Note 1)	AC	31	$1,500.00	$46,500
2	Channel Widening (see Note 2)	CY	315,000	$1.50	$472,500
	Subtotal				$519,000
Downstream of HWY 83					
4	Channel Widening/Dredging (See Note 3)	CY	134000	$7.50	$1,005,000
5	Rock Riprap for 19 jetties/bendway weirs, haul and placement (See Note 4)	CY	8000	$90.00	$720,000
6	Excavation for Rock Riprap (See Note 5)	CY	11,500	$7.50	$86,250
	Subtotal				$1,811,250
7	Mobilization/Demobilization	LS	1		$233,025
	Cost of Project Components				$2,563,275
	Engineering Costs	LS	1		$75,000
	Subtotal				$2,638,275
	Contingency (15%)	LS	1		$395,741
	Total Project Construction Costs				$3,034,016
	Permitting-Section 404/401 Certification/Floodplain (See Note 6)	LS	1	$300,000.00	$300,000
	Easements/Management Agreements (See Note 7)	LS	1	$0.00	$0
	TOTAL PROJECT COSTS				$3,334,016

Note 1 Removal of vegetation/trees from mid-channel bar (unit cost reflects removal of large trees)
Note 2 1.5 ft of depth, 130 acres, 350 ft wide; no haul off site required
Note 3 Average depth of 2 ft, 300 ft wide; $5/CY for haul included
Note 4 Rock quantities include jetty/dike, tie-back into bank, and toe; 2-ft height, 3-ft burial depth
Note 5 Includes excavation for tie-back, jetty/dike section, toe protection; $5/CY for haul included
Note 6 Assumes Individual Permit/EA, CLOMR/LOMR floodplain permits, and 401 permit
Note 7 No costs assumed based on previous projects involving "No harm, channel improvements".

presently coincides with a minor flood stage of 6.0 feet as defined by the National Weather Service (NWS).

- The area determined by the difference in the limits of inundation between 3,000 cfs and 1,560 cfs was developed to represent the impact associated with the SDHF.
- Parcel information within the limits of inundation was obtained from the Lincoln County Assessor's office. This information included the assessed value of the land and all improvements including insurable structures.
- Parcels/structures along the south bank of the North Platte River within the corporate limits of the City of North Platte were specifically identified to determine the impact of the SDHF within the city limits.
- Residential properties in Lincoln County that are developed along the north bank (adjacent to North River Road) were also identified and included in the information provided by the Lincoln County Assessor's office.

The area of interest for this study focused on residential properties or parcels with structures along both the south and north bank of the North Platte River. The area of interest is illustrated on Figure 10 along with the results of the inundation mapping along the North Platte River in the vicinity of Highway 83. As indicated on Figure 10, the impacts of the SDHF are focused on the properties along the north bank (south of North River Road) of the river. Containment of the impact area along the south channel bank of the river is also largely reflected on the inundation mapping; limited inundation of land is noted along the south bank. Figure 10 also identifies specific parcels/structures within the inundation limits. The information obtained from the Lincoln County Assessor's office was utilized to determine the impact of the inundation on the individual parcels. Based on the evaluation of the parcel data and the inundation mapping, the following information is provided:

- Twenty-eight parcels along the north river bank (adjacent to North River Road) and the south bank in the vicinity of the City of North Platte are impacted by the SDHF and identified for compensation attributed to inundation.
- No insurable structure was determined to be within the limits of the inundation.
- Two (2) secondary buildings were determined to be within the limits of the inundation.
- The total area of property inundated, and representing the area where compensation for inundation may be required, is estimated to be 87 acres. The land inundation area does not include acreage associated with existing ponds within the parcels.

Implementation Costs

The parcels impacted by the SDHF are specifically identified in Table 4 along with specific information related to land or structure impact fees. The total cost associated with the Property Inundation Mitigation Alternative is also presented in Table 4. These costs reflect information obtained from the Lincoln County assessor's office. Total assessed value was increased by 20% for the purpose of this evaluation. As indicated in Table 4, pertinent data for each parcel impacted by the SDHF of 3,000 cfs was compiled and

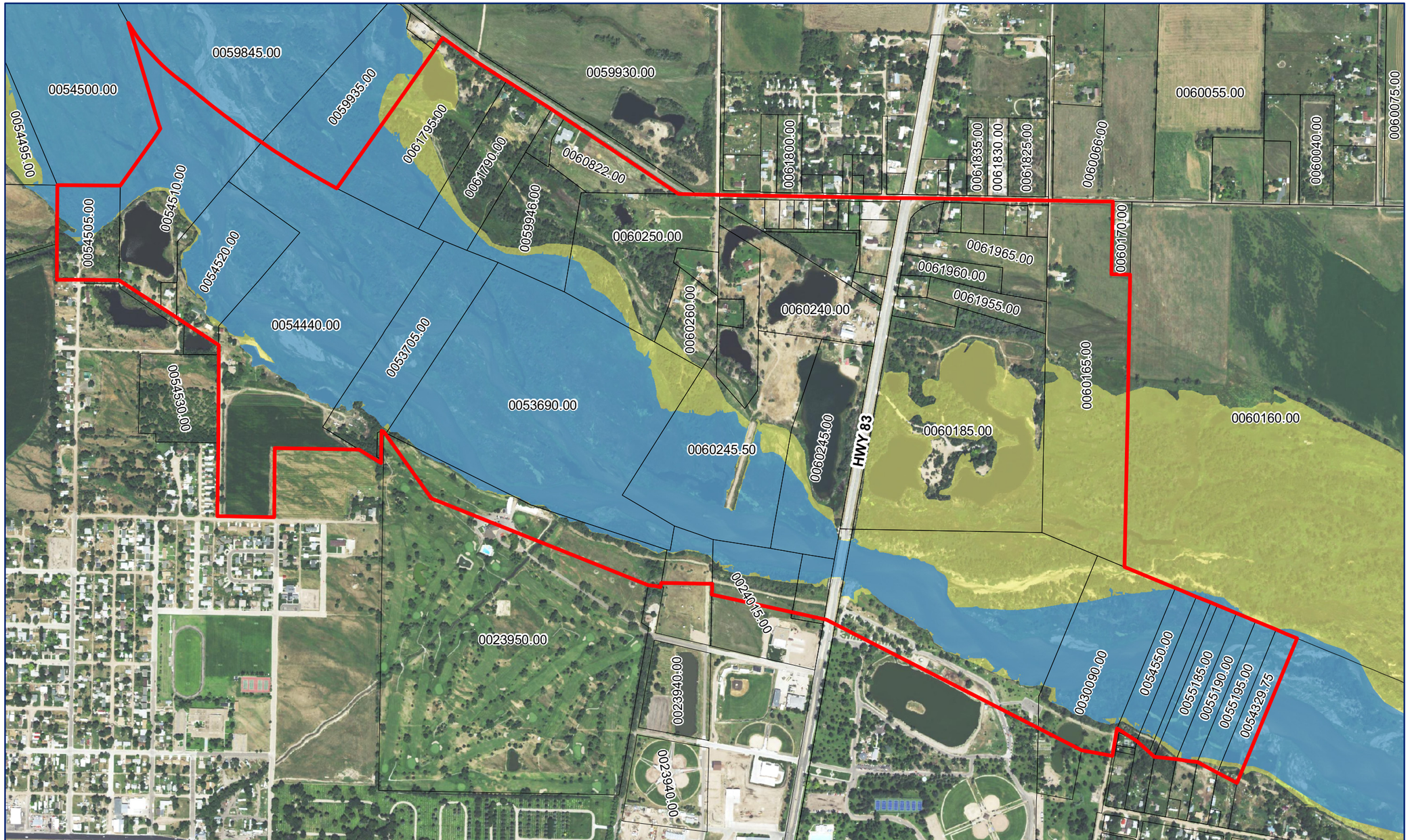

Figure 10 - Map of Floodplain Inundation at 3,000 cfs (assumes State Channel has been constructed)

reviewed. Areas of inundation were determined for each parcel along with identification of structures that were inundated. No insurable structures were inundated. For two parcels, it appears that secondary buildings are impacted and fees determined. Structure impact fees for secondary structures were conservatively assumed to represent 40% of the improvement value associated with each parcel. The unit cost associated with the land impact fee is based on the average per acre land value multiplied by a factor of 60% associated with the impact of inundation. The land impact unit cost was determined to be $1,200/acre and was applied to each acre impacted by the SDHF of 3,000 cfs. As indicated in Table 4, the total cost for the Property Inundation Mitigation Alternative is estimated to be $373,790. This cost reflects a one-time inundation impact fee associated with land and structures. As noted above, this cost also reflects the area determined by the difference in the limits of inundation between 3,000 cfs and 1,560 cfs to determine the impact of the SDHF. If the area is defined by the inundation of the entire floodplain associated with the 3,000 cfs SDHF, the total cost for this alternative is slightly less than $1,000,000. In addition, more detailed survey data may reflect the impact to an insurable structure which may further increase the cost by an additional $450,000. The strategy for development of the property inundation mitigation costs must ultimately include impacts to both land and structures. Given the strategy developed for inundation mitigation, the costs range from $373,790 to as much as $1,450,000.

It should be noted that the costs in Table 4 do not assume *acquisition* of the land or structures impacted by the inundation. This information represents a reasonably conservative estimate to initiate the negotiation and development of inundation compensation agreements with each individual parcel owner. In addition, it assumes that the owner of the parcel/structure is willing to enter into a compensation agreement associated with the inundation impacts within the parcel. During the development of the compensation agreements, other considerations may be discussed and included in the agreement such as implementation/construction of improvements to floodproof portions of the parcel/structure through placement of berms, walls, etc.

Feasibility Considerations

The feasibility assessment of each alternative included an evaluation of several factors and considerations as indicated below.

- Implementation costs including estimates of construction quantities, unit costs, and total construction cost, or equivalent land and structure inundation impact fees (provided in Tables 2, 3 and 4).
- Estimates of long-term operation and maintenance costs.
- Identification of potential permitting requirements.
- Determination of the impact on regulatory 100-year base flood elevations.
- Schedule associated with implementation of the alternative.

A discussion of information pertinent to each consideration is presented in the following paragraphs.

Table 4. Cost Information for Property Compensation Alternative

ACE Parcel #	Data provided by Lincoln County Assessor's Office						3,000 cfs Floodplain Inundation (Mapping Based upon Tetra Tech Permit Model & 2009 LiDAR)			
	PID	OWNER NAME	TOTAL VALUE	LAND VALUE	IMPROVEMENTS	PARCEL AREA (acres)	Inundated Area (sq ft)	Inundated Area (acres)	Does Property Have a Structure?	Primary or Secondary Structure Inundated?
1	23950	COUNTRY CLUB OF NORTH PLATTE	$ 749,725	$ 233,760	$ 515,965	115.05	7,637	0.18	YES	NO
2	24015	FIRST CHURCH OF THE NAZARENE	$ 498,165	$ 3,465	$ 494,700	15.26	9,737	0.22	YES	NO
3	54440	VIEYRA, JEROME & DONNA	$ 203,650	$ 70,920	$ 132,730	62.55	19,935	0.46	YES	NO
4	54505	MAC MILLAN, CHARLES P.	$ 96,175	$ 23,890	$ 72,285	8.72	5,595	0.13	YES	NO
5	54510	MC QUADE, TIMOTHY J. & WF.	$ 182,555	$ 56,675	$ 125,880	24.89	14,984	0.34	YES	NO
6	54520	ALBRECHT, JAMES E.	$ 287,730	$ 37,400	$ 250,330	15.98	15,995	0.37	YES	NO
7	60165	PUTMAN, CHARLES FRANCIS & WF.	$ 116,190	$ 46,165	$ 70,025	40.74	896,826	20.59	YES	NO
8	60185	T.C. LAND & CATTLE CO.	$ 382,480	$ 63,525	$ 318,955	53.37	993,611	22.81	YES	Secondary*
9	60245	EWING, DARRYL L. & CATHERINE S.	$ 270,720	$ 28,445	$ 242,275	19.85	62,598	1.44	YES	Secondary*
10	60250	JENSON, KENNETH & SHERRY L. ET AL	$ 75,525	$ 40,235	$ 35,290	22.57	131,980	3.03	YES	NO
11	60260	RUPP, RYAN DAVID & TRACY L. DRUEKE	$ 132,050	$ 15,340	$ 116,710	5.90	27,202	0.62	YES	NO
12	61790	MEAD, CHARLES B. & CHERYL L.	$ 206,555	$ 22,550	$ 184,005	13.14	28,642	0.66	YES	NO
13	61795	DISHMAN, SCOTT & LINDA K.	$ 145,240	$ 29,020	$ 116,220	21.85	205,841	4.73	YES	NO
14	30090	CITY OF NORTH PLATTE	$ -	$ -	$ -	26.17	141,370	3.25	NO	
15	53685	CITY OF NORTH PLATTE	$ -	$ -	$ -	3.42	2,185	0.05	NO	
16	53690	JENSON, KENNETH & SHERRY L. ET AL	$ 57,000	$ 57,000	$ -	71.77	157,539	3.62	NO	
17	53695	STATE OF NEBRASKA	$ -	$ -	$ -	3.13	5,897	0.14	NO	
18	53705	VIEYRA, JEROME F. & DONNA L.	$ 13,360	$ 13,360	$ -	19.08	2,489	0.06	NO	
19	54329.75	CHRISMAN, ALAN M. & SANDY	$ 4,515	$ 4,515	$ -	5.14	6,599	0.15	NO	
20	54550	COLLINS, JESS PATRICK E AL	$ 4,275	$ 4,275	$ -	5.18	2,914	0.07	NO	
21	55175	YOUNG, ROGER L.	$ 1,425	$ 1,425	$ -	1.66	1,762	0.04	NO	
22	55180	ENGEL, BARRY & THOMAS COLLINS	$ 2,850	$ 2,850	$ -	3.62	923	0.02	NO	
23	55185	MARTIN, JEFFREY D.	$ 4,465	$ 4,465	$ -	4.97	6,984	0.16	NO	
24	55190	BALANGA, SHIRLEY I.	$ 4,560	$ 4,560	$ -	4.68	3,144	0.07	NO	
25	55195	CHRISMAN, ALAN M. & SANDRA	$ 4,515	$ 4,515	$ -	5.07	7,378	0.17	NO	
26	59946	PANKONIN, JOHN L.	$ 11,400	$ 11,400	$ -	13.60	51,776	1.19	NO	
27	60245.5	BAKER, MICHAEL L. &	$ 44,720	$ 44,720	$ -	33.83	165,274	3.79	NO	
28	n/a	n/a (Cody Park)	$ -	$ -	$ -	112.33	831,214	19.08	NO	

STRUCTURE INUNDATION IMPACT FEE	Assessed Value	Value increased by 20%	LAND INUNDATION IMPACT FEE (All Parcels)	
Parcel 60185 (Secondary Bldg only)	$ 127,580	$ 153,100	Inundated AC	87.0
Parcel 60245 (Secondary Bldg only)	$ 96,910	$ 116,290		
			Unit Cost/AC**	$1,200
			LAND INUNDATION IMPACT FEE	**$104,400.00**
INUNDATION IMPACT FEE	$ 224,490	**$ 269,390**		
TOTAL STRUCTURE AND LAND INUNDATION IMPACT FEE		**$ 373,790**		

* Primary insurable structure not inundated. Secondary building(s) inundated. Assume 40% of Assessed Improvements

** Unit cost based on 60% of the average land value per acre.

Blue corresponds to parcels with primary/secondary structures

Green corresponds to parcels with secondary structure inundated

Long-Term Operation and Maintenance Costs

Long-term operation and maintenance costs for the Diversion Alternative-PVID Alternative 1 will coincide with costs related to annual operation and maintenance of the headgate structure, crossing structures, and siphons along the diversion canal alignment. For the purposes of this evaluation, the long-term operation and maintenance costs are assumed to not more than $10,000 per year. This alternative also relies on the existing PVID diversion dam to create the headwater necessary for the diversion of as much as 1,500 cfs and it is likely that long-term costs may be necessary to ensure the longevity of the diversion dam. Coordination with the PVID will be required to ascertain the potential rehabilitation costs related to this structure.

Long-term operation and maintenance costs for the Recommended Construction Alternative largely reflect vegetation treatment and dredging costs. For the area upstream of Highway 83, vegetation treatment within the mid-channel bar may be required over 100% of the acreage every 3 years based on experience on previous projects. Assuming vegetation treatment is required every 3 years, the long-term operation and maintenance cost becomes $15,500 per year. Costs associated with dredging (within the 300-ft channel section) may be required periodically in the area downstream of Highway 83. Assuming the channel section requires removal of 1.5 feet of sediment over a length of 600 feet once every 5 years, approximately 10,000 CY of dredging/hauling may be required. Under this assumption, the annual long-term operation and maintenance cost becomes $15,000. The combined annual operation and maintenance costs for the Recommended Construction Alternative is estimated to be $30,500.

No long-term operation and maintenance costs associated with the Property Inundation Mitigation Alternative have been identified. The costs for this alternative assume a one-time inundation impact fee associated with land and structures.

Permitting Requirements

Permitting requirements for the *Diversion Alternative-PVID Alternative 1* include:

- Section 404 of the Federal Clean Water Act
- Section 401 of the Federal Clean Water Act requiring Water Quality Certification
- Crossing permits from the UPRR and the Nebraska DOT

Section 404 of the Clean Water Act regulates the discharge of dredged and/or fill material in waters of the U.S. Fill material may include rock, sand or other materials from excavation activities. Projects involving the discharge of dredged and/or fill material into waters of the U.S. require authorization from the Corps of Engineers.

The Section 404 review process generally involves submittal of a jurisdictional determination report providing descriptions and mapping to identify the limits of the project site as well as the limits of waters of the U.S. For projects such as the Diversion Alternative, a pre-application meeting is encouraged to obtain guidance on the specific permit applicable to the project. Standard Permits or General Permits will

be discussed during the meeting. Standard Permits include Individual Permits and Letters of Permission (LOPs) while General Permits include Nationwide Permits and Regional Permits.

Individual Permits typically involve the comprehensive evaluation of specific information related to a proposed project. The process includes the solicitation of input from the public and resource agencies through publication and distribution of a public notice, an evaluation of the aquatic resource effects of the project relative to Section 404(b)(1) Guidelines, full public interest review pursuant to the National Environmental Policy Act of 1969 (NEPA), and ultimately the preparation of an environmental assessment (EA) or environmental impact statement (EIS). Based on the limited impacts to waters of the U.S., the construction of the Diversion Alternative may be eligible for a Nationwide Permit.

An applicant for a Section 404 permit must also submit an application to the state for certification under Section 401. A Section 404 permit is contingent on approval of the application for certification under Section 401.

Coordination will be required to obtain special use/crossing permits for both UPRR crossings and the crossing of Highway 30. It is likely that the UPRR crossings will not allow for excavation within the right-of-way which may require boring methods of construction. Typically, crossing permits from the UPRR require extensive coordination, submittal and approval of design drawings, and a permitting fee. These costs have not been estimated or included in the costs for this alternative. Similarly, the Nebraska DOT will require coordination and a crossing/special use permit.

Permitting associated with the *Recommended Construction Alternative* will include:

- Section 404 of the Federal Clean Water Act
- Section 401 of the Federal Clean Water Act requiring Water Quality Certification
- FEMA documentation documenting no impact on regulatory floodplains

Section 404 of the Clean Water Act and Section 401 permit information has been provided in the paragraphs above. Based on the impacts associated with the construction of the project, it is likely that an Individual Permit will be required and may lead to the preparation of an EA.

When construction occurs within a floodplain regulated under the National Flood Insurance Program (NFIP), a formal application to FEMA must be submitted to document the impacts associated with construction. Furthermore, construction within a regulated floodway must demonstrate that no increase will result to the base flood elevations associated with the 100-year flood event. Following the completion of design details or plans associated with the proposed improvements and prior to construction, an application for a Conditional Letter of Map Revision (CLOMR) must be submitted to FEMA for review and approval. Construction cannot be initiated until approval of the CLOMR is received. Following construction, an application for a Letter of Map Revision (LOMR) must be submitted to document that the construction was completed in accordance with the design details and plans. The development and review of each CLOMR and LOMR application may range from 4 to 6 months.

During this feasibility assessment, a preliminary evaluation of the floodplain impacts related to the Recommended Construction Alternative was completed. The limits of the 100-year floodplain evaluation

are presented in Figure 11 and the results summarized in Table 5. The results identify a decrease in the base flood elevation data ranging in magnitude from 0.1 to 0.9 feet. Decreases in base flood elevation correspond to the increased conveyance provided by the dredging and channel widening within the reach.

No permitting requirements have been identified with the *Property Inundation Mitigation Alternati*ve.

Implementation Schedule

Several items must be considered during the development of an implementation schedule for each alternative. The majority of these items pertain to the Diversion Alternative and the Recommended Construction Alternative rather than the Property Acquisition Alternative.

For the *Diversion Alternative-PVID Alternative 1*, the following items were considered along with the estimated duration for completion of each item.

Permitting	
Section 404:	12 to 18 months, initiated upon notice to proceed
Section 401:	3 months, concurrent with Section 404
Crossing Agreements	
UPRR:	2 years
Nebraska DOT:	1 year
Land Purchase Agreements	1 year
Design	10 months
Construction:	1.5 years to 2 years
Easement and Management Agreements:	3 to 6 months, should be initiated immediately upon notice to proceed.

The schedule for construction assumes that the design and acquisition of purchase agreements can be completed concurrent with the permitting (Section 404/Section 401/Crossing Agreements), it is anticipated that these initial items will extend as long as two (2) years after notice to proceed with the Diversion Alternative-PVID Alternative 1. The duration associated with the crossing agreements is the item that drives the schedule and may extend the implementation schedule well beyond 2 years prior to initiation of construction activities. Construction activities will extend the project an additional 1.5 to 2 years. In summary, assuming initial permitting activities can be completed within 2 years, the scheduled duration for implementation of the Diversion Alternative-PVID Alternative 1 becomes 3.5 to 4 years as a minimum.

Table 5. Comparison of Existing and Proposed Construction Alternative 100-Year Water Surface Elevations

Model Cross Section	Existing Conditions	Proposed Construction Alternative	Difference in Water Surface Elevation (feet)
	100-Year Water Surface Elevation (Q = 14,700 cfs)		
881352.8	2825.33	2825.33	0.0
879774.8	2823.55	2823.52	0.0
878955.8	2822.65	2822.52	-0.1
878229.8	2821.83	2821.65	-0.2
877549.8	2820.89	2820.62	-0.3
876992.8	2820.09	2819.64	-0.5
876651.8	2819.75	2819.36	-0.4
875207	2818.14	2817.36	-0.8
873651.8	2816.01	2815.63	-0.4
872175.8	2814.3	2814.04	-0.3
871230.8	2813.11	2812.83	-0.3
870627.8	2812.26	2812.07	-0.2
868867	2810.51	2810.09	-0.4
867193.8	2808.96	2808.66	-0.3
866413.8	2807.99	2807.09	-0.9
865541.8	2807.2	2806.37	-0.8
864789	2806.61	2806.06	-0.6
863865.8	2806.25	2805.83	-0.4
862379.8	2805.58	2805.19	-0.4
861578.4	2805.38	2804.92	-0.5
861321.8	2804.77	2804.37	-0.4
861241.8	2804.48	2804.22	-0.3
861072.2	2804.33	2804.1	-0.2
860690.8	2804.13	2803.92	-0.2
860390.8	2803.34	2803.26	-0.1
860315.9	HWY 83 Bridge		
860268.8	2801.88	2801.44	-0.4
860173.8	2802.18	2801.69	-0.5
859767.8	2801.71	2801.54	-0.2
858771.8	2800.43	2800.36	-0.1
857869.8	2799.06	2798.68	-0.4
857526.8	2798.66	2798.4	-0.3
855960.8	2795.94	2795.73	-0.2
854241.8	2794.31	2794.1	-0.2
853365.8	2793.45	2793.18	-0.3
852679	2793.02	2792.82	-0.2
851072.8	2790.48	2790.43	-0.1
850378.8	2790.49	2790.45	0.0
849624.8	2790.22	2790.22	0.0
848912.8	2789.93	2789.93	0.0
848799.9	Railroad Bridge		

*Analysis conducted using Permit Review Model developed by Tetra Tech. Cross section locations are provided on Figure 11.

N
W E
S

1,700 850 0 1,700 Feet

Model Cross Sections

Cross Sections from Tetra Tech Mode.
Note that full length of Cross Section not shown.

Figure 11 - HEC-RAS Model Cross Section Location Map

For the *Recommended Construction Alternative*, the following items were considered along with the estimated duration for completion of each item.

Permitting		
	Section 404:	2 to 3 years, initiated upon notice to proceed
	Section 401:	3 months, concurrent with Section 404
	FEMA (CLOMR):	4 months, initiated upon completion of design details
	FEMA (LOMR):	4 months, initiated following completion of construction
Design		3 months
Construction		6 to 8 months

Assuming that the design and acquisition of easement and management agreements can be completed concurrent with the permitting (Section 404/Section 401/FEMA CLOMR), it is anticipated that these initial items will extend as long as three (3) years after notice to proceed with the Recommended Construction Alternative. The duration associated with permitting is the item that drives the schedule and may extend the implementation schedule well beyond 3 years prior to initiation of construction activities. Construction activities along with permitting (FEMA LOMR) will extend the project an additional year. In summary, assuming initial permitting activities can be completed within 3 years, the scheduled duration for implementation of the Recommended Construction Alternative becomes 4 years as a minimum.

Alternatively, the implementation schedule for the *Property Inundation Compensation Alternative* considers the negotiation process related to inundation of parcels and structures. While it is acknowledged that this process may involve several iterations with multiple landowners, it is assumed that the scheduled duration of completion of this process is 1 year as a minimum. Furthermore, this schedule assumes that all landowners/parcels impacted by inundation associated with SDHFs will participate in the development of an inundation agreement.

A summary of the feasibility considerations for all alternatives is presented in Table 6.

Table 6. Summary of Feasibility Considerations

Considerations	Diversion Alternative	Recommended Construction Alternative	Property Inundation Compensation Alternative
Project Costs	$13,051,200	$3,334,016	$373,790 to $1,450,000
Long-Term O&M Cost	$10,000	$30,500	None
Potential Permitting	Nationwide Permit UPRR Permit Nebraska DOT Permit	Individual Permit/EA 401 Certification Floodplain Permit	None
Implementation Schedule	4 years	3 to 4 years	1 year

Summary and Recommendations

Based on the information and results provided above, the following summary is provided with respect to the feasibility assessment of the three alternatives: (a) Diversion Alternative, (b) Recommended Construction Alternative, and (c) Property Acquisition Alternative.

- The implementation Costs associated with the Diversion Alternatives and Recommended Construction Alternative were estimated to be $13,051,200 and $3,334,016, respectively, versus $373,790 for the Property Inundation Compensation Alternative. The implementation costs for the Property Inundation Compensation Alternative represents a one-time inundation impact fee associated with land and structures.
- Long-term operation and maintenance costs were estimated to be $10,000 for the Diversion Alternative compared to $30,500 for the Recommended Construction Alternative. No long-term operation and maintenance costs were identified for the Property Inundation Compensation Alternative.
- Potential permitting requirements are more extensive with the Recommended Construction Alternative. It is likely that an Individual Permit/Environmental Assessment, 401 Certification and floodplain permits will be required. The Diversion Alternative will require extensive coordination to obtain the crossing permits with the UPRR and the Nebraska DOT and will also require compliance with Section 404 of the Clean Water Act. No federal or state permitting requirements were identified for the Property Inundation Compensation Alternative.
- The proposed design and configuration of the Recommended Construction Alternative tends to decrease the base flood elevations associated with the regulatory floodplain. No impact to the base flood elevation is anticipated for the Diversion Alternative or the Property Inundation Compensation Alternative.
- The implementation schedule associated with the Diversion Alternative is dictated by the duration necessary to obtain crossing agreements, estimated to require as much as 2 years to obtain approval. The Recommended Construction Alternative is largely impacted by the duration of the permitting process which is estimated to take as much as 2 to 3 years to complete. Construction duration for both alternatives is also a consideration. The Diversion Alternative may require as much as 2 years to complete compared to less than a year for construction of the Recommended Construction Alternative. The Property Inundation Compensation Alternative is largely dictated by the time to negotiate and obtain landowner agreements which is estimated to be 1 year.

The information in this summary indicates that the Property Inundation Compensation Alternative achieves the objectives of the PRRIP more cost effectively and timely that either the Diversion Alternative

or the Recommended Construction Alternative. Consequently, it is recommended that the Property Inundation Compensation Alternative be further investigated as a means to achieve the SDHF goals of the PRRIP. Should this alternative be selected, site-specific information related to each parcel will be required to better describe the inundation impacts, costs associated with the inundation, or alternatives to minimize the inundation (such as retaining walls, berms, etc.). The additional investigation should also include: (a) coordination with the NWS will be required to determine how this alternative will be reflected in notification of property owners, (b) consideration of additional property owners impacted by SDHF in close proximity to the parcels identified within the area of interest, and (c) integration of cost effective measures such as vegetation removal or other construction within the channel to reduce the impact of SDHF to adjacent property owners.