MEMORANDUM

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

DATE: June 8, 2018 **ACE PROJECT NO.:** NEHEADWATERS04-04

TO: Jason Farnsworth, BCES, Headwaters Corporation

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

SUBJECT: North Platte Chokepoint: Updated Modeling and Inundation Mapping

In May 2015, Anderson Consulting Engineers (ACE) completed a feasibility assessment of alternatives to safely convey short duration high flows (SDHF) of 3,000 cfs through the North Platte River at the Choke Point. The assessment was further refined by ACE in September 2016. One-dimensional (1D) hydraulic modeling and inundation mapping used to inform the assessment was largely based upon LiDAR data collected in 2009.

Hydraulic modeling and inundation mapping on the North Platte River at the Choke Point was updated and enhanced using LiDAR data collected in October of 2017. Modeling and inundation mapping were developed to: 1) demonstrate benefits of the State Channel Berm, 2) update HWY 83 Gage flood stage information, and 3) update mapping and costs associated with the Property Inundation Compensation Alternative.

Hydraulic Modeling

The 1D HEC-RAS hydraulic model developed for previous evaluations was updated to reflect the 2017 LiDAR terrain. In addition, a two-dimensional (2D) HEC-RAS hydraulic model was developed. The 2D modeling allowed for more accurate inundation mapping in backwater and side channel areas and was used in the evaluations described in this memo.

Benefits of State Channel Berm

The State Channel re-activation project, currently under construction, includes restoration and improvements to the existing but degraded berm (State Channel Berm) located in the left overbank area upstream of HWY 83. State Channel Berm improvements are intended to divert higher flows away from properties and structures located along North River Road.

To demonstrate the benefits of the project, 2D hydraulic modeling was developed to determine the extent of inundation associated with a SDHF of 3,000 cfs with and without the State Channel Berm in place. Figure 1 shows a comparison of inundation at 3,000 cfs with and without the State Channel Berm. The comparison demonstrates that the State Channel Berm is effective at providing protection to approximately 30 individual properties located along North River Road, many of which have insurable structures.

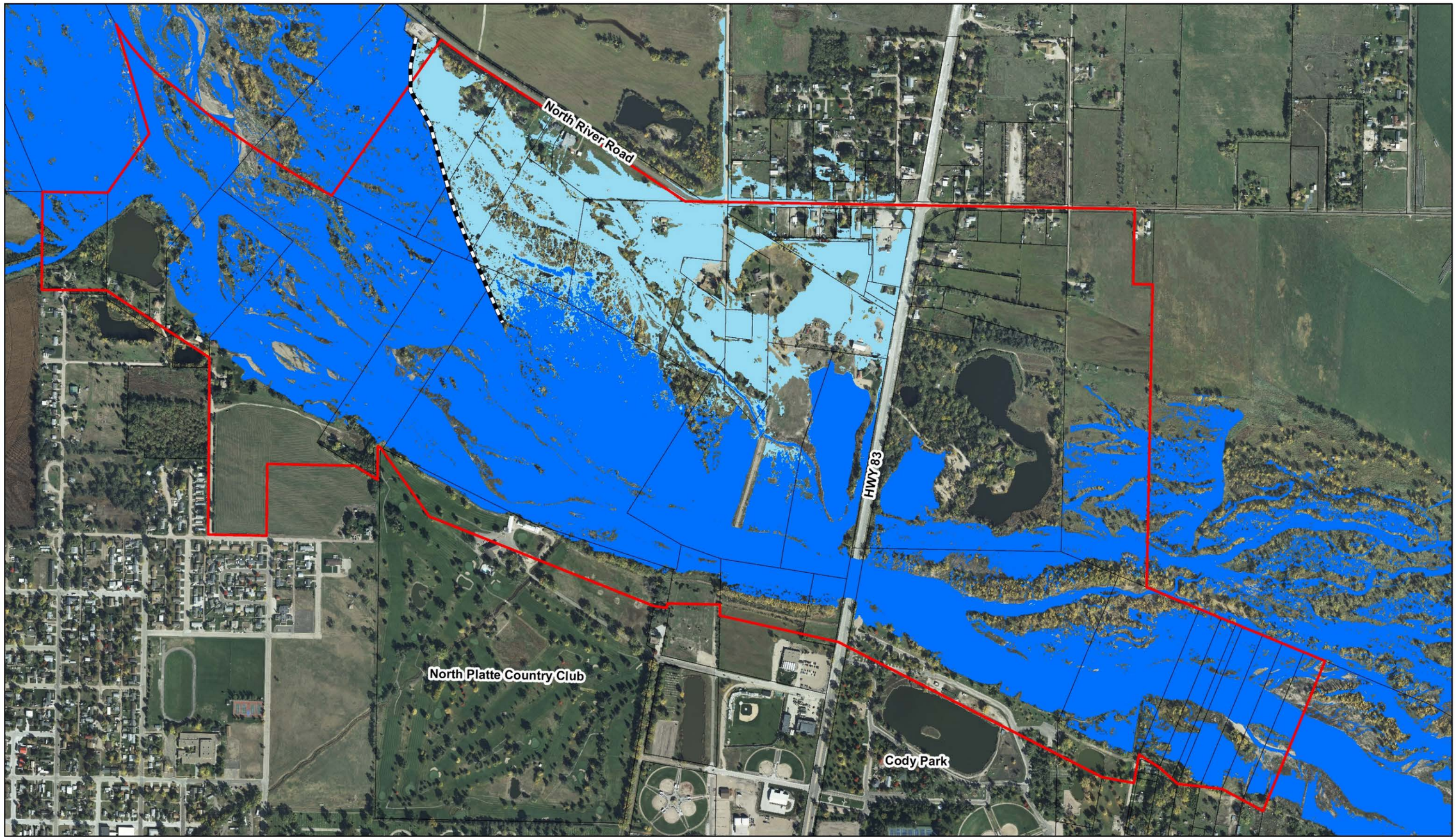

Figure 1 - Map of Floodplain Inundation 3,000 cfs with and without State Channel Berm 2D Modeling

Flood Stages at HWY 83 Gage

The 1D and 2D hydraulic model developed with 2017 LiDAR data was used to determine the stage vs discharge relationship at the HWY 83 Gage. The 1D and 2D modeling results were found to be consistent with more accuracy noted in the 2D results. To verify validity of the 2D hydraulic model results were compared to measured data collected at the gage between 2016 and 2018. Hydraulic modeling results were found to be in excellent agreement with measured data. Figure 2 provides the resulting stage vs discharge curve.

The National Weather Service (NWS) has designated minor, moderate, and major flood stages at the HWY 83 gage as 6.0 ft, 6.5 ft, and 7.0 ft, respectively. The discharge associated with each flood stage calculated by the 2D hydraulic model is summarized in Table 1 and shown graphically in Figure 2. The rating curve also indicates that a stage of 6.6 ft is associated with the SDHF of 3,000 cfs.

Table 1. North Platte River at Highway 83 Discharge Capacity at Flood Stages

Flood Stage (feet)	Discharge (cfs)
6.0 Minor	2,032
6.5 Moderate	2,875
7.0 Major	3,956

The 2D hydraulic model was used to determine floodplain inundation at each flood stage. Inundation mapping of 2,000 cfs, 3,000 cfs, and 4,000 cfs were developed and correspond to 6.0, 6.6, and 7.0 ft of flood stage, respectfully. The 2,875 cfs (6.5 ft flood stage) and 3,000 cfs (6.6 ft flood stage) events at the Highway 83 gage do not result in appreciably different floodplain inundation extents, so only the 3,000 cfs event was modeled, rather than both the 2,875 cfs and 3,000 cfs events. Modeling and inundation mapping assumes that the State Channel Berm is in place. The resulting inundation mapping is provided in Figure 3. A brief description of flooding at each stage is summarized in Table 2.

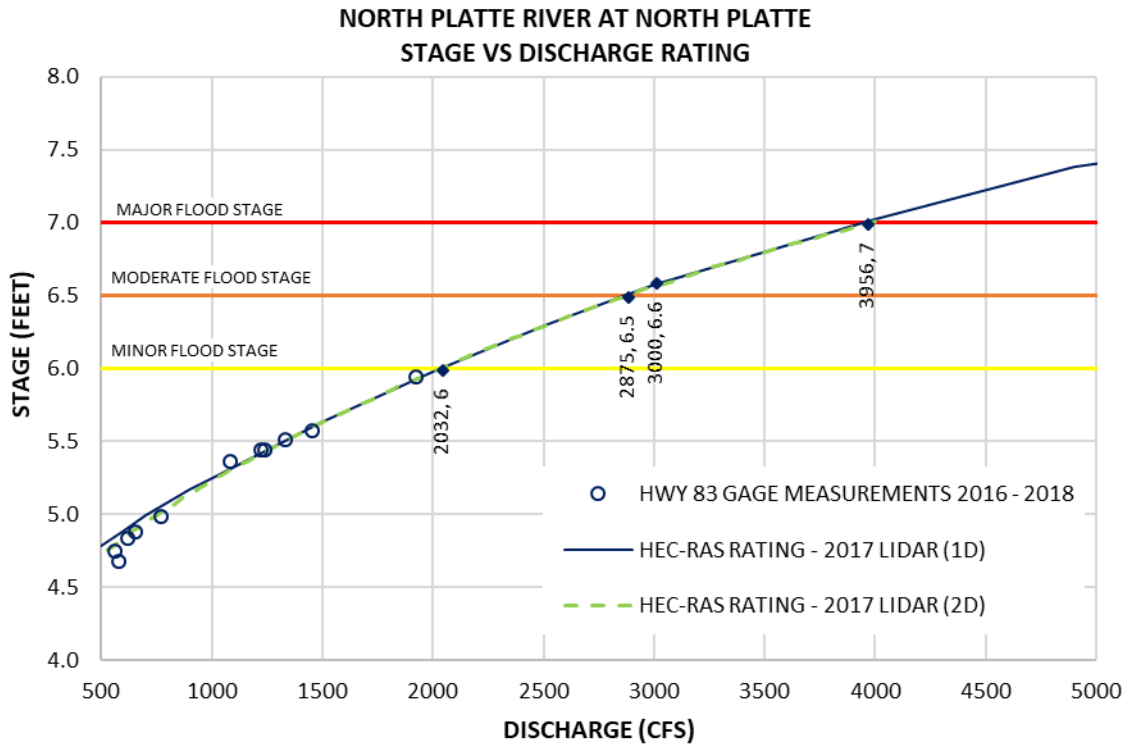

Figure 2 Stage vs Discharge Rating Curve at HWY 83 Gage.

Table 2 Flood Impacts by Stage

Stage / Flood Designation	Discharge	Description
6.0 Feet Stage Minor Flood	2,032 cfs	Minor flooding of low lying and agricultural land begins along the north bank of the North Platte River from Highway 83 to approximately 4 miles west of Highway 83 south of North River Road. Minor water intrusions into low lying areas of Cody Park in North Platte begins. Side channels on the north and south banks are engaged between Highway 83 and the railroad. People should be cautioned against being in the water along the banks of the river especially near Cody Park.
6.5 Feet Stage Moderate Flood	2,875 cfs	Moderate flooding begins but is contained to the south and west of the State Channel Berm west of Highway 83, providing protection to properties along North River Road. North bank flooding of low lying and agricultural lands extends from Highway 83 east to the railroad and encroaches on some outbuildings. Water encroachment into low lying areas of Cody Park worsens.
7.0 Feet Stage Major Flood	3,956 cfs	Major and widespread flooding occurs along the north bank of the North Platte River from Highway 83 to about 4 miles west of Highway 83 south of North River Road. The State Channel berm is overtopped which causes flooding on some properties along North River Road. However, structures are not yet affected on these properties. North bank flooding also extends from Highway 83 east to the railroad. Water encroaches into some residences and outbuildings in this area. Major and widespread flooding occurs along the south bank from the Nebraska Game and Parks Recreational Vehicle Campground Site to Cody Park in North Platte.

Note: Hydraulic modeling, inundation mapping, and flood descriptions assume that the State Channel Berm is in place.

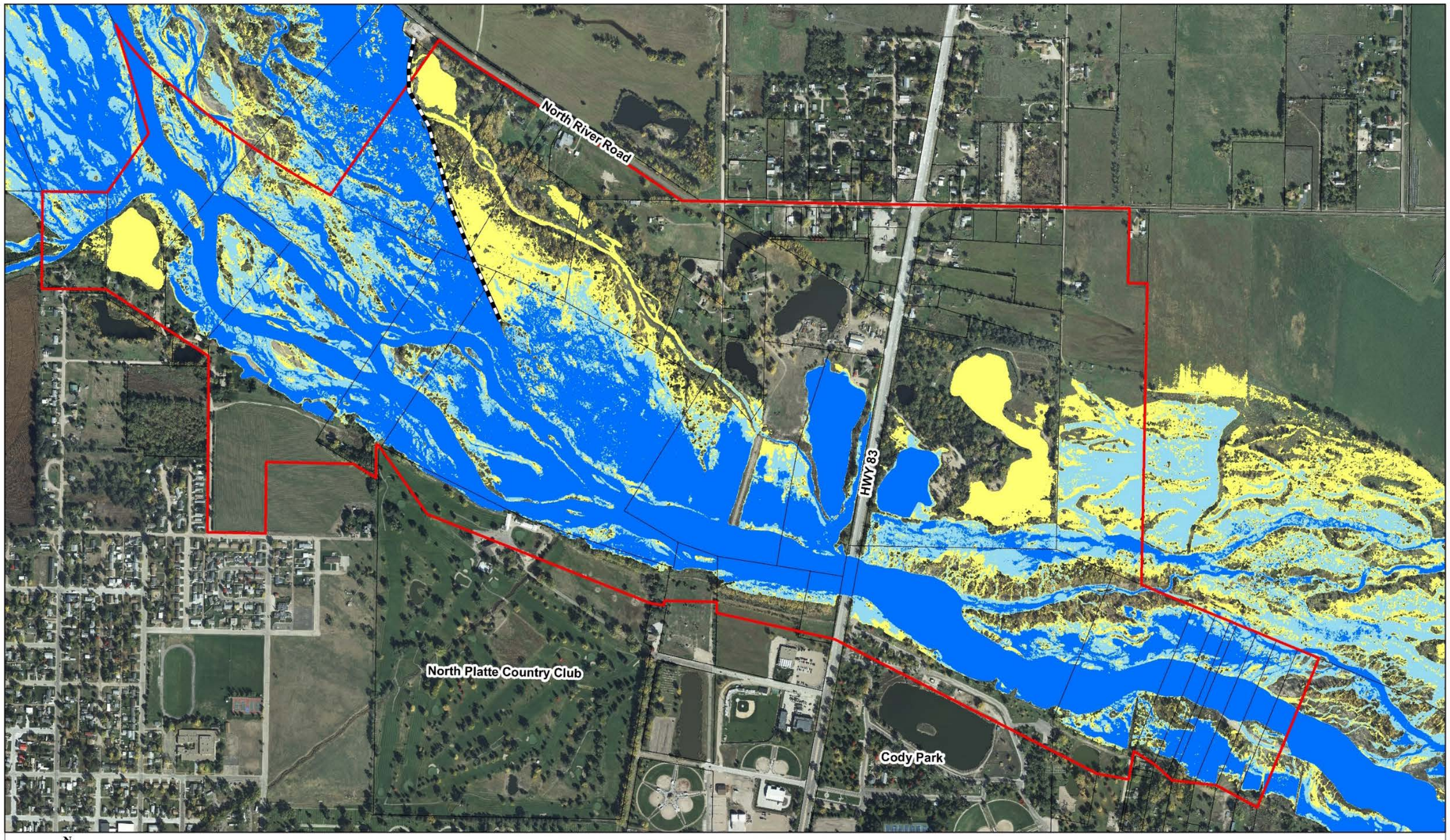

Figure 3 - Map of Floodplain Inundation 2,000, 3,000 and 4,000 cfs with State Channel Berm 2D Modeling

Property Inundation Compensation Alternative

The Property Inundation Compensation Alternative proposes compensating land owners 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:

- The 2D hydraulic model was utilized to determine the extent of flooding associated with a SDHF of 3,000 cfs. This corresponds to a flood stage of 6.6 feet at the HWY 83 Gage. *The hydraulic model assumed improvements associated with the State Channel (east of Highway 83) are in place*.
- The 2D hydraulic model was also utilized to determine the limits of flooding associated with a minor flood stage of 6.0 feet (2,000 cfs) as defined by the NWS at the HWY 83 Gage. The area determined by the difference in the limits of inundation between 3,000 cfs and 2,000 cfs was developed to represent the impact associated with the SDHF.
- Results of the revised inundation mapping were used to update implementation costs of the alternative.

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 4 along with the results of the inundation mapping along the North Platte River in the vicinity of Highway 83. As indicated on Figure 4, 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. The information obtained in April of 2015 from the Lincoln County Assessor's office was utilized to determine the impact of the inundation on the individual parcels.

The difference in floodplain inundation extents between 2,000 cfs (6.0 feet flood stage) and 3,000 cfs (6.6 feet flood stage) was calculated for each affected 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. Owners of each parcel will be compensated at a rate of $1,200 per acre for difference of inundation acreage between the 2,000 cfs (6.0 feet flood stage) and 3,000 cfs (6.6 feet flood stage) on their parcel. The 2D modeling shows an increased inundation between the 2,000 cfs (6.0 feet flood stage) and 3,000 cfs (6.6 feet flood stage) of 77 acres spread over 29 parcels. The land inundation area does not include acreage associated with existing ponds within the parcels. The 2D modeling also showed that no primary or secondary structures were inundated in the 3,000 cfs SDHF event, so the total cost of compensation is limited to land inundation impact costs. The 77 acres of inundation results in a land inundation impact cost of $92,400.

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 2,000 cfs (6.0 feet flood stage) and 3,000 cfs (6.6 feet flood stage) 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 within the area of interest, the total cost for this alternative is $320,400.

The parcels impacted by the SDHF are specifically identified in Table 3 along with specific information related to land impact fees.

It should be noted that the costs in Table 3 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.

Table 3 Cost Information for Property Compensation

ACE Parcel #	Data provided by Lincoln County Assessor's Office (April 2015)						Additional Floodplain Inundation at 3,000 cfs (6.6 ft Flood Stage) in excess of 2,000 cfs (6.0 ft Flood Stage)			
	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	10,066	0.23	YES	NO
2	24015	FIRST CHURCH OF THE NAZARENE	$ 498,165	$ 3,465	$ 494,700	15.26	37,609	0.86	YES	NO
3	54440	VIEYRA, JEROME & DONNA	$ 203,650	$ 70,920	$ 132,730	62.55	558,807	12.83	YES	NO
4	54505	MAC MILLAN, CHARLES P.	$ 96,175	$ 23,890	$ 72,285	8.72	71,594	1.64	YES	NO
5	54510	MC QUADE, TIMOTHY J. & WF.	$ 182,555	$ 56,675	$ 125,880	24.89	143,100	3.29	YES	NO
6	54520	ALBRECHT, JAMES E.	$ 287,730	$ 37,400	$ 250,330	15.98	152,884	3.51	YES	NO
7	60165	PUTMAN, CHARLES FRANCIS & WF.	$ 116,190	$ 46,165	$ 70,025	40.74	404,129	9.28	YES	NO
8	60185	T.C. LAND & CATTLE CO.	$ 382,480	$ 63,525	$ 318,955	53.37	195,988	4.50	YES	NO
9	60245	EWING, DARRYL L. & CATHERINE S.	$ 270,720	$ 28,445	$ 242,275	19.85	57,173	1.31	YES	NO
10	60250	JENSON, KENNETH & SHERRY L. ET AL	$ 75,525	$ 40,235	$ 35,290	22.57	51,500	1.18	YES	NO
11	60260	RUPP, RYAN DAVID & TRACY L. DRUEKE	$ 132,050	$ 15,340	$ 116,710	5.90	4,885	0.11	YES	NO
12	61790	MEAD, CHARLES B. & CHERYL L.	$ 206,555	$ 22,550	$ 184,005	13.14	15,435	0.35	YES	NO
13	61795	DISHMAN, SCOTT & LINDA K.	$ 145,240	$ 29,020	$ 116,220	21.85	107,602	2.47	YES	NO
14	60245.75	FLOROM, KENT E. & KIMBERLY J.	$ 271,090	$ 22,955	$ 248,135	8.52	9,210	0.21	YES	NO
15	30090	CITY OF NORTH PLATTE	$ -	$ -	$ -	26.17	163,666	3.76	NO	
16	53685	CITY OF NORTH PLATTE	$ -	$ -	$ -	3.42	5,328	0.12	NO	
17	53690	JENSON, KENNETH & SHERRY L. ET AL	$ 57,000	$ 57,000	$ -	71.77	552,809	12.69	NO	
18	53695	STATE OF NEBRASKA	$ -	$ -	$ -	3.13	13,338	0.31	NO	
19	53705	VIEYRA, JEROME F. & DONNA L.	$ 13,360	$ 13,360	$ -	19.08	98,818	2.27	NO	
20	54329.75	CHRISMAN, ALAN M. & SANDY	$ 4,515	$ 4,515	$ -	5.14	36,489	0.84	NO	
21	54550	COLLINS, JESS PATRICK E AL	$ 4,275	$ 4,275	$ -	5.18	36,579	0.84	NO	
22	55175	YOUNG, ROGER L.	$ 1,425	$ 1,425	$ -	1.66	7,041	0.16	NO	
23	55180	ENGEL, BARRY & THOMAS COLLINS	$ 2,850	$ 2,850	$ -	3.62	19,924	0.46	NO	
24	55185	MARTIN, JEFFREY D.	$ 4,465	$ 4,465	$ -	4.97	28,209	0.65	NO	
25	55190	BALANGA, SHIRLEY I.	$ 4,560	$ 4,560	$ -	4.68	34,121	0.78	NO	
26	55195	CHRISMAN, ALAN M. & SANDRA	$ 4,515	$ 4,515	$ -	5.07	49,707	1.14	NO	
27	59946	PANKONIN, JOHN L.	$ 11,400	$ 11,400	$ -	13.60	25,537	0.59	NO	
28	60245.5	BAKER, MICHAEL L. &	$ 44,720	$ 44,720	$ -	33.83	149,973	3.44	NO	
29		Cody Park	$ -	$ -	$ -	112.33	321,819	7.39	NO	

*Blue highlighting corresponds to parcels with primary/secondary structures

LAND INUNDATION IMPACT FEE (All Parcels)	
Inundated AC	77.0
Unit Cost/AC**	$1,200
LAND INUNDATION IMPACT FEE	**$92,400.00**

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

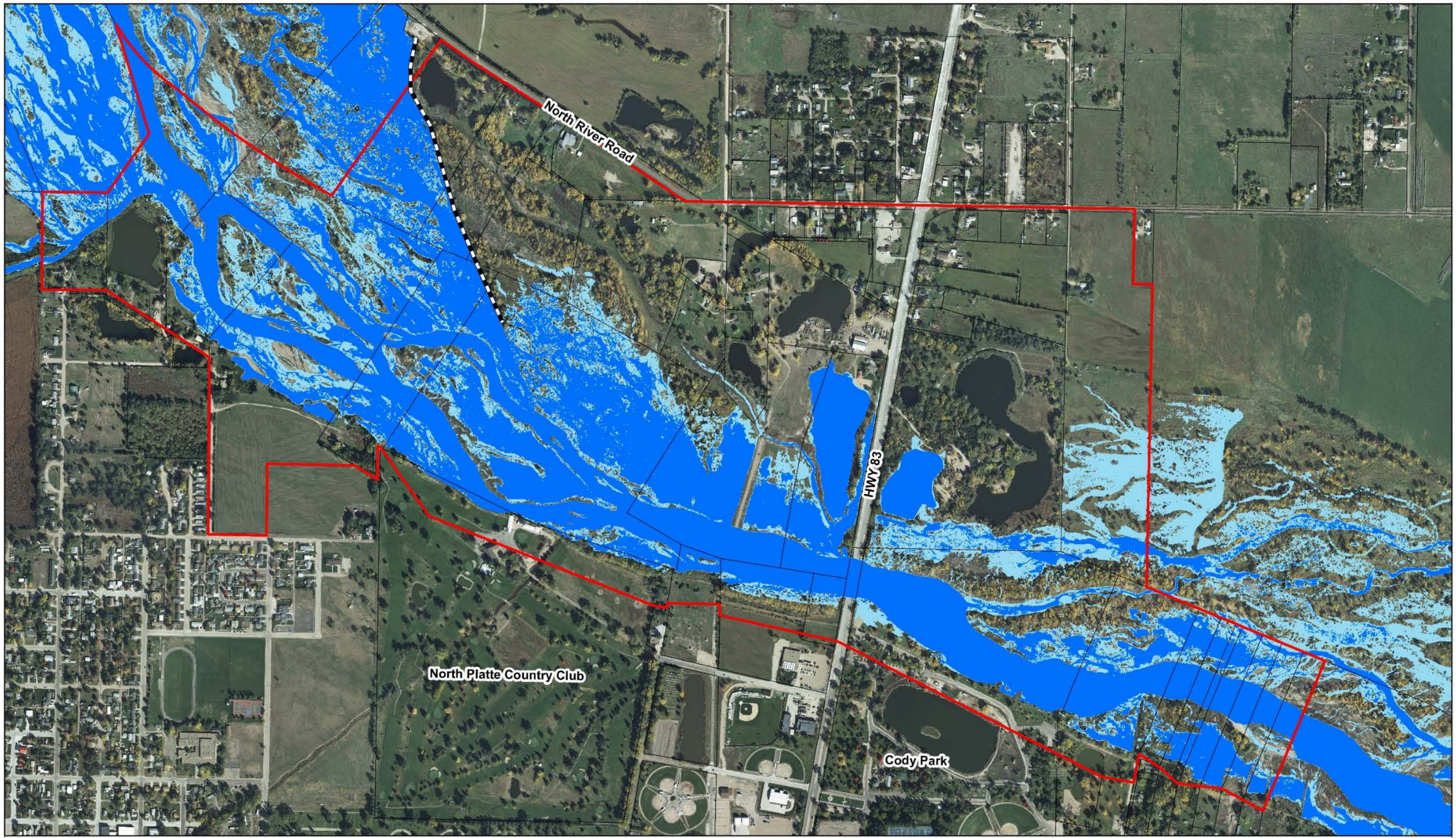

Figure 4 - Map of Floodplain Inundation 2,000 vs. 3,000 cfs with State Channel Berm 2D Modeling