PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM
2022 Sediment Augmentation Implementation Plan

INTRODUCTION

In 2007, the Platte River Recovery Implementation Program (Program or PRRIP) began its 13-year First Increment and implementation of an Adaptive Management Plan (AMP) to learn more about the physical processes of the central Platte River and the response of four target species to management actions: interior least tern (*Sterna antillarum*), piping plover (*Charadrius melodus*), whooping crane (*Grus americana*), and pallid sturgeon (*Scaphirhynchus albus*). In 2020 the Program began a 13-year Extension of the First Increment to provide additional time to complete and operate Program water projects and to conduct the monitoring and research necessary to determine the best use of Program water to benefit the target species.

The Program's original AMP was updated in 2022 as an Extension Science Plan, providing a concise and practical roadmap of Program science priorities during the Extension. The Extension Science Plan includes protocols for monitoring target species, habitat, and physical processes as well as plans for data analysis and synthesis to better understand interrelationships and provide information for evaluating habitat and species response to management actions. This document serves as the implementation plan for conducting sediment augmentation to halt channel incision and narrowing downstream of the Johnson-2 (J-2) Central Nebraska Public Power and Irrigation District (CNPPID) hydropower return.

Whooping crane roosting is dependent upon wide, shallow river channels associated with the braided channel morphology of the central Platte River. The upper reaches of the Program's AHR, most notably downstream of the J-2 return, are transitioning from braided and anastomosed to a wandering planform, largely in response to altered land use and hydrology. Since beginning operations at J-2 in the early 1940's, this clearwater return channel has undergone more than 15' of incision. This is indicative of sediment deficit, which can be offset via augmentation of alluvial material. Between 2006 and 2013, seven pilot-scale sediment augmentation efforts were implemented between Plum Creek and Cottonwood Ranch Complexes totaling approximately 400,000 tons of sediment (PRRIP 2018). These efforts provided information about the cost and efficiency of various augmentation methods and volumes. Modeling indicated that the average annual deficit is approximately 100,000 tons per year, with very high annual variability between 25,000 and 250,000 tons (HDR Engineering, Inc. 2011). A revised HEC6T model (Tetra Tech, Inc. 2015), defined the reach-scale deficit in the south channel to be approximately 55,000 tons. In 2017, after receiving input from the ISAC to bolster knowledge gained from these models, an augmentation target of 60,000 tons was set with an accompanying augmentation design plan (PRRIP 2017, 2018). Sediment augmentation has been designed to address sediment deficit and attempt to halt the narrowing and incision in the south channel of the Platte River immediately downstream of the J-2 return and prevent it from migrating further downstream to negatively impact the area of suitable whooping crane roosting and in-channel foraging habitat.

Information collected following the implementation of sediment augmentation is used to evaluate the response of the channel and the effectiveness of augmentation for maintaining wide, shallow, unobstructed channel widths for whooping cranes. Several critical scientific and technical uncertainties about physical processes and the response of the target species to management actions will be the focus of the application of rigorous adaptive management in the First Increment Extension through implementation of the Program's Extension Science Plan. These uncertainties are captured in statements of broad hypotheses in Table 1 on pages 8-9 of the Extension Science Plan and, as a means of better linking science learning to Program decision-making, those uncertainties comprise a set of "Extension Big Questions" that provide a template for linking specific hypotheses and performance measures to management objectives and overall Program goals (see PRRIP 2020).

Extension "Big Question" (EBQ) #3 relates directly to measuring channel response to sediment augmentation:

- ***EBQ #3*** **–** Is sediment augmentation necessary to create and/or maintain suitable whooping crane habitat?

Implementation of sediment augmentation to address this question provides valuable information on the quantity of sediment necessary for effective channel maintenance while providing information on the cost and benefits of augmentation for maintaining suitable roosting and in-channel foraging habitat for whooping cranes.

To assess progress toward this objective and gather information to reduce remaining uncertainties during the Extension, a finer-scale priority management hypotheses was developed by Program participants to receive focused attention. For sediment augmentation, the priority hypothesis is:

- ***EBQ #3*** Management Hypothesis: Sediment augmentation is necessary to halt narrowing and incision in the south channel downstream of the J-2 Return.

PURPOSE

This plan is intended to provide implementation guidance for designing and implementing sediment augmentation. The implementation plan describes the conceptual design, tools, data, and procedures that are used to plan for and implement augmentation of 60,000 tons of sediment to the South Platte River immediately downstream of the J-2 return.

DESIGN CONSIDERATIONS AND SPECIFICATIONS

Area of Interest

Sediment augmentation sites are located in western region of the AHR, beginning approximately 0.75 miles downstream of the J-2 return and currently extend one mile east (Figure 1.)

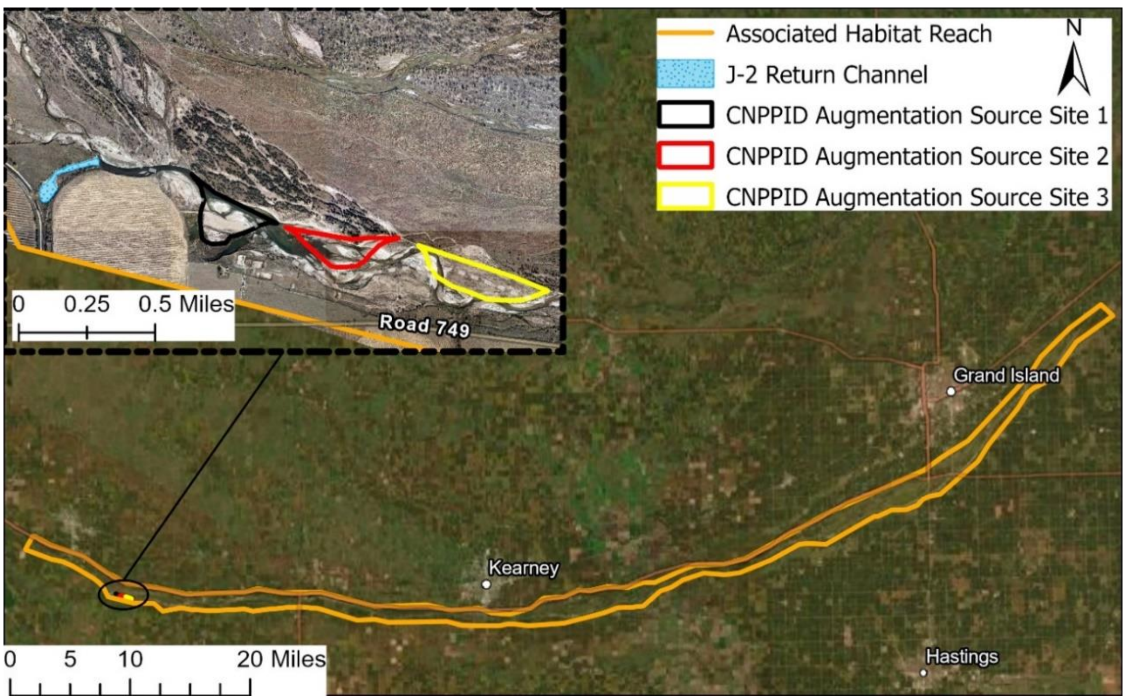

Figure 1

This one-mile section includes 3 areas – red polygons in Figure 1 - that Central Nebraska Public Power and Irrigation District (CNPPID) has designated as available source sites for augmentation. Since 2017, only 2 have been used for source material. These sites are bounded by the black, red, and yellow polygons in Figure 2. Pending evaluation of results, augmentation may continue in a downstream direction with one more major grading site targeted in this upstream reach (Site 3 in Figure 2) before moving downstream to the Plum Creek Complex, bounded by yellow polygons in Figure 1.

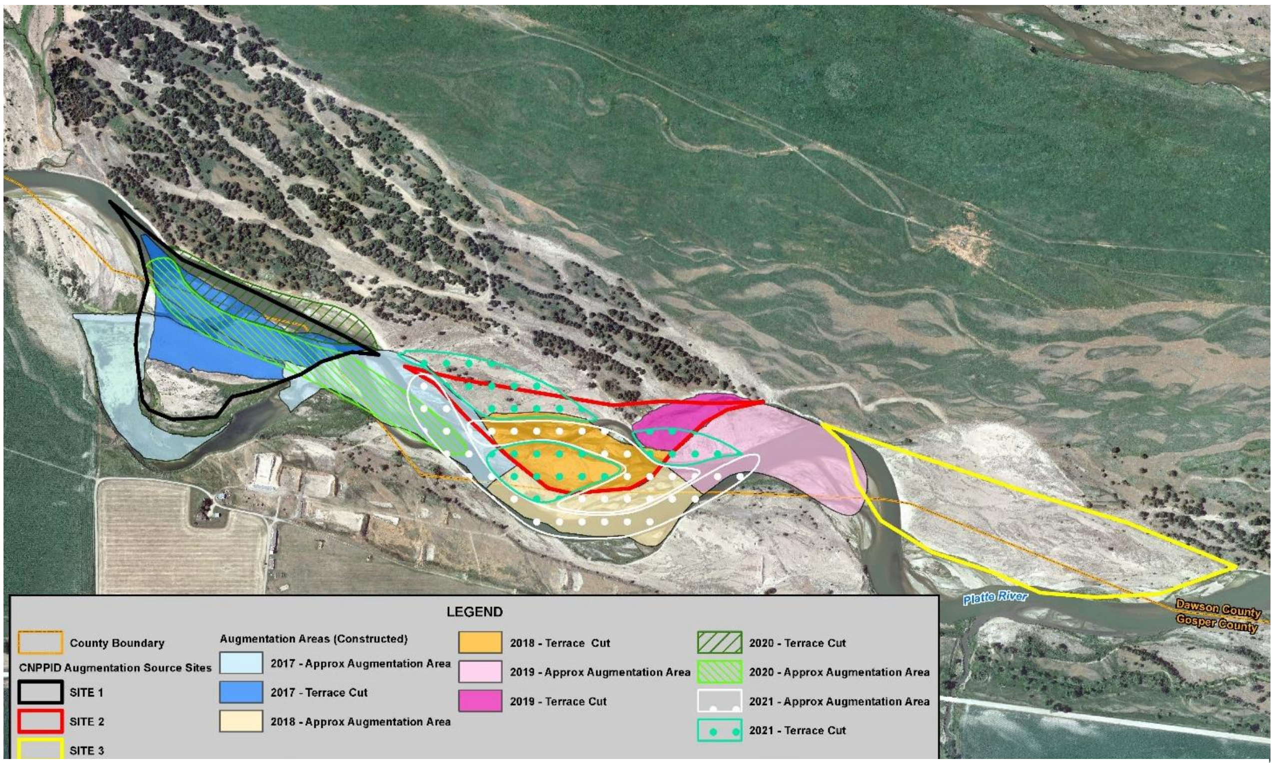

Figure 2

Timing

Sediment augmentation is implemented in the late summer/early fall each year to coincide with conducive flows out of the J-2 return. Summer low flows allow sediment to be staged, whereas long, high flow releases beginning in mid-September transport material away from the site. Due to CNPPID's hydropower production schedule, these long flows are interrupted by intermittent low flows. During these low flows, contractors are able to operate heavy equipment within the channel and stage more sediment for transport.

Design Considerations

Alluvial material augmented to the riverbed is intended for transport downstream to mitigate sediment deficits. A full-scale sediment augmentation target was set between 60,000 to 80,000 tons (equivalent to approximately 40,000-53,333 cubic yards) per year over a design-life of 18 years of augmentation beginning along the high banks below the J-2 return (Figure 2).

To begin the design process, the existing stage range elevations within the chosen area must be calculated. These elevations are calculated by running hydraulic models at peak and low flows (1650 cfs and 300 cfs, respectively) typical for CNPPID hydrocycling during late summer/early fall. These values are used to guide excavation (cut) and augmentation area elevation targets.

To encourage natural erosion of high terraces on the north bank, an elevation near the average of the stage range is chosen as the final grade for the excavation area (terrace cut areas in Figure 2 from which the sediment is excavated). This allows occasional inundation during high flow events, during which some bank material will be removed. To prevent nominal stage increase within the reach, the augmentation area of the project is designed at an elevation near the lowest end of the stage range.

Given those elevation targets, the design tonnage of the project must be determined. System-scale monitoring data collected from 2009 to 2014 demonstrated that trends in aggradation-degradation are highly dependent on hydrology (Tetra Tech, Inc. 2014). Knowing this, it is important to consider the hydrologic condition for the given design year. If it appears that there is a dry trend, CNPPID may operate in a conservation mode, releasing less flow into the south channel. Under these conditions, design tonnage tends to be lower to match expected lower flows for sediment distribution. If it is a wet year, flow releases may be higher, allowing for the distribution of more material pushed into the channel.

Knowing elevation and volume targets, the last piece of the design equation is excavation area. Loading LiDAR data from the previous year into Civil3D (Autodesk, San Francisco, CA) provides an existing grade against which the design surfaces can be compared. By creating an approximate design surface set to the final grade elevation, volume differencing calculations can be run. Due to the variability of elevation along the existing grade surface, an iterative approach is necessary to adjust the excavation area until the "Cut" volume is approximately equal to the target value.

Given the possibility that flows may be too low for sediment transport during construction, it is important that there is enough area within the channel for the augmented material to be placed at the lowest stage elevation. Using an approach similar to above, an approximate design surface is created within the channel at the lowest stage elevation. This surface is compared to the existing grade and its area adjusted until "Fill" volume is approximately equal to "Cut" volume.

Sediment Augmentation Summaries

The design approach for 2017 and 2018 targeted 60,000 tons of immediate augmentation (Table 1), while encouraging the channel to continue to erode material out of the high terrace (north bank) on Jeffrey Island. (PRRIP 2018) In fall of 2017, the upstream-most meander in the channel was cut off by excavating a pilot channel through an abandoned terrace and constructing a berm to shift the river to the north and mobilize sediment. 60,000 tons was augmented to the main channel and 20,000 tons of sediment was augmented into the abandoned meander.

In fall of 2018, efforts moved downstream with the same target of 60,000 tons and a more passive approach. By cutting down the next downstream bar, we were able to keep the sediment source on the adjacent high terraces on the left bank and encourage some deposition from upstream sources

The passive approach from 2018 was maintained in 2019, again with a target of 60,000 tons. This excavation was completed just downstream of the 2018 site.

The 2020 design moved upstream, overlapping some of the original 2017 site. Due to Normal-to-Wet hydrologic conditions and high terraces on the site, the augmentation target was higher at 74,000 tons.

The fall 2021 design also had higher tonnage at 80,100 tons. This was due to the spread-out nature of the design, with 3 separate excavation sites being augmented into the channel.

Augmentation in 2022 was designed in the same area as 2017 and 2020 since the high terraces of the area provided ample material for augmentation. With flows lower in 2022, the design tonnage was reduced to 65,550 tons.

Table 1. Sediment augmentation design summaries 2017-2022.

Year	Stage Range	Excavation Area Elevation Target (ft)	Augmentation Area Elevation Target (ft)	Design Tonnage	As-Built Tonnage
2017	N/A	2335.5	N/A	60,000	65,000
2018	2334.8 - 2336.2	2335.5	2334.0	60,000	64,305
2019	2333.6 - 2335.5	2336.0	2334.5	60,000	63,500
2020	2336.2 - 2338.1	2337.0	2336.0	74,000	86,475
2021	2333.3 - 2335.5 2333.0 - 2335.0 2331.8 - 2334.0	2335.5* 2335.2* 2334.0*	2334.5	80,100	64,281**
2022	2336.1 - 2337.7	2336.9	2336.0	65,550	TBD

*3 separate excavations with different elevation targets

**Preliminary volume – actual volume dependent on LiDAR data delivery

Monitoring

Information collected following the implementation of sediment augmentation is used to interpret the movement and influence of the augmented material to better inform future augmentation efforts and evaluate effectiveness in preventing further channel incision and downstream migration of the incised channel. The south channel of the river below the J-2 return is largely cut off from the main channel, with a unique hydrology influenced principally by the amount of water released from the J-2 return by CNPPID. In accordance with the initial 2017 design plan, stage loggers were installed upstream and downstream of the augmentation area to monitor stage evolution in this unique portion of the reach (PRRIP 2017). In 2019, the stage loggers were removed largely due to maintenance issues, relying instead on CNPPID discharge data to inform J-2 discharge flow corresponding with annual sediment augmentation. Alternatively, flow through the south channel can be calculated by subtracting flow upstream of the J-2 return at the Darr gage (baseflow) from the flow at the Overton gage (combined flows from the J-2 return and baseflow).

$$Q_{Overton} - Q_{Darr} = Q_{J-2} \text{ where } Q \text{ is flow in CFS}$$

This formula provides an estimate that must take lag time and flow attenuation into consideration. From 2017-2021 system-scale remote sensing efforts were conducted in this reach twice a year both before (June/July) and after annual augmentation (October/November), providing topo bathymetric LiDAR data in tandem with aerial imagery. However, higher flows during June/July resulted in poor LiDAR data quality. From 2022 forward LiDAR acquisition will be limited to once annually in the fall when flows are lower to improve data quality and to collect data immediately following sediment augmentation each year. Aerial imagery continues to be collected twice a year. Supplemental data are collected over the course of construction using a Drone and Trimble GPS survey unit. An initial survey is performed to collect GPS points at corners of excavation and augmentation areas and imagery is taken prior to construction. Similarly, an "as-built" survey is performed upon project completion. The as-built survey is used for calculation of approximate as-built tonnage prior to receiving remote sensing data. The combination of LiDar informed elevation data, field measurements, and imagery enables us to calculate as-built augmentation volume, identify aggradation and degradation trends, and identify changes in channel slope, wetted channel width, and average channel width. In 2022, five years of monitoring data at a variety of discharge volumes will be available to better evaluate the efficacy of this management action.

REFERENCES

HDR Engineering Inc. in association with Tetra Tech, Inc. and The Flatwater Group, Inc. 2011. 1-D Hydraulic and Sediment Transport Model Final Hydraulic Modeling Technical Memorandum. Prepared for Platte River Recovery Implementation Program.

Platte River Recovery Implementation Program (PRRIP). 2017. Full-Scale Sediment Augmentation Design Summary.

Platte River Recovery Implementation Program (PRRIP). 2018. Sediment Augmentation Monitoring Brief.

Tetra Tech Inc. 2014. Final 2013 Platte River Data Analysis Report Channel Geomorphology and In Channel Vegetation. Prepared for the Platte River Recovery Implementation Program.

Tetra Tech Inc. 2015. Draft Model Results, Platte River Sediment-transport Modeling, South Channel at Jeffrey Island. Memorandum to the Platte River Recovery Implementation Program.