Programmatic Environmental Impact Statement
Technical Appendix

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Whooping Crane Appendix

This document describes the procedures and technical materials used to analyze the effects of Platte River Recovery Program EIS alternatives on whooping cranes and on whooping crane critical habitat.

I. Channel Roost Habitat

The selection of aquatic areas that have wide views and are free from disturbance is generally considered to be innate to the roost behavior of wild whooping cranes. Rivers and other wetlands that are used by cranes for nightly roosting provide security from predators.

To improve the Platte River habitat for use by migrating whooping cranes the FEIS action alternatives propose several actions. The first proposed action is to restore wide river channels in certain river reaches that have narrowed. Secondly, the action alternatives would maintain river flows at levels to provide suitable aquatic roost habitat. Third, sediment and water management activities that would undertaken to avoid/reverse narrowing channel trends and help sustain wide channels.

A. Wide Channel Availability (GIS)

A Geographic Information System (GIS) database produced by the EIS team (Friesen et al. 2000) was used to evaluate the extent and the distribution of wide river channels. The GIS was developed to represent the 1997 baseline conditions specified by the Platte River Cooperative Agreement, and is described in supporting materials to the EIS. GIS coverage extends the length of the river valley from Lexington to Chapman, Nebraska, and includes an area roughly 3.5 miles on either side of the main river channel.

The GIS coverage is divided into short segments of the valley separated by river bridge crossings. There are 13 segments in the study area, which, in this report, are referred to as "bridge segments."

A GIS statistical routine was used to compute the amount of open channel of various width categories. The categories ranged from 170 feet -- the narrowest channel whooping cranes have been observed to use (Fish and Wildlife Service 1990, WEST Inc. 2005) -- to channels greater than 1,000 feet. Two GIS cover classifications comprise the "open channel" designation: *barren beach/bar* and *wetted channel*.

Figure 4-WC-1 of the FEIS displays the amount and location of open channel habitat for various channel-width categories of Present Condition. The corresponding values are tabulated in spreadsheet: "**Platte River FEIS WC Appendix - chwidth_all.xls**."

Program channel restoration activities for the four FEIS action alternatives fall into two basic categories:

1) The Gov. Committee, Water Leasing, and Wet Meadow alternatives represent roughly 8.9 miles of mechanical island leveling and channel widening. These activities occur within five bridge segments mostly upstream of Kearney, Nebraska;

2) The Water Emphasis alternative represents roughly 6.4 miles of mechanical island leveling and channel widening. These occur within three bridge segments mostly upstream of Kearney.

The amount and location of open channel analyzed for each of the action alternatives are also tabulated in spreadsheet: "**Platte River FEIS WC Appendix - chwidth_all.xls**."

Limitations. The GIS analysis represents a "snapshot" of fixed channel-width conditions of 1998, on which the footprint of channel manipulation expected to occur in the Program's first increment are superimposed. The analysis assumes that all mechanical channel widening described for each alternative is fully implemented by the end of the first increment (i.e., at year 13). It does not reflect natural trends in channel width from river processes that could occur over time or at year 13. In other words, it does not reflect the sustainability of the open, wide, channel cover types. This factor is discussed in the "Wide Channel Sustainability" section, below.

B. Characteristics of Wide Channels (PHABSIM)

The combined effect of the channel widening and aquatic habitat characteristics within the channel were evaluated using the concepts and principles of Physical Habitat Simulation Methodology (PHABSIM) (Bovee 1982).

PHABSIM Mechanics

By their nature, models are conceptual simplifications of a system. Models can help structure the available information, evaluate hypothesis or predictions, and analyze options based on specific management objectives. Temporal, spatial, and conceptual scales of model are chosen based on the objective of the application and the resources (e.g., data, time, and funding) available. Models can be word descriptions, or very simple or elaborate physical models, or very simple (a linear regression for a few points) or highly complex numerical models.

The PHABSIM hydraulic model was developed by the US Bureau of Reclamation (1987, 1989) for the Platte River Management Joint Study to analyze various Platte River habitat relationships. The PHABSIM hydraulics model consists of detailed measurements of the channel geometry and river hydraulics at cross sections spaced throughout the 90-mile-long study area, from Lexington to Chapman, Nebraska. These field surveys measurements are designed to enable simulation of the river channel characteristics at a wide range of river flows (US Bureau of Reclamation 1987).[1]

The PHABSIM hydraulic datasets compute many flow-related variables of the channel. The PHABSIM model simulations are used in this EIS to depict the channel area meeting several basic characteristics, which are considered to be important factors of whooping crane roost habitat. Use of the PHABSIM model for the EIS analysis consisted of three steps:

Step 1: Computing a flow relationships for channel variables

Variables considered important for whooping crane migrational habitat have been identified by workshops, technical workgroups of biologists and model users, and scientific literature (Johnson and Temple 1980; FWS 1987, 1990; Ziewitz 1992; Johns et al. 1997; Carlson et al. 1994; Austin and Richert 2001). Most existing knowledge of whooping crane behavior and information on whooping crane use of migrational habitat is based on chance observation at stopover areas. Austin and Richert (2001) describe the nature of the available information. Some systematic studies of sandhill cranes also may be relevant to whooping crane habitat use of the Platte River. More detailed understandings of whooping crane use of migrational habitats are being sought through continuing investigations.

Information gathered at stopover sites over several decades has led crane experts to identify some general characteristics important for habitat management. Essential characteristics for the Platte River habitat that are described by whooping crane authorities (Service 1987, Lutey 2002) include:

- Wide channels providing open views and an expanse of water
- Some shallow area for cranes to stand
- No disturbance features in the surrounding area

Based on existing information, it is believed that the absence of any one of these characteristics would preclude crane use or substantially reduce the habitat value. For comparative evaluation of alternatives, this PHABSIM analysis focuses on the changes in three channel variables:

- Wetted area occurring in channels greater than 500 feet wide;
- Area of wide channel having a total shallow water width, measured in a straight perpendicular line from one bank to the other, of at least 100 feet;
- Wide channels having an absence of disturbance features (road, bridges, housing or commercial development) within one-quarter mile.

These variables are reasonable for purposes of comparing alternatives given the current information and measurements from whooping crane use-sites on the Platte River, the general scientific information available and interpretations of whooping crane biologists and behavioral

[1] During 1998-2001, channel surveys and hydraulic measurements were updated at eight of Reclamation's study sites on the central Platte River that represent reaches with wide channels and/or high whooping crane and sandhill crane roosting use. (See Sutton 1998, 2002a,b,c).

experts, and the Program's objective for restoring the distribution and availability of whooping crane roost habitat on the Platte.

Alternatives Analysis

To implement these variables the model essentially applies two screening criteria: The first screen eliminated river channels that are less than about 500 feet wide from the model. A second screen eliminated channels lying near (usually within one-quarter mile) disturbance-associated features (roads, railroads, and centers of urban, industrial, and commercial development) of the landscape. Model output is generated for 85 channel cross-sections nested within 16 sub-segments of the 90-mile-long study area.

For the EIS the outputs from the 16 sub-segments were aggregated into four hydrologic reaches, each associated with a river-flow gage. These are: 1) the south channel of Jeffrey's Island, from the Johnson-2 Hydropower Plant Canal Return to the confluence with the north channel flow near the Overton bridge (gage of J-2 Discharges); 2) from the Overton bridge to the Kearney Canal Diversion Dam near Elm Creek (USGS Overton gage); 3) from the Kearney Canal Diversion Dam to the Kearney Canal return of flows to the main channel, about two miles east of the Gibbon bridge (USGS Kearney gage), and; 4) from the point two miles east of Gibbon bridge to the Chapman bridge (USGS Grand Island gage). These four hydrology gages are also nodes in the Central Platte River hydrology model. (See a description of the hydrology model in FEIS Chapter 4).

Step 2a: Combining channel functions with flow scenarios

The second step of the modeling process incorporated the flow regimes of EIS alternatives. Monthly flow data from the central Platte River Optsudy hydrology model are used to produce a 48-year time series of channel characteristics of each of the four hydrologic segments for each action alternative. The PHABSIM model was used to generate output for two flow-dependent variables: the wetted area within the wide channels, and the area of wide channel having at least a 100-foot width (in total) of shallow water.

The output data for existing channel conditions and water management operations ("Present Conditions") are contained in the ***PC_ Chanl Characteristics w PHABSIM.xls*** spreadsheet. Table 4-WC-1 in the FEIS contains summaries of the data for the spring (March to May) and fall (October and November) months of whooping crane migration.

Step 3: Estimating channel characteristics with channel manipulations

Initial PHABIM model runs (i.e., for Present Condition) view the channel geometry as having the fixed shape measured in the field. However, under the EIS action alternatives the Program would acquire channel properties to be restored as managed as wide channel habitats. At specific locations, multiple narrow anabranched channels would be converted to a single wide channel more suitable for crane use.

For three action alternatives--the Governance Committee, Full Water Leasing, and Wet Meadow Alternatives--channel reshaping was simulated to occur in five river segments and total about 9.6 miles. The Water Emphasis Alternative was simulated to alter modify a total of about 6.4 miles of channel in three river segments.

GIS Seg.	**Bridge Segment**	**Length (mi) of Restored Channel**	
		Governance Committee, Full Water Leasing , and Wet Meadow Alternatives	Water Emphasis Alternative
13	Lexington-J-2 Canal	0	0
12	J-2 Canal – Overton	0	0
11	Overton – Elm Creek	2.7	2.7
10	Elm Creek – Odessa	0	0
9	Odessa – Kearney	2.1	2.1
8	Kearney – Highway 10	0.9	0
7	Highway 10 – Gibbon	0	0
6	Gibbon – Shelton	1.6	0
5	Shelton – Wood River	0	0
4	Wood River – Alda	0	0
3	Alda – Highway 281	0	0
2	Highway 281 – Highway 34	0	0
1	Highway 34 – Chapman	1.6	1.6
	Total	8.9	6.4

Location and length of channel habitat restoration simulated for EIS Alternatives.

The model must be mathematically modified to simulate the wider channels that would be restored in place of the existing narrow channels that were surveyed. To simulate the wide-channel restoration a length of wide channel was substituted, mathematically, in place of the habitat/flow function of poorer habitat (narrow channel).

It was assumed that restored wide channels would resemble the wide channel sites where greater whooping crane use most frequently occurs. Specific guidelines for channel restoration are given in Program Documents, Land Plan, Table 1, and are summarized in table 3-1 of the FEIS. To model this change, the channel conditions for three sub-segments of river channel with relatively high whooping crane use were averaged: National Audubon Society’s, Rowe Sanctuary, near Gibbon; and two sites owned by the Whooping Crane Habitat Maintenance Trust, one between Shelton and Wood River and another near Alda, Nebraska. The averaged channel characteristics were then substituted, mathematically, in place of river reaches with narrow-channel. The habitat/per unit length of river was scaled to the length of simulated channel restoration.

The new channel function was combined with the hydrologic time series using the procedure similar to that explained for Present Condition, above. The output of each action alternative was compared to the Present Condition.

Tables 5-WC-2 and 5-WC-3 of the FEIS summarize channel characteristics for each month. Though the values for individual variables are presented separately in these tables, the variables would actually occur in combination. Figures 5-WC-2 and 5-WC-3 of the FEIS provide one method for displaying the combination of wetted area and the channel area having a minimum shallow width of 100 feet during April, and October and November over the 48 year period. Again, these values represent channels wider than 500 feet and free of disturbance features.

Computational details of FEIS action alternatives are contained in four spreadsheets:

GC_ Chanl Characteristics w PHABSIM.xls
FWL_ Chanl Characteristics w PHABSIM.xls
WE_ Chanl Characteristics w PHABSIM.xls
WM_ Chanl Characteristics w PHABSIM.xls

A summary spreadsheet compares results for the alternatives by month and hydrologic reach:

"***Compare--Chanl Characteristics w PHABSIM.xls***"

Limitations. Like GIS, PHABSIM is a tool that represents a "snapshot" of channel conditions. In other words, the channel characteristics for 1998 conditions with the footprint of channel manipulation expected to occur under the Program's first increment (as described in the EIS) superimposed. The analysis assumes that all mechanical channel widening described for each alternative is fully implemented by the end of the first increment (year 13). It does not reflect the natural trends in channel changes occurring over time, or in any way represent the sustainability of the open channel cover types. This factor is discussed in the "Wide Channel Sustainability" section, below.

A second limitation is that a relatively steady flow is assumed. The channel characteristics described in the PHABSIM analysis of the river system would differ, and the biological impacts could substantially differ, under a rapidly fluctuating flow regime (e.g., hydrocycling).

C. Wide Channel Sustainability – SEDVEG-Gen3 simulations

Effects of the Program alternatives on the processes that sustain wide channels are a primary consideration in whooping crane habitat conservation. The SedVeg-Gen3 modeling was developed to address factors influencing channel sustainability. These factors include sediment balance, bed-material particle size, vegetation growth characteristics, and the effects of peak flow timing frequency and magnitude.

The SedVeg-Gen3 model generates a variety of daily river characteristics at 62 channel cross-sections, spaced throughout the Lexington to Chapman reach, for a 48-year simulation period (see *River Geomorphology* in Chapter 4 of the FEIS for further details of SEDVEG-Gen3). The 48-year simulation is intended to capture a range of the hydrologic variation that could occur following full Program implementation.

"Open view" is one variable computed by SEDVEG-Gen3. "Open view" is used as a measure of the wide, open, and unobstructed channels that whooping cranes are found to typically use. In the two-dimensional channel cross sections used in SEDVEG-Gen3, open view is measured as a horizontal distance between coded visual obstructions, i.e., tall vegetation or river banks, greater than three feet above the water surface.

A spreadsheet macro was written to extract the widest "open view" at each channel cross-section, for each day of the crane migration season. These data are given in files

Widest Open View Trend-PC.xls
Widest Open View Trend-GC.xls
Widest Open View Trend-FWL.xls
Widest Open View Trend-WE.xls
Widest Open View Trend-WM.xls

These worksheets average and summarize the open view data. For each alternative, data were summarized in six subsets: cross sections upstream and downstream of Shelton bridge; cross-sections where Program channel widening is simulated to occur (unmanaged cross sections) and cross section where no Program channel widening would occur; and unmanaged cross-sections upstream and downstream of the Shelton bridge.

The change in average open view of the widest channels of each cross-section is given in FEIS table 5-WC-4. Due to the preliminary nature of existing models, these estimates should be viewed as relative difference and ranking of alternatives rather than an explicit prediction of the amount of channel change.

Summary data from which FEIS table 5-WC-4 is derived, and plots/comparisons of open view trends among the alternatives are given in the spreadsheet: ***Widest Open View Trend - Comparisons.xls***

C.2. Wide Channel Sustainability – Hydrology of Pulse Flows

Most Platte River investigators regard seasonally high flows, termed "pulse flows," to be a major factor affecting channel maintenance processes on the Platte River. The detailed physical and biological mechanisms by which they operate remain uncertain, however.

Five prominent hypothesis of channel forming flow events have been proposed. These are discussed in FEIS text, and in their basic form are represented as follows:

1. Magnitude of the 1.5 year recurrence interval (Murphy et al. 2004)

2. Winter and early spring flows, particularly during ice break up (Johnson 1994)
3. June flows averaged over several years (Johnson 1994)
4. A 10-year running average of a 5-day peak flow for achieving 8,300 to 10,500 cfs (and ascending and receding limbs) (O'Brien 1994)
5. Restoration of a normative flow regime (NAS 2005)

The FEIS examined the effects of the alternatives on channel-forming flow events from each technical perspective, and recognizes that all of the alternatives incorporate future scientific investigations and adaptive management, as has been recommended by principle investigators.

Flows associated with these recommendations for each alternative are provided in the spreadsheet: ***Hydrology for hypothesized channel-forming flows.xls***

The Platte River Cooperative Agreement requested and received review of Platte River endangered species science from the National Research Council. The NRC review (2005) recommended that water management and conservation focus on restoration of a normative flow regime (item #5, above). In general terms, a normative regime is one which mimics the natural pattern of basin hydrology (i.e., seasonal and inter-annual timing, duration, rate of change, and frequency) but is modified in magnitude.

A current technique commonly used to measure/assess changes in stream flow characteristics that is consistent with the normative flow regime approach is to evaluate a number of different indicators of hydrologic alteration, or IHA (Richter et al. 1996). In responding to the NRC recommendation the FWS initiated an evaluation using the IHA (D. Anderson, FWS hydrologist, pers. comm.., January 2005).

Application of the IHA analysis to the central Platte River is hampered by limitations in the historic flow record, not only for the 'predevelopment' period, but also to some extent for the period prior to the rapid increase in reservoir storage around 1940. Although a substantial level of water development was in place by 1923-1940, flow records for this period at Overton probably represent a reasonable basis and the best available reference information for an IHA analysis of year-round flow regime changes in the central Platte River in the 20^{th} century.

A table of output from the IHA analysis is provided in spreadsheet: ***Central Platte IHA - 1923-40 and 1954-71.xls***

II. Riparian Meadow Hydrology

Two aspects of meadow hydrology discussed in the FEIS are the potential influence of river stage on groundwater levels, and connectivity of surface-water aquatic habitat produced by over-bank river flows.

A. River Stage – Groundwater Influences

Based on the existing scientific information, seasonally high river stages appear to influence the ground-water gradient, and in turn the hydrology and ecology of low-lying riparian meadows in the downstream portions of the study area (Wesche et al. 1994, Hurr 1983). Precipitation influences meadow hydrology temporally, and soil composition and surface drainage patterns may influence local site hydrology. These factors, however, are not associated with individual Program Alternatives and are therefore regarded as a part of the baseline.

The analysis of meadow hydrology accounted for the seasonal timing, frequency, and duration of saturation. These hydrologic parameters are widely described in scientific literature as variables that define the basic processes and functions of wetlands (Mitsch and Gosselink 1993).

River water surface elevations output from SEDVEG-Gen3 model were used. These elevation data account for differences changes in river elevation due to both river flow differences and to erosion and deposition trends of the channel bed.

The analysis focuses on the downstream portion of the Central Platte Habitat Area where native wet meadows are most prevalent on large islands or adjacent to the river channel. Years with moderate or high river stages were assumed to have a greater influence on the long-term maintenance of wet meadow biological communities than years with low river stage. This analysis focused on years with the high or moderate river stages (i.e., those exceeded in 70 percent of years).

On a seasonal time scale, we considered that average daily hydrologic values may not always be an appropriate parameter as an indicator of biological impacts. For example, an aquatic habitat dewatered for a few minutes can render it wholly unable to support certain aquatic fauna; and a day or two of aeration can alter physio-chemical effects of sustained saturation. In many cases, exceedance statistics, which represent the minimum level at which water is sustained, are a relevant parameter.

In this particular instance, however, the daily flows are not predictive of future events but are merely the pattern of the historic daily variation superimposed on differences in monthly flows among the alternatives. Average values for river flow and stage were therefore assumed to be adequate for comparing alternatives.

For the early spring period, mid-February to mid-March, a 30-consecutive-day average water surface elevation is calculated for each SEDVEG-Gen3 channel cross section. The elevations for the 25 channel cross sections below Shelton bridge were averaged to produce a computational reference value for each year of the 48-year simulation. The 48 reference elevations are then ranked from high to low (i.e., as an elevation exeedance curve) for comparison with those of other alternatives. Final results are given as the relative increase or decrease in river water surface elevations from the Present Condition.

Similarly, for the late spring period of mid-April to mid-July, a maximum 30-consecutive-day river elevation is computed for each year. The water surface elevations for 25 cross sections in the downstream portion of the study are (below Shelton bridge) are again averaged to provide an annual reference value for each of the 48 years. The procedure for comparing results of Alternatives follows that outlined for the early spring period.

The computations of early spring river water surface elevations (FEIS, tables 5-WC-8 and 5-WC-10) in the downstream portion of the Habitat Area (below RM 195), from SEDVEG-Gen3, incorporate changes due to both altered hydrology and channel morphology.

Computation details used to compare river water surface elevations are prepared for each alternative in spreadsheets:

WSE Trend-Step2 PC.xls
WSE Trend-Step2 GC.xls
WSE Trend-Step2 FWL.xls
WSE Trend-Step2 WM.xls
WSE Trend-Step2 WE.xls

Comparison of water surface elevation frequencies for the early spring and late spring seasonal periods are provided in spreadsheet: ***WSE Trend - Compare.xls***

Limitations. This analysis does not address the potential impacts of unsteady or fluctuating river stage (e.g., hydrocycling regime) on the ground-water buildup or ground-water gradient.

B. Surface Water Connectivity- Over-bank flows

Surface water connectivity occurs when the slews and channel scars in low lying wetlands fill from seepage from the subsurface or from river over-bank flows. Some river channels and natural next to meadows and natural drainages within low-lying wetlands spill into adjoining depressions. The surface water also may increase saturation in the nearby soil profile.

A relatively small rise in river water stage/elevation can have important effect on wetted surface area. Riparian wetlands have shallow topography, thus relatively small water elevation changes can influence a relatively large proportion of the wetland area. Surface-water connectivity is observed to reintroduce and redistribute aquatic organisms within the mosaic of meadow wetland communities (T. Seibert, pers. comm., presentation to Dept of the Interior pulse flow science panel, May 1994)

In downstream portions of the study area, over-bank flows into wet meadow depressions have been observed at river flows of approximately 8,000 cfs and above. A continuum of ecological effects may occur throughout a range of high flow events. This analysis examined the annual frequency that flows in the 8,000 to 12,000 cfs range occur under Present Conditions and each Action Alternative. Hydrologic data for annual peak flow events under the action alternatives are given in spreadsheet: ***Maximum Annual Flows.***

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