RJH CONSULTANTS, INC.

GEOTECHNICAL AND
WATER RESOURCES ENGINEERING

SCREENING-LEVEL EVALUATION REPORT
JEFFREY ISLAND ALTERNATIVE SITE

J-2 REGULATING RESERVOIR PROJECT
PHELPS AND GOSPER COUNTIES, NEBRASKA

Submitted to
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Project 13130

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SECTION 1 - INTRODUCTION

This report presents a screening-level evaluation for developing the J-2 Regulating Reservoirs (Project) on Jeffrey Island in Dawson County, Nebraska. The objective of the Project is to enable regulation and retiming of discharges from the J-2 hydropower plant to the Platte River and Phelps Canal. The Central Nebraska Public Power and Irrigation District (Central) retained RJH Consultants, Inc. (RJH) to perform this screening-level evaluation.

An alternatives analysis and screening study was previously performed for the Project by other consultants under contract to the Platte River Recovery and Implementation Program (PRRIP). Based on results of the previous alternatives analysis, a project location was selected in northern Gosper and Phelps Counties, Nebraska (Existing Site). However, the Jeffrey Island site was not included in the previous alternatives evaluation and Central requested that RJH evaluate the feasibility and costs for locating the Project on Jeffrey Island (Jeffrey Island Alternative). The Jeffrey Island site (Site) is located about a half mile north of the Existing Site as shown on Figure 1.1.

The objectives of this screening-level evaluation were to:

- Identify key issues that would affect the design and construction of the Jeffrey Island Alternative.
- Identify if there are any potential "fatal flaws" with developing the Project on Jeffrey Island.
- Develop concepts for, and a general layout of the primary Project components.
- Develop an opinion of probable project cost (OPPC) for the Jeffrey Island Alternate.

RJH performed the following tasks for this evaluation:

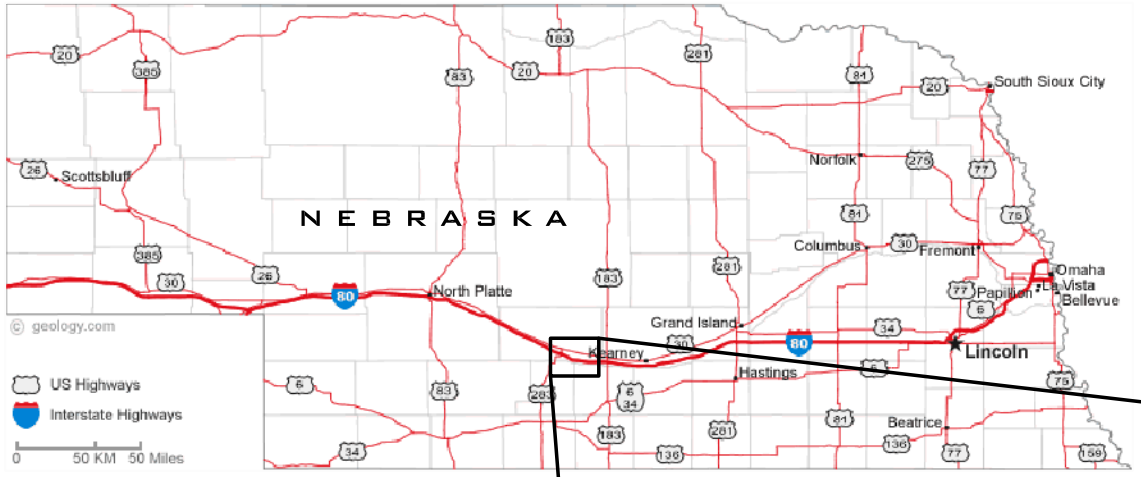
- Collected, assembled, and reviewed available information including topographic data, soil and geologic maps, aerial photography, and property boundaries.
- Performed a Site visit to Jeffrey Island to identify topographic, surficial, and general subsurface conditions.
- Developed a preliminary Site plan for the reservoirs, including development of elevation-capacity curves for the reservoirs.

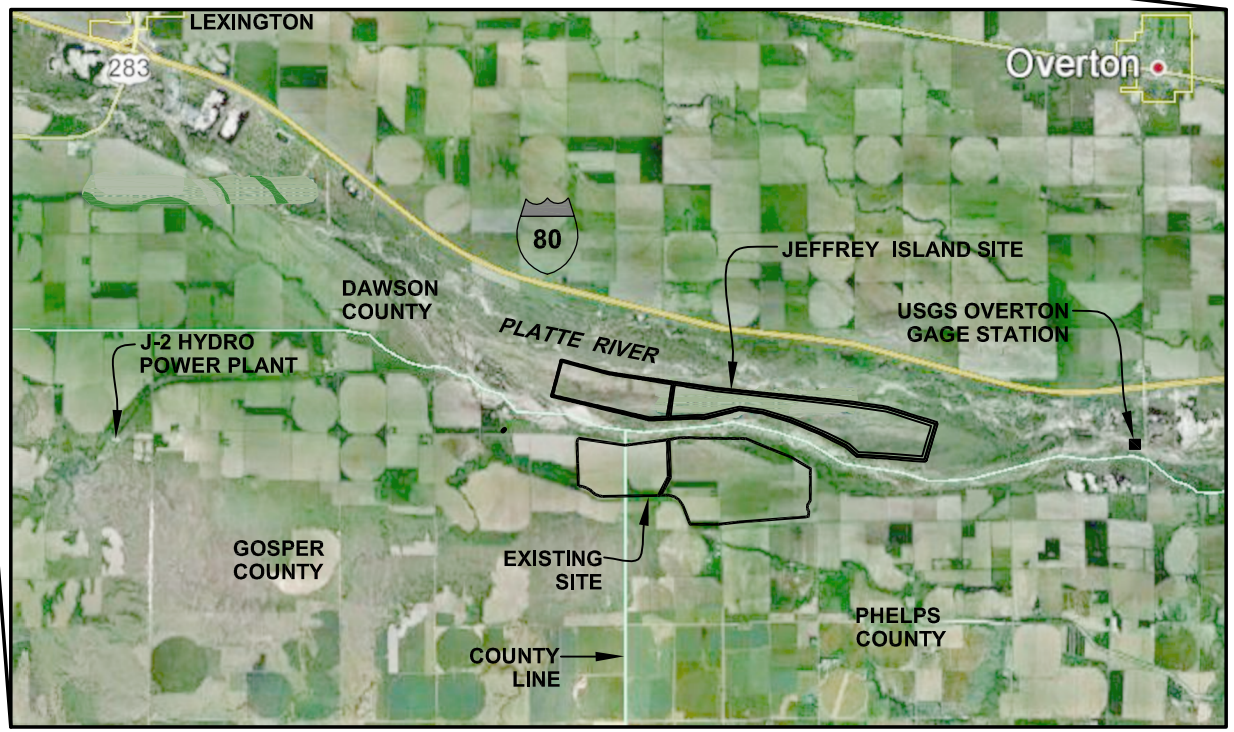
- Evaluated flood hydrology and floodplain limits for the Platte River, which encompasses Jeffrey Island.
- Developed a concept to convey water through an extension of the Supply Canal to and from the reservoirs.
- Developed a concept to appropriately manage seepage in the reservoirs.
- Developed concepts for the primary components of the Project including dam embankments, hydraulic conveyance, gates, and other significant ancillary facilities.
- Estimated the approximate quantities required to construct the primary Project components.
- Developed an OPPC.
- Presented the results to Central's Board and prepared this report to document the evaluation.

The primary personnel responsible for the evaluation described in this report are:

Robert J. Huzjak, P.E.	Project Manager
A. Tom MacDougall, P.E.	Project Engineer
James A. Olsen, P.E.(1)	Geotechnical Engineer
Tracy E. Owen, P.E.(1)	Water Resources Engineer

(1) Licensed in states other than Nebraska.





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SCREENING - LEVEL EVALUATION REPORT FOR JEFFREY ISLAND DAWSON COUNTY, NEBRASKA

SITE VICINITY MAP

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Figure 1.1

P:\13130 - J-2 REGULATING RESERVOIR\CAD\TASK_ORDER_2_PRE-DESIGN\TASK_2.4_JEFFERY'S_ISLAND\REPORT FIGURES\FIG 1.1_SITE_VIC_MAP.DWG 2/12/2015 12:49 PM

SECTION 2 - EXISTING CONDITIONS

2.1 Site Description

Jeffrey Island is approximately 5.5 miles long and approximately 0.5 mile wide at the widest section. The island will be owned by Central in 2016 through a lease-purchase agreement. Central entered into the lease-purchase agreement to obtain lands for wildlife habitat as a requirement of the Federal Energy Regulatory Commission (FERC) for the Kingsley Dam hydropower license.

Jeffrey Island is covered with grassland and intermittent areas of large trees. The topography is relatively flat and slopes gently down to the east similar to the general slope of the river (approximately 1 vertical foot every 750 horizontal feet on average). The majority of the island is elevated approximately 5 to 15 feet above the bottom of the north and south river channels, respectively. In most areas, the perimeter of the island (adjacent to the river channels) consists of a series of one to two, 2- to 4-foot-high benches between the primary part of the island and the river channels. Horizontally, the width of these benches vary from tens of feet to a few hundred feet. In some areas, near-vertical cutbanks have formed between the river channel and the primary ground surface of the island and the benches are not present.

2.2 Hydrologic and Hydraulic Conditions

The Site is encompassed by two main river channels of the Platte River: a north channel and a south channel. The two main river channels each consist of various relatively shallow braids. A levee is located across the south channel of the Platte River at the western end of Jeffrey Island. The levee provides vehicle access to the Site and diverts normal river flow into the north channel. The south channel is fed primarily by discharges from Central's J-2 Return. The bottom of the south river channel is about 10 feet below the bottom of the north main channel.

Federal Emergency Management Agency (FEMA) Flood Insurance Studies (FIS) have not been published for either Phelps or Gosper Counties. A FEMA FIS was available and obtained for Dawson County. Effective Flood Insurance Rate Mapping (FIRM) for the Platte River near the Project is Approximate Zone A and no base flood elevations (BFEs) or regulatory discharges are provided. Based on the Approximate Zone A mapping, all of Jeffrey Island is within the 100-year floodplain.

RJH performed a peak discharge and flood frequency analysis based on U.S. Geological Survey (USGS) stream gage data for the USGS gage near Overton (USGS station number 06768000) for the years 1941 to 2012. RJH computed flows for various recurrence intervals as shown in Table 2.1.

TABLE 2.1
PLATTE RIVER PEAK DISCHARGE AND FREQUENCY
Based on Overton Gage Analysis (1941-2012)

Event	Discharge (cfs)
10-Year	12,430
50-Year	22,700
100-Year	28,450
500-Year	45,850

RJH performed a screening-level hydraulic analysis in the Platte River to evaluate likely maximum water surface elevations during a 100-year flow event. RJH developed an existing conditions model of the Platte River utilizing flow rates estimated from gage analysis, and conservatively assumed that the entire Platte River discharge could be conveyed in either the north channel (if the levee did not fail) or in the south channel (if the levee failed). Based on model results, the main ground surface of Jeffrey Island would begin to be inundated with less than 1 foot of water between about the 25-year and 100-year flow events. The approximate extents of the inundation for the 100-year flood are shown on Figure 2.1. Given the analysis was conservative, most of the Site is likely above the 100-year inundation limits. Based on the model results, most of the Site becomes inundated with more than 1 foot of water between the 200-year and 500-year flood events.

RJH considered that the Site location (between active channels of the Platte River) could be a technical fatal flaw for the Jeffrey Island Alternative. However, based on inundation mapping, RJH concluded that most of the Site is above the 100-year floodplain elevation and that development of a reservoir on Jeffrey Island would likely result in a negligible impact to the 100-year floodplain. RJH specifically concluded that the 100-year flood risk for Interstate 80 or riverside homes adjacent to Jeffrey Island should not be affected from a reservoir on Jeffrey Island. Additionally, the likelihood that routine flooding would expose the exterior of a dam embankment to flow would be relatively low.

RJH also considered the potential for flooding in the Platte River to cause lateral bank erosion that could undermine a dam on Jeffery Island. Based on a review of historical

aerial photographs, the perimeter of Jeffrey Island appears to be relatively stable and only a few portions of the channel banks would likely need to be stabilized as part of the Project. Therefore, RJH concluded that the Site location within the river did not present a clear technical fatal flaw and that completing the remainder of the screening-level evaluation was appropriate.

Although for this screening-level study, RJH did not identify clear technical fatal flaws for the Site, FERC is the lead permitting agency for this Project. FERC typically requires dams to be designed to withstand floods much greater than the 100-year flood event. Obtaining regulatory approval and permission from FERC to develop a dam and reservoir on Jeffrey Island could be very difficult or impossible because of the inherent risks associated with locating a dam on an island within an active river channel where the exterior of the dam would be exposed to high flows relatively frequently for dams (i.e., approximately the 200-year flow event). RJH is unaware of Federally-Regulated dams being permitted when encompassed by an river. Alternatively, the cost to provide erosion protection to the entire exterior of the embankment would likely pose an economic fatal flaw for this Project concept.

2.3 Subsurface and Groundwater Conditions

2.3.1 Site Geology

The geology at Jeffrey Island consists of Quaternary-age (less than 2 million years old) alluvium overlying the Pliocene-age (2.6 to 5.3 million years old) Ogallala Formation (Dreeszen, 1973). According to published mapping near the Site and a preliminary geologic review of the Site, the surficial alluvium consists predominately of a terrace deposit. The terrace deposit likely consists of a relatively thin upper layer of sandy or silty soils (less than about 10 feet thick). Below the terrace deposit, the alluvial material is likely similar to the material in the active channel of the Platte River, sandy and gravelly soils with little to no silt or clay content (Condon, 2005).

According to the geologic maps of the Project area, the Ogallala Formation is highly permeable and predominately soil-like, but may include localized zones of cemented materials (Dreeszen, 1973). Based on borings drilled within a few miles of the Site, the Ogallala Formation is likely about 30 to 40 feet below the ground surface. The Ogallala Formation averages about 300 feet thick, contains intermittent and discontinuous layers of varied material types (i.e., clays, silts, etc.) within the larger sandy soil matrix, and is a regional aquifer with a relatively high permeability (Dreeszen, 1973) (Schreurs and Rainwater, 1956).

2.3.2 Geotechnical Conditions

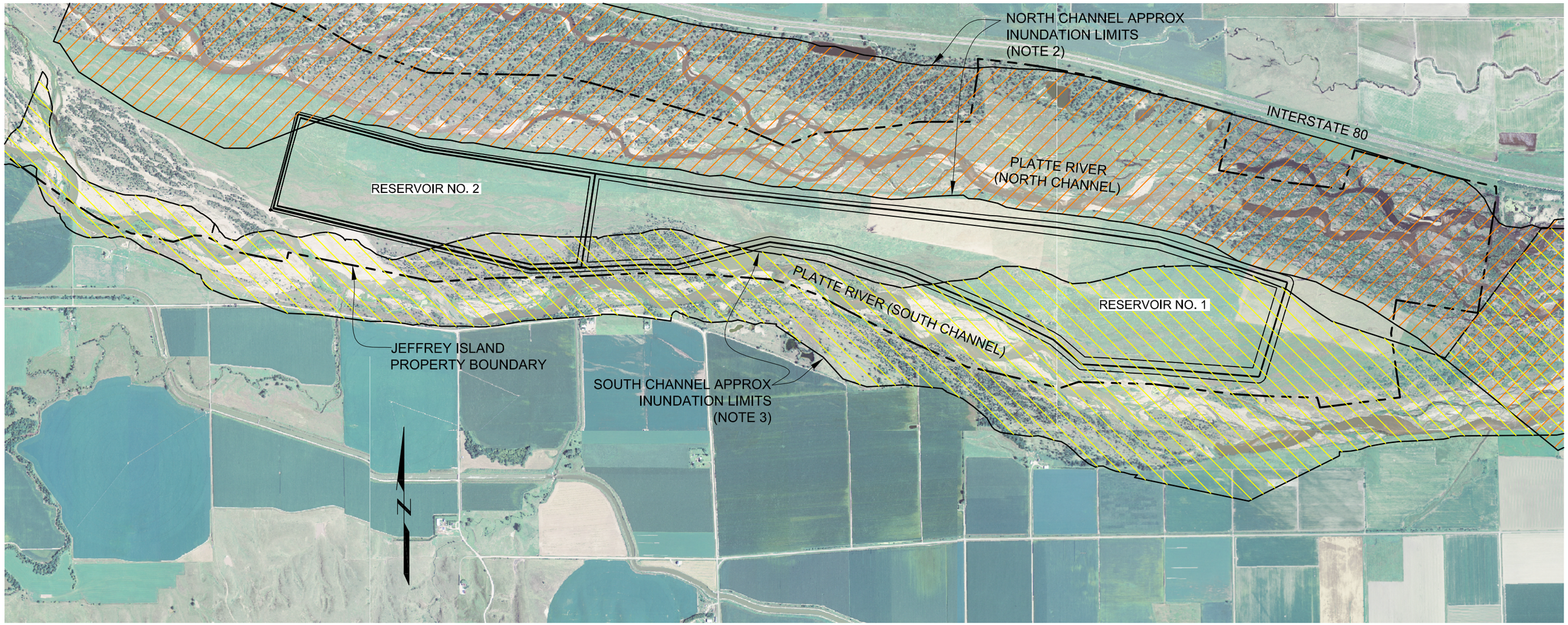
In October 2014, RJH performed field reconnaissance at the Site. The Site reconnaissance included observations of exposed soils along the banks of the Platte River and excavation of one 6.5-foot-deep hand-auger boring. In addition to Site observations, RJH reviewed the Natural Resources Conservation Service (NRCS, 2014) soil maps and Nebraska Department of Natural Resources (DNR, 2014) records for three wells constructed on Jeffrey Island (Well ID Nos. 164797, 164798, and 217454).

Based on the data collected, subsurface conditions on Jeffrey Island generally consist of up to about 3 feet of clayey sand topsoil (where present), overlying relatively sandy alluvium that generally contains less than 5 percent fines with varying amounts of gravel. Sand within about 3 feet of the ground surface was generally fine grained and did not include significant quantities of gravel. Below about 3 feet, the sand encountered in the hand-auger boring was fine grained to coarse grained and included increasing amounts of gravel with increasing depth. During construction of DNR Well No. 217454, a 6-foot-thick zone of sandy clay was encountered at depths ranging from 36 to 42 feet below the ground surface. This layer of sandy clay corresponds to the estimated depth of the Ogallala Formation and is likely discontinuous based on the lithology described by Dreeszen, 1973 (as presented in Section 2.3.1 of this report).

2.3.3 Groundwater

Groundwater at the Site is anticipated to generally correspond to the water surface elevation in the braided stream channels on the north and south sides of Jeffrey Island. RJH reviewed available topographic data for the site and the water surface elevation in the various stream channels in the Platte River to estimate groundwater depths below Jeffrey Island. Based on our review of available data, the depth to groundwater beneath Jeffrey Island generally decreases from west to east. Near the west end of the island, groundwater is anticipated to normally range from about 11 to 12 feet deep. Near the east end of the island, groundwater is anticipated to normally range from about 5 to 6 feet deep. Groundwater beneath Jeffrey Island is anticipated to fluctuate with changes in river stage and could saturate portions of the ground surface during high water.

Two of the three DNR well construction records at Jeffrey Island report groundwater depths of 4 feet; however, groundwater was not encountered in the 6.5-foot-deep hand-auger boring. Based on our understanding of Site geology, groundwater depths reported on DNR well records may not reflect average conditions.



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NOTES:

1. FLOOD INUNDATION LIMITS FOR THE 100-YEAR FLOOD EVENT ARE APPROXIMATE AND REPRESENTATIVE OF A SCREENING LEVEL STUDY.
2. BASED ON AN ASSUMPTION THAT 100-YEAR FLOW IS ALL WITHIN THE NORTH CHANNEL.
3. BASED ON AN ASSUMPTION THAT 100-YEAR FLOW IS ALL WITHIN THE SOUTH CHANNEL.

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SCREENING - LEVEL EVALUATION REPORT FOR JEFFREY ISLAND DAWSON COUNTY, NEBRASKA

PROJECT NO. 13130

PLATTE RIVER 100-YEAR FLOOD APPROXIMATE INUNDATION LIMITS

February 2015 **Figure 2.1**

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SECTION 3 - PROJECT CRITERIA

The requirements for storage and conveyance of water for the Jeffrey Island Alternative would need to be similar to those developed for the Existing Site (RJH, 2013). These include:

- Conveyance for up to 1,700 cubic feet per second (cfs) into the Reservoirs from Phelps Canal (extended Supply Canal) with 2 feet of differential head between Phelps Canal and the reservoirs.
- Two reservoirs with a total regulating capacity of approximately 18,000 acre-feet (ac-ft). One of the reservoirs would need about 840 ac-ft of storage that could readily be returned to Phelps Canal for irrigation.
- Conveyance for up to 1,000 cfs (the 840- ac-ft identified above) from the Reservoirs to Phelps Canal with 1 foot of differential head between the Reservoirs and Phelps Canal.
- The ability to routinely release flows between 5 and 500 cfs from the reservoirs to the Platte River (target flows).
- Facilities to release 2,000 cfs to the Platte River for 3 consecutive days, a total of 11,900 ac-ft, with no inflow from Phelps Canal (i.e., short duration high flows (SDHF)).

SECTION 4 - KEY TECHNICAL AND DESIGN ISSUES

Based on conditions at the Site and the operational criteria, RJH has identified the following key technical and design issues for the Jeffrey Island Alternative:

- The Site is encompassed by the 100-year floodplain and active river channels. Regulators may not issue permits for the Project because of the potential for external embankment, foundation erosion, or other potential dam safety issues.
- The Site has relatively flat topography and to develop reservoirs, perimeter ring dams will be required. Additionally, Jeffrey Island is relatively long and narrow, which will require relatively long embankments to impound the reservoirs (i.e., the reservoirs have an inefficient ratio of embankment length to reservoir capacity).
- The Site is not adjacent to the existing Phelps Canal or Supply Canal. Therefore, long conveyance facilities between the existing canal and the Site will be required.
- The subsurface materials at the Site are predominately sandy soils. The sandy soils are highly permeable and will not be effective in retaining reservoir water without the addition of seepage control measures. Additionally, the sandy soils are susceptible to erosion, which will require designs that protect against both external and internal erosion.
- Clayey soils are generally not present on Site and on-site borrow is not available to construct needed seepage control measures.
- Groundwater is relatively shallow at the Site. The shallow groundwater will limit the location of the reservoir bottom, limit the depth of borrow excavations or require significant dewatering, and will impact the design and construction of hydraulic structures.
- Site access is limited and a new access bridge will be needed for construction and post-construction operations and maintenance.
- Planned operation of reservoirs will require the reservoir level to routinely fluctuate from full to empty and in some conditions, the reservoir will be lowered from full to near empty in about 3 days. This will expose the entire upstream slope to the effects of wave erosion and the embankment to routine extreme drawdown events.

SECTION 5 - PRIMARY PROJECT COMPONENTS

5.1 General

RJH developed concepts for primary Project components needed to meet the design requirements and address the identified key technical and design issues. The primary Project components include:

- Perimeter embankment dams that would impound two reservoirs. The height of the embankments would range from about 10 to 40 feet above the existing ground surface.
- Two clay-lined reservoirs sized with a regulating capacity of about 18,000 ac-ft. Reservoir No. 1 would be the eastern reservoir and Reservoir No. 2 would be the western reservoir. The two reservoirs would be separated by an earthen embankment and together both reservoirs would occupy about 950 surface acres.
- An inverted siphon (Siphon) that would extend below the Platte River. The Siphon would be capable of conveying 1,700 cfs from the Phelps Canal to Reservoir No. 2 (with 1.7 feet of differential hydraulic head) and conveying 1,000 cfs from Reservoir No. 2 back to the Phelps Canal (with 0.7 feet of differential hydraulic head).
- An interconnect structure that would convey 1,700 cfs from Reservoir No. 2 to Reservoir No. 1 with 1.7 feet of differential hydraulic head.
- Conveyance channel through Reservoirs Nos. 1 and 2 that would convey 1,700 cfs from the inlet to the outlet of each reservoir. This channel would be needed to protect against erosion of the sandy (and erodible) protective cover that would overlie the clayey reservoir liner especially when reservoir levels would be low.
- An outlet from Reservoir No. 1 to the Platte River that would be sized to:
  - Discharge routine supplemental flows of up to 500 cfs.
  - Meet SDHF discharge requirement of 2,000 cfs for 3 consecutive days.
- A vehicle access bridge capable of supporting two lanes of construction equipment.
- Riverbank protection at selected locations around the perimeter of the island where lateral cutting of the banks by the Platte River would be most likely to compromise the safety of the dams.

Figure 5.1 shows the concept for the Jeffrey Island Alternative. Additional information for each primary component is provided in the following sections.

5.2 Embankment Dams

RJH developed a concept for perimeter earthen embankment dams to impound the reservoirs. The maximum embankment height would be approximately 40 feet and the perimeter embankment would be approximately 8.6 miles. The embankment partitioning Reservoirs No. 1 and No. 2 would be approximately one-third of a mile long and about 15 feet high.

Based on soils available for construction of the embankments, RJH selected a concept of a zoned earthfill dam with the following zones:

- A central core comprised of low-permeability fine grained soils to reduce and control seepage through the embankment. The embankment core would connect with a reservoir liner and consist of on-site soils mixed with off-site clayey borrow.
- Upstream and downstream sandy embankment shells to provide embankment stability during the anticipated loadings and to utilize on-site soils available for borrow.
- A filter sand zone (chimney) downstream of the central core. This zone would mitigate the likelihood for piping or internal erosion in the embankment and manage seepage flow through the embankment. Seepage collected by the filter sand could be conveyed into the sandy foundation soils or could be collected in slotted drainage pipes that could discharge into the river.
- Soil-cement upstream slope protection to protect the embankment from wave erosion. Soil-cement slope protection is considered to be more economical for this Site than riprap or concrete cellular mats and can be manufactured using available on-site sandy soils. The top 6 feet of the soil-cement would be stair-stepped to help dissipate wave energy near the embankment crest.
- A gravel drainage layer beneath the soil-cement to prevent excessive uplift pressure during relatively routine rapid drawdowns of the reservoir.

Based on RJH's experience with similar types of reservoirs, the interior (reservoir) side of the embankments would need to be inclined at 4 horizontal to 1 vertical (4H:1V) slopes to provide adequate stability during rapid drawdown and to facilitate construction of the soil-cement. RJH selected 3H:1V slopes along the exterior sides of the

embankments primarily for maintenance purposes. RJH selected an embankment crest width of 14 feet to provide access for maintenance and inspection vehicles and equipment. A typical embankment section is shown on Figure 5.2.

5.3 Clay Lined Reservoirs

The concept is for two reservoirs with a combined regulating capacity of 18,000 ac-ft. Reservoir No. 1 (the eastern reservoir) would have approximately 14,735 ac-ft of capacity. Reservoir No. 2 would have a maximum capacity of about 3,265 ac-ft and be capable of providing 840 ac-ft of storage in the top 3 feet of the reservoir pool to provide irrigation water back to the canal. Different than the concept for the Project at the Existing Site, the reservoirs would be situated in series with respect to flow. The Supply Canal would only be connected to Reservoir No. 2. Flow to Reservoir No. 1 could only come from Reservoir No. 2. Discharge to the Platte River could only be from Reservoir No. 1. The total footprint of the reservoir and embankments would cover about 950 acres of land as shown on Figure 5.1.

RJH selected the western limit of Reservoir No. 2 based on the anticipated alignment of the supply siphon. We selected the location of the embankment that partitions Reservoirs No. 1 and No. 2 and the eastern limit of Reservoir No. 1 based on achieving similar capacities as the concept developed for the Existing Site. RJH set the location of the exterior toes of the perimeter embankment at least 100 feet from the edge of primary ground surface (i.e., the terrace edge or the general location where benches and cutbanks begin around the perimeter of the island). We included this 100-foot set-back to provide an area for maintenance, instrumentation, access roads, and a buffer zone for future potential erosion of the island by the river. The reservoir embankments are also located a minimum of 100 feet from property boundaries. The bottom of the reservoir would be sloped to drain toward the outlet structures.

For this screening-level evaluation, RJH selected to manage seepage using a reservoir liner. The reservoir liner would consist of a low-permeable layer of compacted soil that is connected to the central zone of the embankment (low permeable core). The reservoir liner would provide the seepage management needed to mitigate seepage losses and high-energy seepage from undermining and failing the dam (usually referred to as a “piping” failure). RJH selected an 18-inch-thick liner based on the results of previous evaluations performed for the Project. The liner would be constructed in two lifts. Placing the liner in two lifts would significantly decrease the probability that there would be a defect in the liner because two defective zones would have to be constructed on top of each other. The reservoir liner would be overlain with 3 feet of compacted on-site soil to protect the liner

from shrinkage cracking, desiccation, frost, uplift pressures, vegetation, burrowing animals, and vandalism. Except for a few isolated areas, the bottom of the reservoir liner would generally be above the anticipated top of groundwater during normal flow conditions in the river.

Based on geotechnical conditions at the Site, sufficient fine grained material suitable to construct a reservoir liner is likely not available on site for borrow. Therefore, an off-site borrow location would need to be identified from which approximately 3,890,000 cubic yards (CY) of low-permeable material could be obtained. RJH reviewed NRCS soil maps and available information and estimated that this volume of material could likely be obtained within 7 miles of the Site. Based on existing information one possible location for this borrow is the area of the Existing Site.

RJH considered alternatives for lining the reservoirs because the liner represents a significant portion of the overall construction costs. The alternatives we considered for lining the reservoirs included a geosynthetic liner and a bentonite-amended soil liner. Both of these alternatives were estimated to be more expensive than a compacted clay liner. We estimated the cost for a geosynthetic liner (including material and transportation costs) to be approximately twice the cost of the selected liner alternative. We estimated the cost for a bentonite-amended clay liner to be approximately 1.8 times the cost of the selected liner concept.

The reservoir concepts developed for Jeffrey Island also included two supplemental borrow areas for sandy soils. The supplemental borrow areas were east and west of the reservoirs. RJH included the supplemental borrow areas in the concept to reduce:

- The overall depth of borrow excavation in the reservoir (to reduce the need for dewatering).
- Groundwater impacts on construction and during operation of the facility.
- Haul distances for embankment construction.

5.4 The Siphon

To convey water to and from the Site, RJH developed a concept for a siphon that would connect Reservoir No. 2 and the extended Supply Canal. The Siphon would consist of two parallel, 14-foot by 14-foot concrete box conduits that extend approximately 3,700 feet. RJH selected the location of the Siphon to limit its length, which would reduce

hydraulic losses and construction costs. The approximate vertical profile of the Siphon was developed to:

- Provide a minimum of 5 feet of soil cover above the top of the Siphon.
- Reduce dewatering and excavation support during installation.
- Reduce the potential for damage caused by erosion in the Platte River.
- Reduce hydraulic losses associated with bends in the Siphon.

Concepts for the Siphon profile and typical sections are shown on Figure 5.3.

Flow through the Siphon would be regulated with bi-directional flow gates located at each end (i.e., at the extended Supply Canal and at Reservoir No. 2). The concept for the gates between Reservoir No. 2 and the Siphon includes three 10-foot by 10-foot slide gates. The slide gates would be upward opening gates with the inverts at the bottom of the Siphon and Reservoir No. 2. The three slide gates would be capable of conveying about 1,700 cfs with about 1.7 feet of differential head, and about 1,000 cfs with about 1 foot of differential head (in accordance with the operational criteria).

The concept for the connection between the Siphon and the extended Supply Canal is to convey flow both into and out of the Siphon. The concept consists of two channels (a Siphon inlet channel and a Siphon outlet channel) with three parallel, 10-foot by 10-foot bi-directional slide gates spanning each channel. These gates would be used to divert flow to the appropriate destination (i.e., either to Reservoir No. 2 or to Phelps Canal for irrigation. A check structure comprised of a 30-foot-wide by 15-foot-tall radial gate would be located in the extended Supply Canal between the Siphon inlet and outlet channels. The gate locations are shown on the Siphon plan on Figure 5.3. When fully open, the canal check structure gate would allow 1,000 cfs to flow into Phelps Canal. When closed, the check structure would raise the water surface elevation to 2356.0 and divert flow to Reservoir No. 2 through the Siphon. Improvements needed to extend the Supply Canal along the existing Phelps Canal alignment were not evaluated for this screening-level study, because they are expected to be relatively minor based on the work previously completed for the Existing Site.

The Siphon is a relatively major component for the Jeffrey Island Alternative and RJH evaluated an option to convey flow to the Site using an aqueduct over the south channel of the Platte River. The cost of the aqueduct was approximately 280 percent more than the cost of the Siphon concept. The primary reason the aqueduct cost was more than the

Siphon was that a significant structure would be needed to support the heavy load of the water. The load from the water is about 14 times the load for a typical highway bridge. RJH's comparison of costs considered the cost savings associated with combining the conveyance structure with the access bridge (discussed in Section 5.8).

5.5 Reservoir Interconnect Structure

RJH developed a concept to convey flow from Reservoir No. 2 to Reservoir No. 1 through an interconnect structure. The structure was sized to convey 1,700 cfs with 1.7 feet of differential hydraulic head. Flow through the interconnect would be controlled by three 10-foot-tall by 10-foot-wide bi-directional slide gates situated in a rectangular concrete channel. RJH selected bi-directional gates for the interconnect to accommodate the range of possible combinations of reservoir levels in each reservoir. RJH did not include an outlet from Reservoir No. 2 directly to the Platte River; therefore, the interconnect would convey flow to Reservoir No. 1 for intended releases to the Platte River from Reservoir No. 2.

5.6 Conveyance Channel

RJH considered that protective fill above the reservoir liner would consist predominantly of sandy soils with very little to no fine grained constituents. The sandy soils would be highly susceptible to erosion even at relatively low velocities; therefore, RJH concluded that erosion protection was needed, especially for conditions when flow enters a relatively empty reservoir. RJH developed a concept for a conveyance channel that would extend across the length of Reservoir No. 2 and Reservoir No. 1, as shown on Figure 5.1. The channel would be trapezoidal and built with soil-cement. The dimensions of the channel would be approximately 110 feet wide and have sides 3 feet high with 1.5H:1V side slopes. The channel could convey 1,700 cfs at a velocity of about 5 feet per second (fps), with a slope consistent with the slope of the reservoir bottom (0.0014 ft/ft and 0.0013 ft/ft for Reservoir No. 1 and No. 2, respectively)

5.7 Reservoir No. 1 Outlet

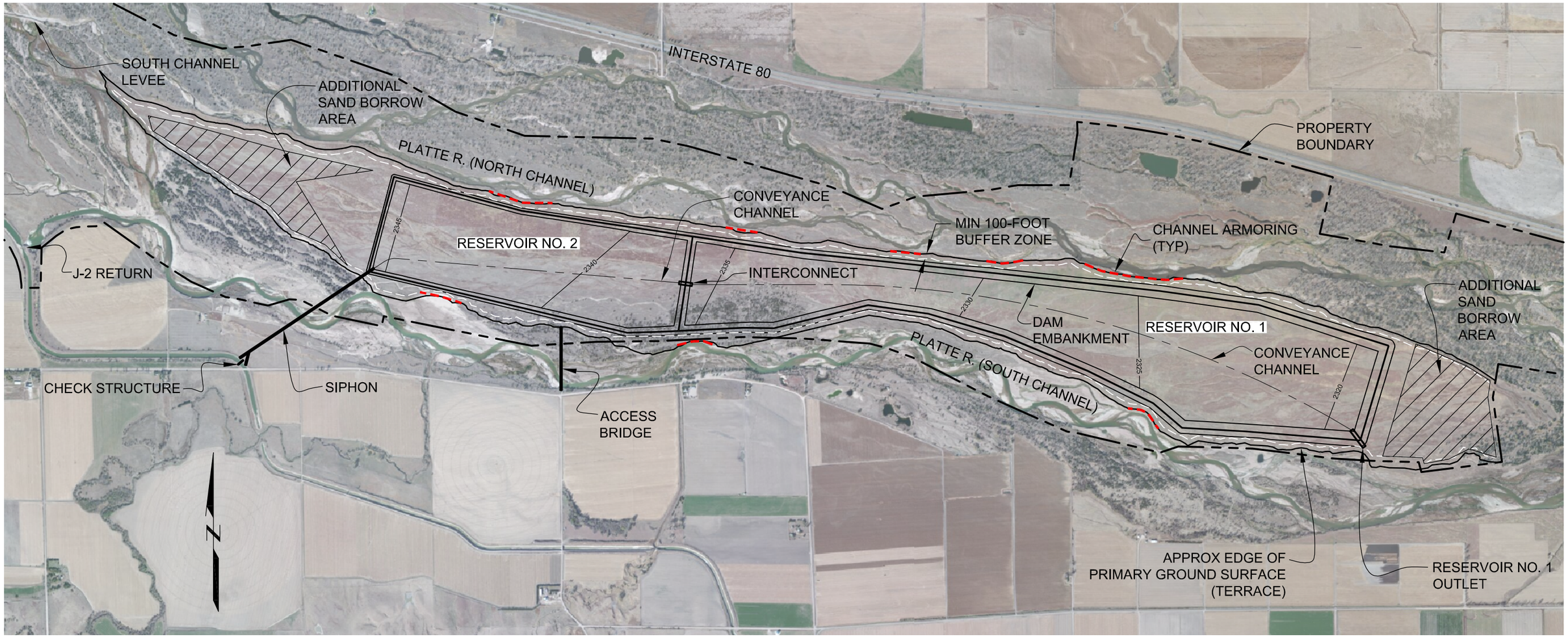
The concept for the Reservoir No. 1 outlet was developed to meet the following criteria:

- Discharge routine flows up to 500 cfs.
- Meet SDHF discharge requirements of 2,000 cfs for 3 consecutive days.

The Reservoir No. 1 outlet would consist of two gates: one 10-foot-tall by 10-foot-wide slide gate and one 38-foot-tall by 15-foot-wide radial gate. The slide gate would be used to discharge flows up to about 500 cfs and the radial gate would be used to discharge higher flows. The outlet structure would include energy dissipation facilities downstream of the gates and upstream of the discharge into the Platte River. The energy dissipation would be configured to allow discharge of the SDHF to the south channel of the Platte River under subcritical flow conditions.

5.8 Access Bridge

Access to Jeffrey Island is currently provided by a levee that extends from the south bank of the Platte River to the western tip of the island. In its current condition, the levee would not be suitable for construction access or for Project access during high River conditions. The crest of the levee is only 10 feet wide and the levee has historically overtopped during flooding. Continuous access to the dam would be required during flood and non-flood events. RJH developed a concept for an access bridge that extends from Road 438 to the island. This bridge would provide reliable access for construction and long-term operations, which is required for dam safety. The access bridge would be about 1,280 feet long and 30 feet wide to allow for traffic in two directions. The general configuration of bridge deck, supports, and deep foundation is anticipated to be similar to the existing bridge at Road 444 that crosses the Platte River downstream of the Site.



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SCALE IN FEET

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CENTRAL Nebraska Public Power and Irrigation District

RJH CONSULTANTS, INC.

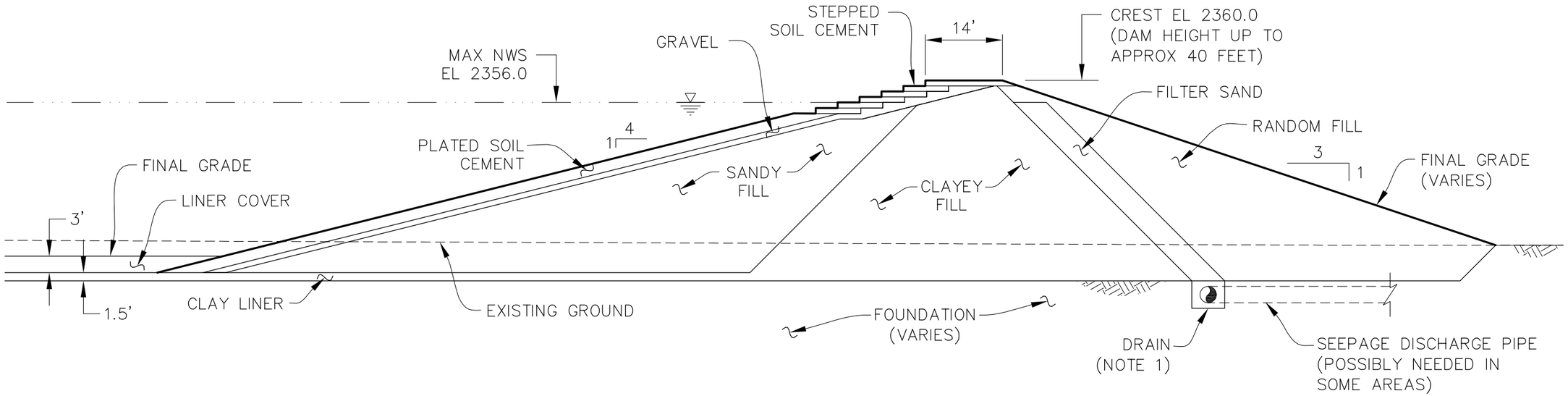
SCREENING - LEVEL EVALUATION REPORT FOR JEFFREY ISLAND DAWSON COUNTY, NEBRASKA

PROJECT NO. 13130

JEFFREY ISLAND ALTERNATIVE PLAN OF PRIMARY PROJECT COMPONENTS

February 2015 **Figure 5.1**

P:\13130 – J-2 REGULATING RESERVOIR\CAD\TASK_ORDER_2_PRE-DESIGN\TASK_2.4_JEFFERY'S_ISLAND\REPORT FIGURES\FIG 5.1_JEFF_ISLAND_LAYOUT.DWG 2/12/2015 1:30 PM



0 10 20 40 60

SCALE IN FEET

NOTE:

1. THE DEPTH OF DRAIN WOULD VARY. COLLECTED SEEPAGE WOULD SEEP INTO UNDERLYING PERMEABLE SANDY FOUNDATION SOILS OR BE COLLECTED IN DRAIN PIPES AND CONVEYED BY GRAVITY TO DAYLIGHT AT THE GROUND SURFACE.

CENTRAL Nebraska Public Power and Irrigation District

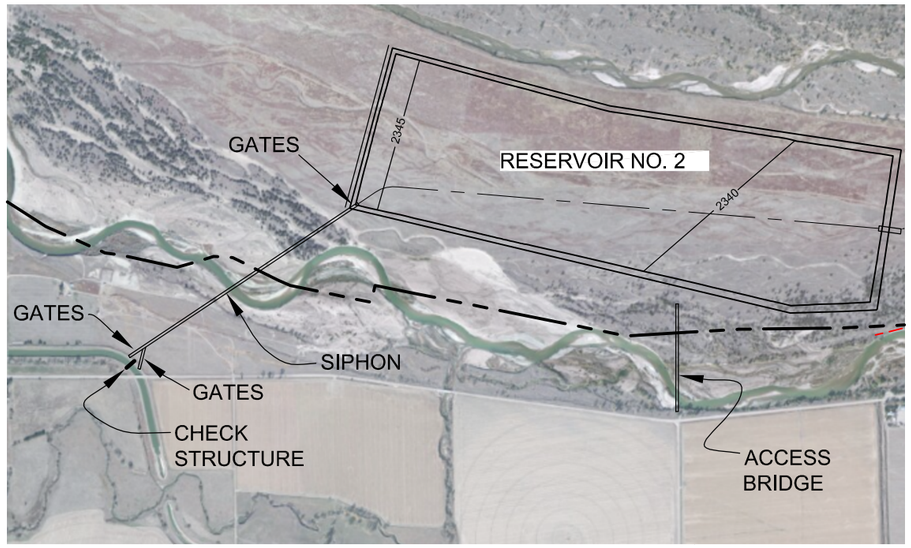
RJH CONSULTANTS, INC.

SCREENING - LEVEL
EVALUATION REPORT FOR
JEFFREY ISLAND
DAWSON COUNTY, NEBRASKA

PROJECT NO. 13130

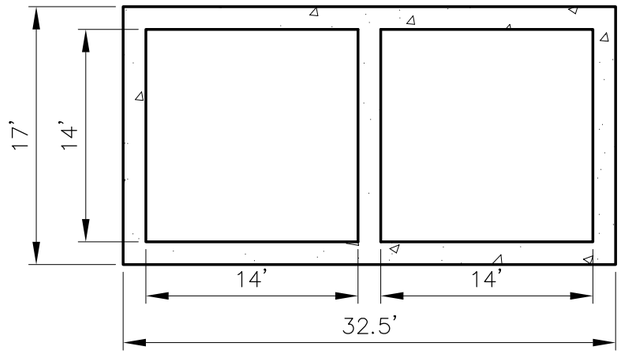
TYPICAL EMBANKMENT SECTION

February 2015 **Figure 5.2**



SIPHON PLAN

NTS



TYPICAL SIPHON SECTION

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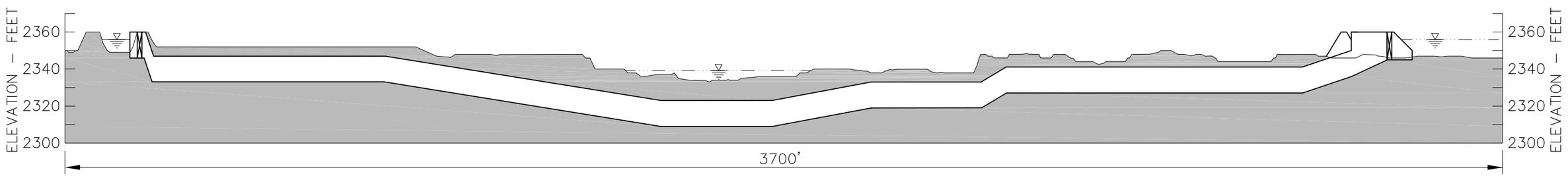

SIPHON PROFILE

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CENTRAL Nebraska Public Power and Irrigation District

RJH CONSULTANTS, INC.

SCREENING - LEVEL EVALUATION REPORT FOR JEFFREY ISLAND DAWSON COUNTY, NEBRASKA

PROJECT NO. 13130

INVERTED SIPHON CONCEPT

February 2015 **Figure 5.3**

P:\13130 – J-2 REGULATING RESERVOIR\CAD\TASK_ORDER_2_PRE-DESIGN\TASK_2.4_JEFFERY'S_ISLAND\REPORT FIGURES\FIG 5.3_INVERTED_SIPHONE_CONCEPT.DWG 2/12/2015 1:38 PM

SECTION 6 - SCREENING LEVEL COST OPINION

RJH developed an OPPC for the screening-level concepts presented in this report. This OPPC is intended to provide Central with information to support budgetary planning, evaluation of alternatives, and selection of preferred concepts to move forward into the next phase of Project development.

RJH developed our OPPC based on estimated quantities and costs for the primary elements of the Project. For consistency in evaluation of alternatives, we used unit costs similar to those used for RJH's OPPC for the Project at the Existing Site (RJH, 2013). RJH developed our unit and lump sum costs based on published price data (i.e., R.S. Means), previous experience, and engineering judgment. We developed our costs using 2013 dollars to allow for a more direct comparison of the Jeffrey Island alternative to the Project at the Existing Site.

The OPPC is based on professional opinions and would likely change as more design details are developed and from other economic factors. RJH developed the OPPC to a Class 4-5 level estimate as defined by the Association for the Advancement of Cost Estimating (AACE). This level is appropriate for a screening study where the design engineering is between 1 and 5 percent complete. Based on guidelines published by AACE and our experience, it is our opinion that the reliability of the cost presented in this report are between minus 15 to plus 30 percent. This means that the final Project cost is likely to be between 15 percent less to 30 percent more than the cost provided in this report, when all costs are compared to 2013 dollars.

RJH's OPPC is about $198 million (2013 dollars). This includes contingencies; direct construction costs; and allowances for engineering, permitting, etc. Our opinion of direct construction costs (DCC) is $141 million. The DCC is RJH's estimate of what we would expect bid costs to be in 2013. Our OPPC for the primary Project elements are shown in Table 6.1.

RJH used allowances for engineering and permitting that are consistent with the allowances used for the existing Project (RJH, 2013). RJH also included a design and construction contingency of 25 percent, which is 5 percent higher than used previously (RJH, 2013). We used a slightly higher allowance because the engineering and field investigation for this Site is less advanced than the current Project.

TABLE 6.1
OPINION OF PROBABLE PROJECT COSTS FOR THE JEFFREY ISLAND ALTERNATIVE

Item	Subtotal ($)
General Site Work and Riverbank Stabilization	4,550,000
Liner and Protective Cover	24,220,000
Embankment Fill	37,250,000
Upstream Slope Protection	28,220,000
Siphon	18,500,000
Hydraulic Structures (Interconnect, Reservoir No. 1 Outlet, and conveyance channel))	14,665,000
Access Bridge	7,980,000
Phelps Canal Improvements	1,850,000
Bonds and Mobilization	3,350,000
Direct Construction Costs	**140,585,000**
Contingency	35,100,000
Engineering, Owner, and Permitting Allowances	22,200,000
Total	**197,885,000**

Note: Costs to purchase land needed for the concept are not included.

SECTION 7 - CONCLUSIONS

Based on the screening-level evaluation we performed, RJH concludes:

- The Jeffrey Island Alternative is technically feasible and RJH did not identify clear fatal flaws with the concept.
- Significant technical issues would need to be resolved to develop the Project on Jeffrey Island. Three key significant technical issues include:
  - The need to safely manage seepage without sufficient low-permeable soils available on the island for borrow.
  - The need to convey large flows across an active river channel to and from Jeffrey Island by gravity.
  - The need to protect the island perimeter from erosion by the encompassing and active river channels.
- Central would need to locate and likely purchase approximately 400 to 600 acres within 7 miles of Jeffrey Island to obtain the needed low-permeable borrow materials for the liner. Given the geology, the most likely location for this material would be at the Existing Site.
- There is significant risk that regulators would not issue permits for a Project on Jeffrey Island. The technical issues related to internal and external erosion of a dam surrounded by a river may be extremely difficult or impossible to resolve with FERC Dam Safety. In addition, Jeffrey Island currently provides environmental mitigation land as part of a FERC licensing requirement. Using this land for other purposes may not be acceptable to FERC. Finding other suitable mitigation lands to meet the current FERC license requirements may be difficult.
- The Jeffrey Island Alternative would provide less functionality than the existing J-2 concept and likely would require more planning and effort to deliver flows in accordance with the water service agreement than if the Project were located at the Existing Site. This is because the reservoirs would be in series and not have parallel intake and outlets. If parallel intakes and outlets to the reservoirs were included in the Jeffrey Island Alterative, the cost would increase by about 5 to 10 percent.
- The cost is likely to exceed $195 million, which is over $120 million more than developing the Project at the Existing Site.

SECTION 8 - RECOMMENDATIONS

RJH recommends the following:

- Central should not continue to evaluate or develop the Jeffrey Island Alternative. It provides significantly less value than another alternative.
- Central should continue to develop the J-2 Project at the Existing Site in accordance with the current schedule.

SECTION 9 - REFERENCES

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