EXHIBIT B

PROJECT OPERATION AND RESOURCE UTILIZATION

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B. PROJECT OPERATION AND RESOURCE UTILIZATION

B.1 CURRENT AND PROPOSED PROJECT OPERATION

B.1.1 Powerplant Operation

The Loup River Hydroelectric Project (Project) is operated manually, but with the support of supervisory control and data acquisition (SCADA) and automated monitoring and alarm systems. While certain subsystems function automatically within prescribed limits, the Project is never left unattended on automatic operation.

At least one qualified operator is on duty in the Columbus Powerhouse at all times to monitor and supervise all Project operations. An additional qualified operator is on duty approximately 40 hours per week in the smaller Monroe Powerhouse. A trained operator is always on duty (or immediately available) at the manually operated Headworks. The two powerhouses are fully interconnected to allow the Columbus Powerhouse operator to remotely monitor and operate the Monroe Powerhouse when the Monroe Powerhouse operator is not on duty. The Columbus Powerhouse operator can also monitor, but not operate, the Headworks.

B.1.2 Estimated Annual Plant Factor

The Project includes turbine generating units at the Monroe and Columbus Powerhouses. The Monroe Powerhouse consists of three turbine generators of 2,750 kilovolt-amperes (kVA) for a total installed plant capacity of 8,250 kVA. The Columbus Powerhouse consists of three turbine generators of 16,000 kVA for a total installed plant capacity of 48,000 kVA. Average annual power generation since Project construction (1938 to 2010) is 136,405 megawatt hours (MWh). At a power factor of 0.95, the total Project plant factor is estimated to be 29.1 percent. For the period from 2007 to 2010 (following completion of the refurbishment of the turbine generating units), the Project plant factor is estimated to be 38.2 percent based on an average annual power generation of 178,874 MWh. Table B-1 lists the individual plant factor for each powerhouse as well as the total plant factor for each time period.

Table B-1. Project Plant Factor

	1938 to 2010	2007 to 2010
Monroe Powerhouse	27.3 percent	50.0 percent
Columbus Powerhouse	39.7 percent	35.9 percent
Total Project	29.1 percent	38.2 percent

These relatively modest plant factors are largely explained by the following:

- The Monroe Powerhouse units were sized to handle the Project design flow of 3,500 cubic feet per second (cfs). However, the Project design flow can be diverted only when conditions permit. The long-term (1938 to 2009[1]) average flow diverted to the Upper Power Canal is 1,630 cfs.
- Similarly, the Columbus Powerhouse units were sized to accommodate the maximum Project design flow of 4,800 cfs. However, because of limited diversion and ponding capacity, this flow rate cannot be maintained for many hours of the day. Furthermore, because there is no spillway or other outlet works at the Columbus Powerhouse, the turbine generating units were designed so that any two units can pass over 4,100 cfs if necessary.
- The District's ability to divert flow during the winter months is limited because an ice cap is developed on the canal while maintaining clearance at bridge crossings. This substantially limits the capacity of the canal during the winter.
- Since 1988, the District's ability to divert flow during the summer months has been reduced by the need to suspend dredging activities during June, July, and August to avoid impacting the endangered interior least tern (*Sterna antillarum athalassos*) and threatened piping plover (*Charadrius melodus*) while they nest at the North Sand Management Area (SMA).

B.1.3 Project Operations

Water from the Loup River is diverted into the 35-mile-long Loup Power Canal. While water is being diverted, the Headgate Operator monitors flow and debris in the Loup River, and sediment accumulation at the intake gates. The operator adjusts flow diversion rates on a daily or even hourly basis to optimize the amount of water diverted into the canal in consideration of the following factors:

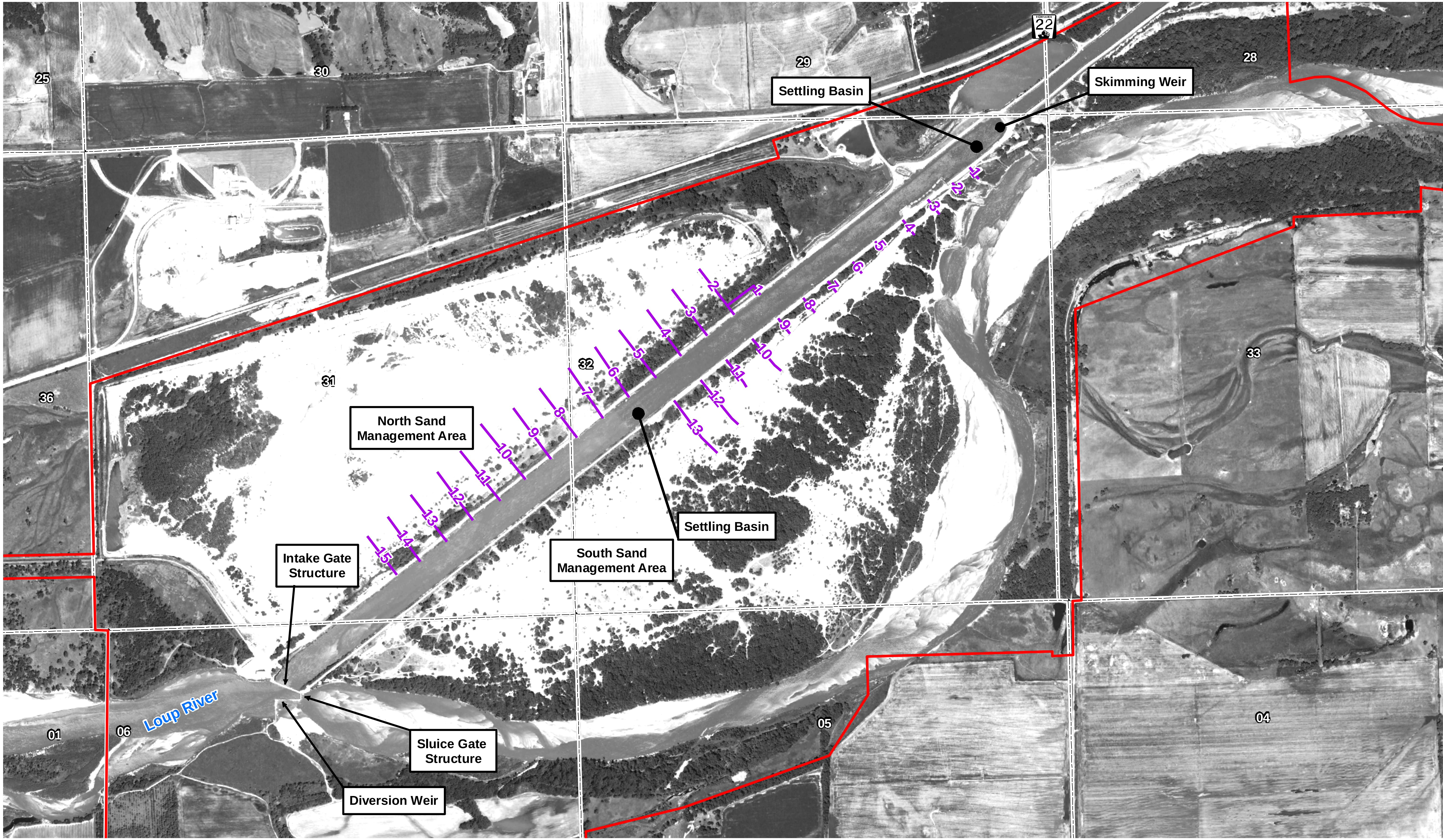
- River conditions, rising or falling flow
- Debris in the river and in the Settling Basin
- Presence of slush or frazil ice
- Sediment accumulation at the intake gates and the need to sluice sediment
- Condition of the flashboards at the Diversion Weir
- Anticipated weather conditions, including temperature, wind, and precipitation

[1] U.S. Geological Survey (USGS) data is not yet available for the 2010 water year.

Water diverted from the Loup River enters the Settling Basin. The Settling Basin is designed for very slow flow velocity to allow heavier sediment materials to settle out of the water before it enters the much narrower, faster flowing Upper Power Canal. Design flow velocity through the Settling Basin is less than 1 foot per second. The Settling Basin is approximately 2 miles long and has a bottom width of 200 feet and a nominal depth of 16 feet. Hydraulic capacity of the Settling Basin varies depending on the accumulation of sand, silt, and sediment within the basin. Maximum hydraulic capacity, when the Settling Basin is largely free of sediment, is 3,500 cfs.

A floating Hydraulic Dredge is employed to remove accumulated sediment from the Settling Basin. Without frequent dredging, the Settling Basin would quickly become choked with sand and cause the Project to shut down. Each year, the Hydraulic Dredge removes approximately 1 million to 1.5 million cubic yards of sediment from the Settling Basin. Sediment (in the form of silt, sand, and gravel) pumped by the dredge is carried through an articulated steel pipeline to a series of fixed steel discharge pipes spaced along both sides of the Settling Basin. These pipes lead to the North and South SMAs, located on either side of the Settling Basin, as shown in Figure B-1. The North SMA is approximately 320 acres in size and is located north of the Settling Basin. The South SMA is approximately 400 acres in size and is located south of the Settling Basin, adjacent to the Loup River. Although designed for the same purpose—to receive and decant dredged material—the two areas have evolved quite differently.

As part of the original Project development, a concrete flume was constructed adjacent to the south bank of the Settling Basin, as shown in Figure B-2. Its purpose was to convey the dredged material to a point downstream of the Skimming Weir, where it discharged material back into the Loup River bypass reach. However, the flume did not have sufficient capacity to convey the dredged material and, as a result, silted in within the first year of operation. Subsequently, all dredged material was pumped to the South SMA from 1937 to 1960. The quantity dredged during that period averaged approximately 2.6 million cubic yards annually. In the mid- to late 1950s, riparian property owners adjacent to the Loup River south of the South SMA expressed concern that immediately downstream of the Diversion Weir, the Loup River bypass reach was migrating south. To remediate this situation, in 1961, the District began pumping dredged material to the North SMA as well as the South SMA. From Project inception, most of the sediment dredged was pumped to the South SMA. However, once the North SMA developed, the majority of sediment has been dredged to the North SMA. Prior to 1973, approximately 75 percent of the sediment dredged was pumped to the South SMA. Since then, only about 28 percent of dredged sediment has been pumped to the South SMA.



N

1,000 500 0 1,000
Feet

Aerial Imagery: 2010 National Agricultural Inventory Project, Nance and Platte Counties Mosaic

Legend

- Project Boundary
- Section Line

Loup Power District Hydro Project

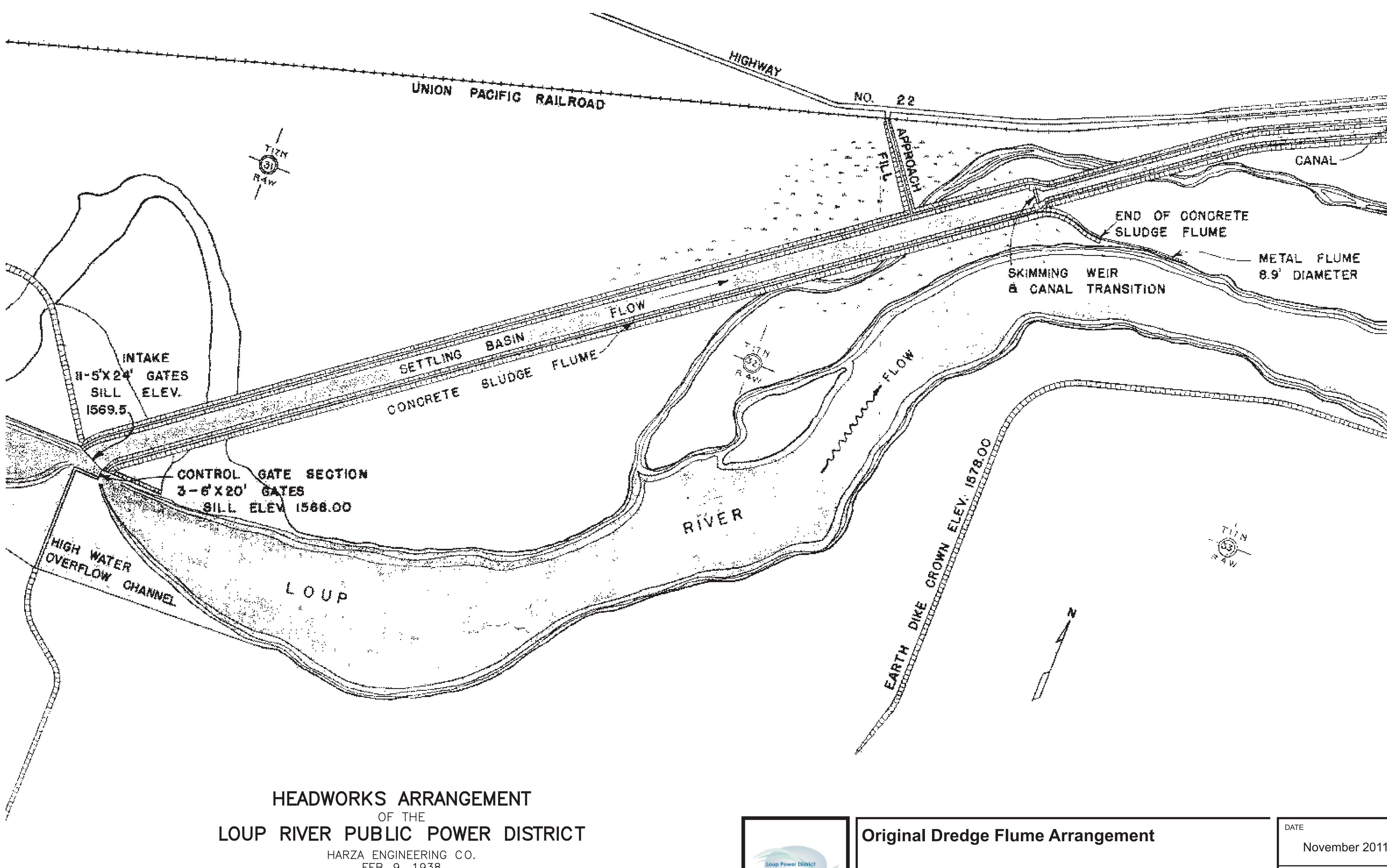
Settling Basin Dredge Discharge Locations

Loup River Hydroelectric Project
FERC Project No. 1256
Draft License Application

DATE
November 2011

FIGURE
B-1

Z:\Projects\Loup_Power_District\37104_LPD_FERC_Relicensing\map_docs\mxd\Figure_B1_LoupRiver_SettlingBasinLocations.mxd, 11/10/2011



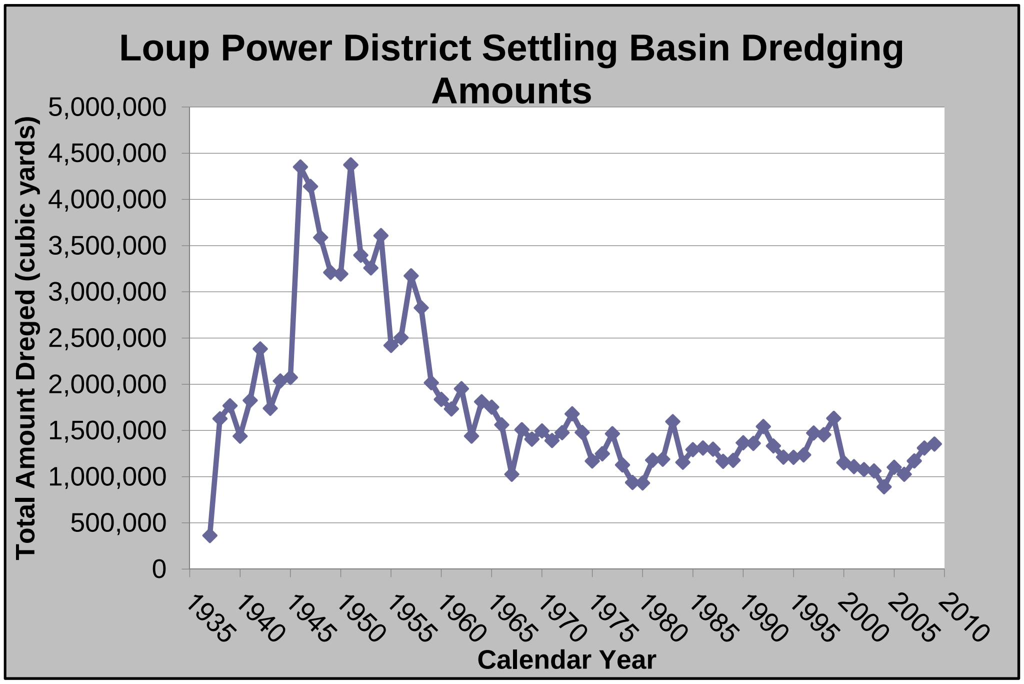
Original Dredge Flume Arrangement

Loup River Hydroelectric Project
FERC Project No. 1256
Draft License Application

DATE
November 2011

FIGURE
B-2

Graph B-1 shows the amount of material dredged since Project inception. The graph reveals a reduction in dredged material after approximately 1974. Prior to 1974, the amount of dredged material was approximately 2.34 million cubic yards per year (3.75 million tons per year). Since 1975, that amount has been reduced to approximately 1.24 million cubic yards per year (2 million tons per year). The reason for this disparity is not clear, but it may be related to development of upstream reservoirs or other changes in the upper Loup River Basin.



Graph B-1. Loup Power District Settling Basin Dredging History

As previously stated, the material is dredged from the Settling Basin and is distributed to the North and South SMAs through fixed 28-inch-diameter discharge pipes on either side of the Settling Basin. There are 13 discharge pipes for the South SMA, evenly spaced from the most northeast corner to the approximate center of the South SMA. The North SMA has 15 discharge pipes evenly spaced along its entire length. The discharge pipe locations are shown in Figure B-1.

Coarser sediment materials settle out in the upstream portion of the Settling Basin, while the finer sediment deposits settle out nearer the downstream end. Sediment accumulates in the greatest quantity at the upstream end of the Settling Basin, and the accumulation quantity decreases in the downstream direction.

The annual dredging operation is initiated in the spring after the winter ice cap melts in early March. Dredging begins at pipe #1 of the South SMA (see Figure B-1) because the downstream end of the Settling Basin has the lowest quantity of accumulated sediment and thus the greatest depth of water to float the dredge. Prior to 1988, the dredging operation would progress from downstream to upstream from

March through November. However, since 1988, the dredging operation is suspended from early June to mid-August to accommodate the interior least tern and piping plover nesting season.

Currently, dredged material is pumped to the South SMA from pipe #1 to pipe #13, and to the North SMA from pipe #1 up to approximately pipe #8 between March and June 1 (see Figure B-1). In mid-August, dredging begins again at the downstream end of the Settling Basin and progresses upstream toward the headgates. Typically, dredging is suspended in mid- to late November when ice begins to form on the Settling Basin. Prior to 1988, when the dredging schedule was modified to accommodate nesting, the entire Settling Basin was dredged at least once annually. However, since 1998, it is rare that the entire basin gets dredged annually. Maintenance on the dredge is typically conducted in the winter between late November and early March, and is conducted as necessary during the nesting season shutdown between June 1 and mid-August.

After dredged material is deposited at the South SMA, the sand and water are conveyed adjacent to the Settling Basin in a northeasterly direction; a majority of the sand and water eventually flows back into the Loup River, as evidenced by establishment of large trees and only small changes in the elevation of the South SMA. However, since the material dredged to the North SMA stays on site, the North SMA eventually covered approximately 320 acres and extended over 80 feet above natural grade.

In 2006, the District was approached by a materials processing company that wanted to purchase and remove sand from the North SMA. The District subsequently entered into an agreement with Preferred Sands[2] to remove sand from the North SMA and process it at Preferred Sands' facility located north of and outside of, the Project Boundary. As a condition of sand removal, the District required that Preferred Sands coordinate with USFWS and NGPC to ensure that sand removal operations would not adversely affect interior least terns and piping plovers. As a result, a Memorandum of Understanding (MOU) was developed by Preferred Sands, USFWS, and NGPC that includes an adaptive management plan to protect the threatened and endangered birds.

The District anticipates that Preferred Sands will continue to remove and process sand from the North SMA for a substantial period of time; however, the length of this operation, and whether it will continue for the entire period of a new license, cannot be estimated because Preferred Sands' operation is dependent on the demand for sand in the marketplace. However, if sand removal operations were to cease, the District would continue to use the North SMA for sand disposal and would evaluate potential expansion if necessary.

[2] The District's original agreement in 2006 was with Harwest. Through transfers and acquisitions, Preferred Rocks of Genoa and then Preferred Sands took over this operation. Each of these companies has accepted and abided by the conditions of the original agreement.

After sediment is removed at the Settling Basin, diverted flows are routed to the Monroe and Columbus Powerhouses to generate electricity. With this particular off-channel hydraulic arrangement, the terms "adverse water year," "mean water year," and "high water year" are not particularly meaningful in their conventional sense. For this reason, the terms "normal operations," "high flow operations," "low flow operations," and "cold weather operations," as described below, have been substituted to more accurately describe operation under the Project. Additionally, Project monitoring and communications are discussed below to more fully explain how the Project is operated.

Normal Operations

Normal Project operating conditions are associated with Loup River flows below 10,000 cfs. All river flow above 3,500 cfs continues down the Loup River bypass reach because 3,500 cfs is the District's water right limit as well as the hydraulic capacity of the canal. During normal operation, the Headworks are operated to divert the maximum practical amount of water (and the least amount of sediment) from the Loup River into the Settling Basin. The amount of flow that can be diverted at any given time is a function of Loup River stage and flow, sediment accumulation in front of the Intake Gate Structure, settings of the 11 fully adjustable gates comprising the Intake Gate Structure, Settling Basin stage, and the sediment situation in the Settling Basin on that particular day. These continuously variable factors make it difficult for operators to deliver a pre-selected rate of diverted flow. There is no automation at the Headworks; the Intake Gates and Sluice Gates are frequently manually adjusted to keep water flow and sediment movement within acceptable ranges.

The long-term average for diverted flow is 1,630 cfs, or 3,233 acre-feet per day. Over the available period of record, the Project has diverted approximately 69 percent of the total Loup River flow at the point of diversion.

The hydraulic capacity of the Loup Power Canal is 3,500 cfs, or 6,942 acre-feet per day. This flow is also the maximum diversion rate allowed under the District's water right. In practice, the District is only able to divert the maximum flow for short periods of individual days when conditions are just right.

The Monroe Powerhouse operates in a traditional run-of-river mode, passing all water coming to it in the Upper Power Canal with no regulation. Water level sensors at the station intake are used to initiate minor adjustments to the turbine wicket gates to maintain a constant canal elevation. Control of the Monroe Powerhouse turbine generating units is normally dispatched remotely by the Columbus Powerhouse operator. Generation of each unit is determined by water levels in the Upper Power Canal and the wicket gate settings on the unit. A radial bypass gate at the Monroe Powerhouse can be operated in manual or automatic mode and is fitted with a floatation device that automatically opens the gate in response to high water levels. This gate will automatically open to a pre-determined position to pass any flow that exceeds the capacity of the turbine generating units on-line. Operation with water level control maintains a steady headwater level at the Monroe Powerhouse.

Water exiting the Monroe Powerhouse enters the Lower Power Canal. Level control in this canal segment is provided by the Sawtooth Weir located at the entrance to Lake Babcock. Water level in the regulating reservoirs is controlled by adjusting incoming canal flow and/or turbine releases at the Columbus Powerhouse.

Project generation is dispatched from the Nebraska Public Power District (NPPD) Control Center in Doniphan, Nebraska. The NPPD dispatcher will request that the District bring generation on- or off-line as demand changes within the NPPD system. When the NPPD dispatcher issues an order, the Columbus Powerhouse Operator makes wicket gate adjustments, brings turbine generating units on-line, or takes turbine generating units off-line, depending on the order.

The turbines are capable of operating in the following four modes:

- Flow control – The flow through the unit remains constant.
- Headwater level control – The headwater elevation is maintained within a narrow band by adjusting turbine wicket gates.
- Power control – The flow is adjusted to maintain a steady generation rate.
- Tailwater control – Wicket gates are adjusted to maintain within a narrow band of a specified tailwater elevations.

The Columbus Powerhouse is generally operated as a daily hydrocycling plant by the NPPD dispatcher. This involves ponding some of the canal inflow in the regulating reservoirs and then drawing the level of the reservoirs down generally about 2 to 3 feet during certain times of the day by generating more power during peak demand. In the off-peak hours, when there is less electrical demand, the turbine generating units are turned down or shut off, and the regulating reservoirs are allowed to refill for hydrocycling the following day.

The controls at both the Monroe and Columbus powerhouses are interfaced electronically to provide optimum control of all water elevations during Project operation. This control, in turn, produces optimum generation from the available flow.

High Flow Operations

Abnormally high flows in the Loup Power Canal could be produced by two scenarios: 1) excessive precipitation runoff into the Loup Power Canal from local drainage areas, and 2) high flows in the Loup River at the Headworks. Although there are several small drainages that flow into the Loup Power Canal, the resulting inflow, even during precipitation events is relatively minor. However, high flows (10,000 cfs and greater) in the Loup River have historically occurred during the spring freshet (that is, the sudden high flow resulting from a thaw). High flows can and do occur whenever there is a major precipitation event in the Loup River Basin.

The District proactively maintains the Project to address high flows in the Loup River before the high flow event occurs. Dikes that connect the Diversion Weir and Intake Gate Structure with high ground on either bank are maintained in good repair. These dikes contain the river channel and prevent shoreline erosion.

When high flow events occur, the Loup River carries large amounts of trash, debris, and occasionally ice. These materials need to be passed down the river and not diverted into the Loup Power Canal. Most of the unwanted material will simply pass over the submerged Diversion Weir; the remainder can be passed downstream using the Sluice Gate Structure. The Headgate Operator resides on site and monitors both weather and river flow conditions. To protect the Project, the Headgate Operator will reduce or curtail flow diversion as necessary prior to or during a high flow event.

The Project was designed to handle normal storm runoff entering the Loup Power Canal from adjacent areas. However, during extreme precipitation events, some storm runoff will enter the Loup Power Canal. To manage such events, the Headgate Operator can reduce diversion at the Headworks prior to an event to provide additional freeboard in the canal segments. If an event occurs with little or no warning, the Headgate Operator can cease diversion. The Headgate Operator can also call for over-generation[3] at both the Monroe and Columbus powerhouses as well as for opening the radial bypass gate at the Monroe Powerhouse. There is no spillway or flow bypass device at the Columbus Powerhouse. In an emergency, any two turbine generating units can safely pass up to 4,100 cfs. This outflow rate is 17 percent greater than the maximum inflow rate to Lake Babcock. These actions will move the high inflows through the Loup Power Canal at a much higher rate.

Low Flow Operations

Low flow conditions on the Loup River can occur at any time of year but are most likely to occur during the summer months when river flow is often impacted by upstream irrigation withdrawals. During these periods, the Project continues to operate normally, albeit with reduced flow available for diversion and generation. An operating consideration regarding low flow in the canal is restricting flow in the canal for maintenance activities during hot weather conditions. The District has implemented a policy to defer non-emergency maintenance activities during high-temperature periods.

[3] Over-generation refers to the practice of admitting more than the rated flow through the turbine gates for short periods to release excessive flow.

Cold Weather Operations

Operations are modified as needed in cold weather (that is, when Project facilities become subject to freezing conditions). In winter, slush begins to form in the Loup River and the Settling Basin. A small amount of slush can normally be diverted into the Settling Basin without causing problems. Heavier concentrations of slush are bypassed down the Loup River to avoid a “plug” forming in the Settling Basin. If this should happen, there could be no further flow diversion until the ice plug melts or dissipates, and the ice plug could remain in place for the duration of the winter season.

As air temperature gets colder, an ice cap forms both on the Loup River and in the Loup Power Canal. Once a solid ice cap exists, a maximum winter diversion rate of about 2,000 cfs can be established. Typically, winter flows are less than the maximum that can be accommodated by the ice cap. Abrupt flow increases are avoided when there is an ice cap in the canal. Ice adheres to bridge pilings and could loosen or damage them if it rises. If a diversion increase is needed, all ice formed around the bridge pilings within the Canal is manually removed first to avoid damaging infrastructure.

Steam produced by an on-site boiler is used to de-ice the intake and sluice gates and keep the Headworks operable. Heavy ice also accumulates on the Diversion Weir flashboards, which cannot be reached with steam. Ice accumulation, rising water, moving ice, and debris may cause damage to the sacrificial flashboards, requiring at least partial replacement each spring.

Winter operation at the Monroe Powerhouse involves monitoring water temperature and watching for the formation of frazil ice. If frazil ice begins to form, diversion is quickly halted at the Headworks as frazil ice can plug the trash racks and lead to overtopping of the Upper Power Canal. The radial bypass gate at the Monroe Powerhouse and its hoist are enclosed in a heated enclosure to prevent freezing. Additionally, the operator is responsible for ensuring that the gate seals are not frozen to the sill or sides of the gate bay. The operator thaws the gate seals as necessary and monitors them frequently to keep them from refreezing.

Winter operation at the Columbus Powerhouse also involves monitoring water temperature and responding rapidly to the formation of frazil ice. At the Columbus Powerhouse, declining pressure readings in the Penstocks indicate that frazil ice is forming on the trash racks. The Columbus Powerhouse Operator may reduce flow through the plant or take the turbine generating units off-line to inhibit additional icing and potential plugging of the trash racks. The Columbus Powerhouse has no bypass gate; therefore, when the powerhouse is taken off-line and the regulating reservoirs reach a certain elevation, flow diversion at the Headworks would need to be halted to allow for handling of water already in the canal system.

Monitoring

Monitoring of the Headworks is done remotely, but the Headgate Operator lives on site, and the operator or a rotating assistant is on duty 24 hours per day, 7 days per week when conditions warrant. The Headgate Operator's primary function is operation of the Intake Gate Structure and Sluice Gate Structure. However, the Headgate Operator also performs routine maintenance, observation, and equipment checks.

The Monroe Powerhouse is designed to be remotely operated from the Columbus Powerhouse. However, the Monroe Powerhouse Operator, who lives on site, normally tends the powerhouse during a daylight shift (8 hours per day, 5 days per week), and is on call 24 hours per day, 7 days per week when conditions warrant.

The Columbus Powerhouse is staffed 24 hours per day, 7 days per week by an operator working a 12-hour shift, rotating at 6:00 a.m. and 6:00 p.m. Five additional District staff are on duty to perform normal maintenance and equipment checks at the Columbus Powerhouse from 8:00 a.m. to 5:00 p.m. during the normal 5-day workweek. The Columbus Powerhouse Operator is the primary lead in normal operation of the Project.

The entire Project is operated, monitored, and controlled by a SCADA system. This system includes remote sensors at the Headworks, Monroe Powerhouse, and Columbus Powerhouse. Operation of turbine generating units in both powerhouses can be fully controlled through the SCADA system at the Columbus Powerhouse. In addition, each turbine generating unit has a manual interface for local control.

The Columbus Powerhouse Operator can monitor the status of all turbine-generator operations, river flow, diversion rate, reservoir elevation, turbine generating unit performance, and other information associated with Project operations.

River flow and diverted flow are continuously monitored by sensors located at the Headworks. Critical inflow information is monitored by USGS Gage 06792500, Loup River Power Canal near Genoa, NE, at the Skimming Weir and backed up by independent sensors at the Headworks.

Water elevation is monitored at three key Project locations: the Headworks, Monroe Powerhouse, and Columbus Powerhouse. Each of these locations has redundant, independent monitors. Project alarms are triggered if any sensor detects water at pre-set elevations.

The SCADA system will automatically initiate a normal or emergency shutdown as required when a turbine generating unit goes off-line. Should this occur, the Columbus Powerhouse Operator immediately contacts the Headgate Operator to adjust diversion accordingly and the NPPD Dispatcher to alert him/her of the change in generation. When a shutdown occurs, turbine controls are locked out, and the turbine generating unit would need to be restarted manually from its powerhouse.

Communications

The Columbus Powerhouse Operator is the primary contact for the NPPD dispatcher and the Headgate Operator for planning long-term diversion and other operational issues that may affect flow diversion and bypass. The Columbus Powerhouse Operator on duty will confirm the operating parameters with the NPPD dispatcher and Headgate Operator at the beginning of each day.

During high flow conditions, the Columbus Powerhouse Operator and the Headgate Operator communicate frequently. The Headgate Operator is available at all times during high flows to adjust diversion. The Columbus Powerhouse Operator will contact both the NPPD Dispatcher and the Headgate Operator when both powerhouses reach their full discharge capacity.

During winter operations, there is a similar need for more frequent communication between the Columbus Powerhouse Operator and the Headgate Operator for safe operation of the system. As stated under "Cold Weather Operations," the Headworks Supervisor, Canal Foreman, Monroe Powerhouse Operator, and Columbus Powerhouse Operator remain in close contact as conditions change along the entire system.

All of the District personnel discussed above have four avenues of communication available: a cell phone, a land-line phone, e-mail, and a business band radio.

B.2 POWER GENERATION

B.2.1 Dependable Capacity and Average Annual Generation

The dependable capacity of the Project is 45 megawatts (MW) based on the NPPD Columbus hydro accreditation, which includes all Monroe and Columbus powerhouse generating units. The capacity value is verified once each summer by operating the Columbus Powerhouse generating units for a duration of 4 hours. During verification, the Monroe Powerhouse operates in a run-of-river mode, and the Columbus Powerhouse operates in hydrocycling mode. Dependable capacity values are not specified for the individual powerhouses because they are operated together as a single entity using the same water, with the two connected regulating reservoirs between them.

Average annual power generation since Project construction (1938 to 2010) is 136,405 MWh. Average total monthly power and average total annual power produced by the Project from 1938 through 2010 are provided in Table B-2. The Columbus Powerhouse is the primary power-generating element of the Project. With 3.5 times the head and 1.4 times the flow capacity of the Monroe Powerhouse, it generates approximately 80 percent of total Project power.

Table B-2. Average Total Project Power Production (1938-2010)

Period	Total Project Average Power (MWh)[a]
January	8,093
February	9,818
March	13,105
April	14,723
May	14,203
June	13,290
July	9,456
August	8,840
September	10,848
October	14,129
November	13,082
December	6,819
Annual	136,405

Note:
[a] MWh = megawatt hour

B.2.2 Project Flows

Project operation is heavily dependent on flow conditions in the Loup River. Since the Project began operating in 1938, numerous external factors have affected the amount of water that can be diverted into the Loup Power Canal; non-project storage dams and reservoirs and diversion dams have been constructed in the headwater streams, and hundreds of water appropriations and consumptive use permits have been issued by the State of Nebraska for domestic, agricultural, and industrial depletions of the natural river flow. Seasonal crop irrigation has had the most noticeable impact on flow depletion at the point of diversion for the Project.

The quantity of flow diverted for power generation is dependent on river flow and sediment conditions at the Project Headworks. Diverted flow is measured and recorded at USGS Gage 06792500, Loup River Power Canal near Genoa, NE, at the outlet of the Settling Basin. The flow rate ranges from a low of 0 cfs to a maximum of 3,500 cfs. The average diversion rate, as measured at the USGS gage, has been 1,630 cfs (based on USGS data from 1937 through 2009).

B.2.3 Minimum, Mean, and Maximum Flows

Average daily flows at the point of diversion were quantified by adding the flows at USGS Gage 06793000, Loup River near Genoa, NE, and USGS Gage 06792500, Loup River Power Canal near Genoa, NE (see Table B-3). These combined flows approximate the flow in the Loup River immediately upstream of the point of diversion. Flow duration statistics were calculated by adding average daily flows at these two gages and then adjusting for losses/reductions in flow, as discussed below.

Additionally, average flow information and flow duration statistics are presented for USGS Gage 06792500, Loup River Power Canal near Genoa, NE, in Table B-4. These flows represent the flow diverted into the Loup Power Canal and used by the Project to produce electricity.

Flow Adjustments

Flow adjustments related to non-gate inflows, dredging activities, evaporation, and seepage were analyzed as described below. Each of the analyzed adjustments was determined to be negligible.

No substantial inflows exist between the point of diversion and the USGS gage on the Loup Power Canal near Genoa (within the Settling Basin). Average annual flow removed from the Settling Basin for dredging activities was estimated by using the average annual hours during which dredging occurs (3,400 hours per year) and the dredging capacity (61 cfs). Using the percentage of time dredging occurs for the year (39 percent), the average daily flow removed from the Settling Basin for dredging activities was estimated at 24 cfs, which is negligible relative to the amount of flow diverted and within the measuring tolerance of the stream gage. A portion of flow diverted for dredging activities returns via seepage to the Loup Power Canal downstream of the Settling Basin and to the Loup River both upstream and downstream of the point of diversion.

Flow losses between the point of diversion and the USGS gage on the Loup Power Canal near Genoa as well as between the point of diversion and the USGS gage on the Loup River near Genoa include evaporation and seepage. These evaporation losses were estimated using average daily pan evaporation data. The nearest available weather station with evaporation data was used. This station is at Grand Island, Nebraska, approximately 40 miles southwest of the Project diversion. The period of record was 1963 to 1994. Net pan evaporation data were computed by subtracting the daily precipitation data from the daily pan evaporation. The daily precipitation was obtained from the National Weather Service gage at Columbus for a period of record of 1949 to 2001 (National Oceanic and Atmospheric Administration [NOAA] National Climatic Data Center [NCDC], August 2002). Evaporation and precipitation data for the month of July were used for estimating conservatively high net pan evaporation. The net pan evaporation estimates were converted to lake evaporation using *The Climate Atlas of the United States* (NOAA NCDC, 1983).

Average daily net evaporation rates were then estimated using the lake evaporation estimates and the total surface area of the Settling Basin (approximately 330 feet wide and 10,000 feet long) and the Loup River between the point of diversion and the respective gages (approximately 100 feet wide and 6.1 miles long). The losses associated with evaporation were calculated to be approximately 1.1 acre-feet per day (0.6 cfs), which is 0.04 percent of the average daily flow for July in the Settling Basin. The losses associated with evaporation for the Loup River between the point of diversion and the USGS gage on the Loup River near Genoa were calculated to be approximately 1.1 acre-feet per day (0.5 cfs), which is 0.16 percent of the average daily flow for July of the Loup River near Genoa; therefore, evaporation losses were considered negligible with respect to the quantity of flow and not used for reduction of average daily discharges.

Sediment is dredged from the Settling Basin from late March to early June and from mid-August to November each year. Given the amount of sediment accumulation and the high percentage of fines in the sediment, the Settling Basin likely reseals between periods of dredging, and seepage would be minimal relative to the quantity of flow diverted and likely within the gage accuracy tolerance. In addition, seepage losses from the Settling Basin likely return to the Loup River through groundwater flows. Therefore, seepage losses between the point of diversion and the USGS gage on the Loup Power Canal near Genoa were considered negligible and not used for reduction of average daily discharges.

Flow Statistics

Monthly flow duration curves for Loup River flows at the point of diversion for Water Year[4] 1950 through Water Year 2010 were developed by ranking average daily flows for each month over the period of record in descending order, calculating the percent exceedance[5] for each average daily discharge, and plotting the average daily discharges versus percent exceedance. These monthly flow duration curves are presented in Appendix B-1. Average daily minimum, mean, and maximum flows on the Loup River at the point of diversion were also calculated for the period of record for each month and are provided in Table B-3. Daily mean flow varies between 1,590 cfs in August and 3,530 cfs in March.

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[4] The USGS term "water year" is defined as the 12-month period from October 1 for any given year through September 30 of the following year. The water year is designated by the calendar year in which it ends and which includes 9 of the 12 months. Thus, the year ending September 30, 1999 is called the "1999" water year (USGS, August 13, 2008).

[5] The percent exceedance is the percentage of time that a given average daily value is equaled or exceeded.

Table B-3. Average Daily Minimum, Mean, and Maximum Flows by Month on the Loup River at the Point of Diversion, Water Year 1950 to Water Year 2010[a]

Month	Minimum Flow (cfs)	Mean Flow (cfs)	Maximum Flow (cfs)
January	304	2,180	7,270
February	367	2,930	26,520
March	293	3,530	33,080
April	1,290	2,930	18,650
May	854	2,710	18,570
June	283	3,010	69,320
July	133	1,810	29,940
August	64	1,590	72,560
September	398	1,880	11,530
October	957	2,220	11,420
November	164	2,390	7,210
December	66	2,090	5,120

Note:

[a] Calculated for period October 1, 1943, through September 30, 2010, using flow records from USGS Gage 06793000 on the Loup River near Genoa and USGS Gage 06792500 on the Loup Power Canal near Genoa. Flows at the point of diversion were calculated by adding the flows at these two gages.

Monthly flow duration curves for the Loup Power Canal near Genoa were developed for Water Year 1950 through Water Year 2010 using the same procedures described above. These monthly flow duration curves are presented in Appendix B-2. Average daily minimum, mean, and maximum flows on the Loup Power Canal near Genoa were also calculated for the period of record for each month and are provided in Table B-4. The daily mean flow varies between 980 cfs in December and 2,140 cfs in April.

Table B-4. Average Daily Minimum, Mean, and Maximum Flows by Month on the Loup Power Canal near Genoa, Water Year 1950 to Water Year 2010[a]

Month	Minimum Flow (cfs)	Mean Flow (cfs)	Maximum Flow (cfs)
January	4	1,160	2,790
February	9	1,520	2,990
March	12	1,840	3,160
April	93	2,140	3,410
May	12	1,990	3,430
June	94	1,950	3,290
July	56	1,390	3,340
August	0	1,280	3,140
September	0	1,580	3,320
October	4	1,950	3,220
November	3	1,870	3,560
December	1	980	3,050

Note:

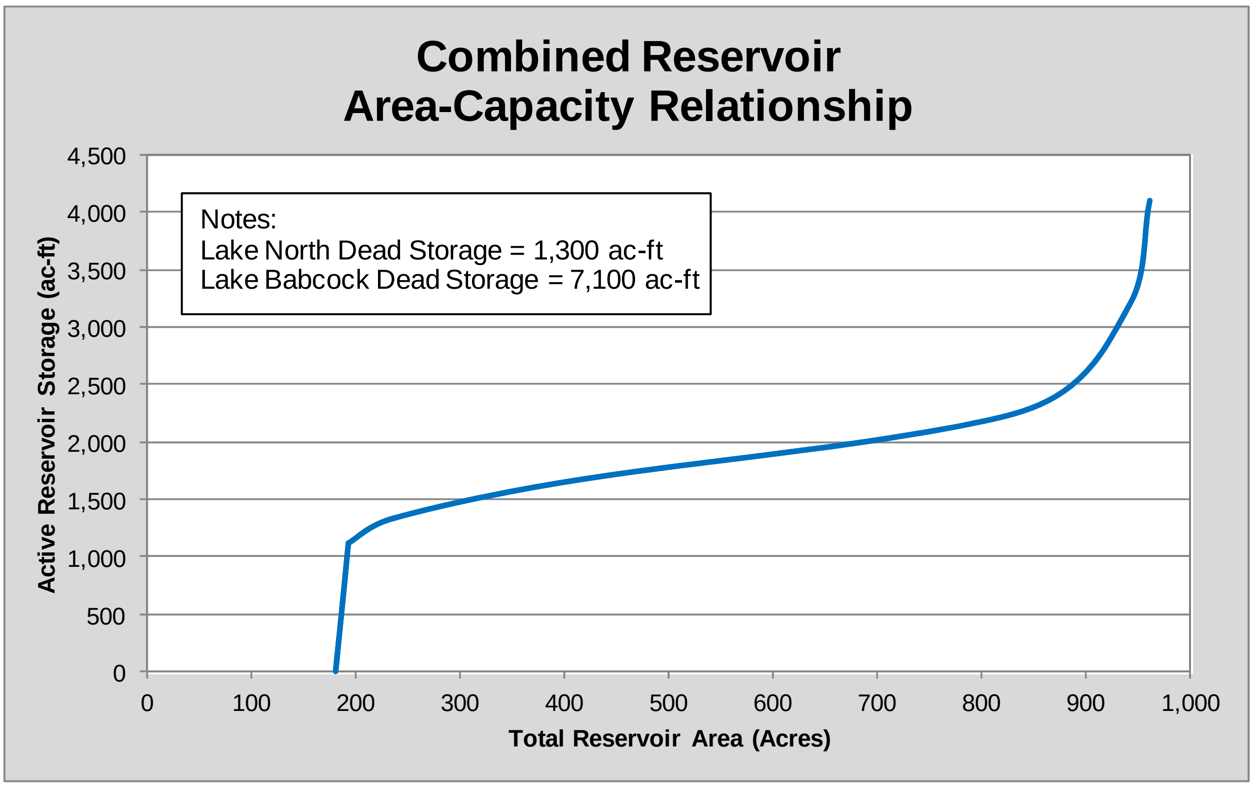
[a] Calculated for period October 1, 1949, through September 30, 2010, using flow records from USGS Gage 06792500 on the Loup Power Canal near Genoa.

B.2.4 Area Capacity Relationship

There is no effective storage capacity in the Upper Power Canal upstream of the Monroe Powerhouse. Power is generated in a run-of-river mode using those variable flows (up to 3,500 cfs) that can be diverted into the Loup Power Canal at the Headworks. From the Monroe Powerhouse, all flows are immediately discharged to the Lower Power Canal and flow on to the regulating reservoirs.

The Project includes two connected reservoirs, Lake Babcock and Lake North, located between the Lower Power Canal and the Intake Canal for the Columbus Powerhouse. Both constructed impoundments function as shallow regulating reservoirs, not as storage reservoirs. The volume of water flowing into them is essentially released for generation on a daily basis. The majority of the time, daily fluctuation of the reservoir surface is about 2 feet; however, during periods of low flow and high electrical demand, reservoir drawdown often increases to 3 feet and on occasion can be as great as 5 feet.

Lake Babcock was the original Project regulating reservoir. When sedimentation substantially reduced its ponding capacity, an adjacent off-channel impoundment, Lake North, was constructed in 1962. Together, these two interconnected lakes form the current regulating reservoir for the Project, which has a normal maximum surface area of 960 acres at an elevation of 1,531 feet MSL. The gross storage capacity of this two-reservoir impoundment is approximately 4,100 acre-feet. An area capacity curve for the two-reservoir impoundment is shown in Graph B-2. The abrupt change in the area capacity curve indicates where Lake Babcock's effective storage is exhausted (1,426 feet MSL). Lake North is less impacted by sediment accumulation and technically provides storage down to its outlet sill at elevation 1,420 feet MSL. However, as explained above, the impoundment is only rarely drawn down below elevation 1,427 MSL.



Graph B-2. Reservoir Area Capacity Curve

There is no specific "rule curve" for operating the regulating reservoirs. However they are normally operated to fluctuate between elevations 1,529 and 1,531 feet MSL. The usable ponding capacity between these elevations is estimated to be about 1,840 acre-feet. This volume is equivalent to about 14 hours at the 1,630 cfs average inflow rate from the Lower Power Canal, or approximately 5 hours at the 4,800 cfs design discharge rate from the Columbus Powerhouse.

B.2.5 Hydraulic Capacity of Power Plants

The Monroe Powerhouse is equipped with three vertical axis Francis turbines. Each unit is rated at a maximum hydraulic capacity of 1,000 cfs at a net head of 28.6 feet. Minimum hydraulic capacity is 300 cfs.

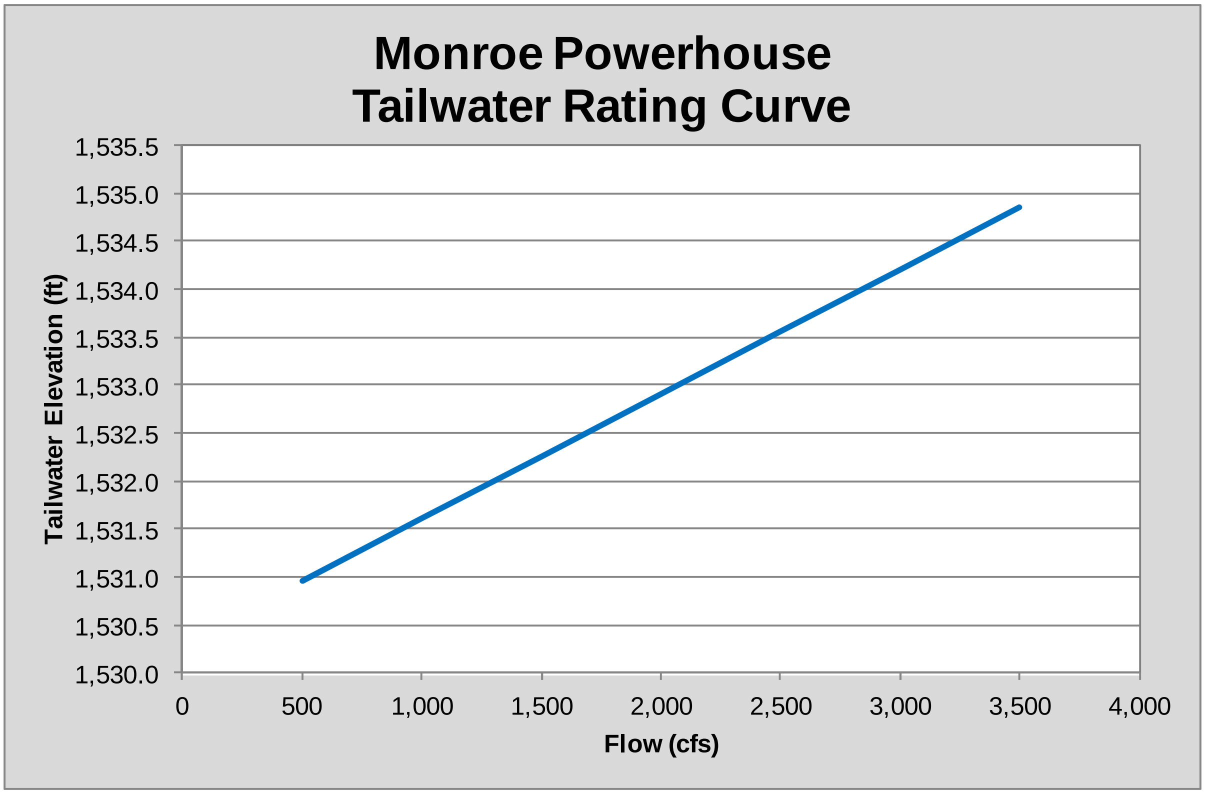
The Columbus Powerhouse is equipped with three vertical axis Francis turbines. Each unit is rated at a maximum hydraulic capacity of 2,060 cfs at a net head of 113.5 feet. Minimum hydraulic capacity is 1,000 cfs.

B.2.6 Tailwater Ratings and Power Capability Versus Head

Project canal segments are sized and designed to convey a relatively narrow range of regulated flows up to, and away from, the two powerhouses. Canal water surface elevation varies within the limited range of regulated Project flows. However, the relative range of head variation across the turbine generating units is not significant by industry standards and allows the units to operate with good efficiency throughout their flow range.

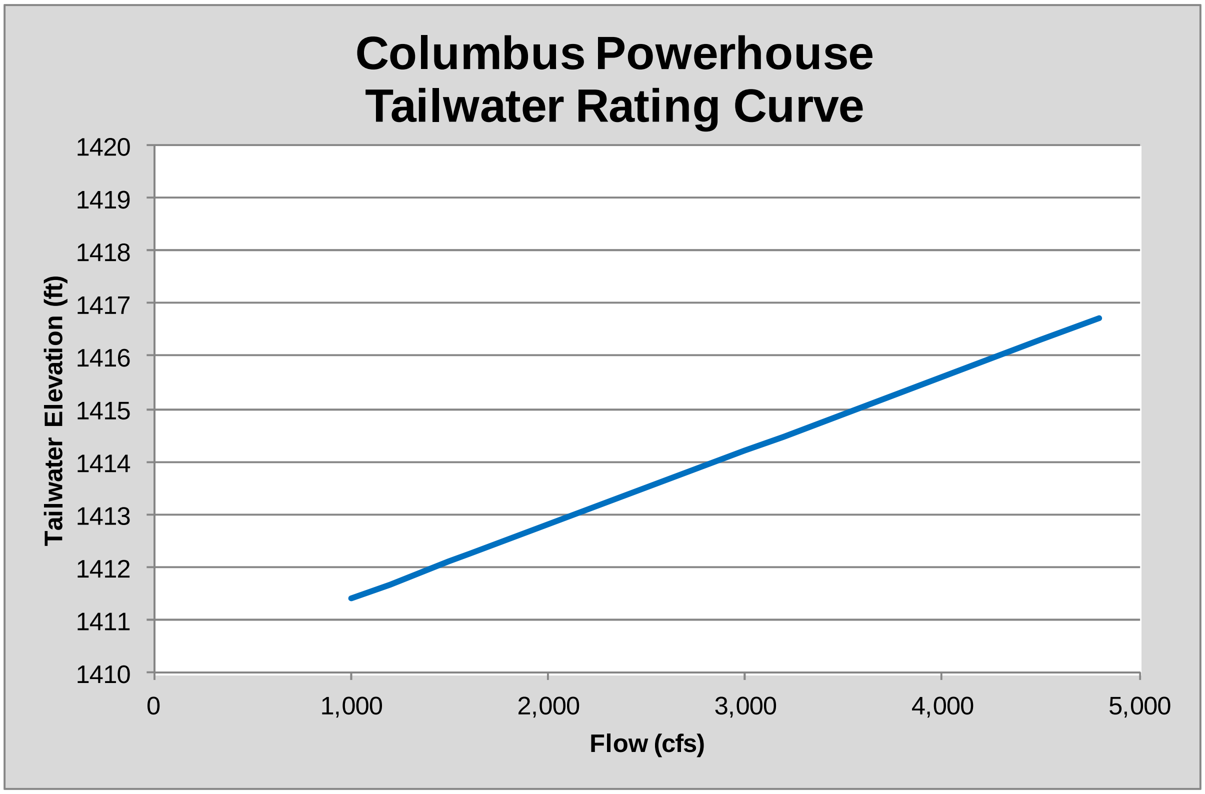
Tailwater rating curves for the Monroe and Columbus powerhouses are shown in Graphs B-3 and B-4, respectively.

The Monroe Powerhouse has no storage reservoir and operates in a strict run-of-river mode. The turbine gates (and bypass gate) are programmed to automatically adjust flow rate to maintain a constant upstream water level at the intake. Therefore, the tailwater rating curve shows the total head variation over the full range of Project flows.



Graph B-3. Monroe Powerhouse Tailwater Rating Curve

Flow entering the Columbus Powerhouse is regulated by ponding in the reservoirs during daily off-peak demand periods to allow for greater flow and power production during on-peak demand periods (hydrocycling). This means that the Columbus tailwater rating curve does not represent the total head variation across the powerhouse. There is typically an additional headwater variation of 2 to 3 feet due to reservoir ponding that must be accounted for in Project operations.



Graph B-4. Columbus Powerhouse Tailwater Rating Curve

No curves showing plant power capability versus head are included here because of the unique characteristics of the Project and its installed generating equipment. Both the Monroe and Columbus powerhouses are capable of generating their rated output throughout the relatively narrow head ranges in which they operate. Project turbines normally operate at peak efficiency, which is about 70 percent gate. Both stations have the ability to adjust wicket gates to pass more water and produce additional power.

B.3 USE OF POWER GENERATED

All power produced at the Monroe and Columbus Powerhouses is sold to NPPD at dedicated metering points in the respective on-site substations, with the exception of the power used for station service. From these points, the power becomes part of the integrated NPPD generation portfolio serving its system-wide customer loads, including Loup Power District. The District's current power purchase agreement with NPPD went into effect January 1, 2007, and continues through December 2021.

Power used for station service at the Project has averaged approximately 6,000 MWh per year for the period from 2007 through 2010.

B.4 PROPOSED FACILITIES AND OPERATIONAL CHANGES

The Project is considered to be fully developed and capable of efficiently generating electrical power using all of the water available under its established Nebraska water right. No major power generation facilities have been added since the Project was last relicensed in 1984[6]. Furthermore, the District has no plans for future generation capacity development or other material expansion of the Project, and the District has no plans to make any substantive changes in its operation of the Project.

B.5 REFERENCES

NOAA NCDC. 1983. *The Climate Atlas of the United States.* Asheville, NC: National Climatic Data Center.

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USGS. August 13, 2008. “Explanations for the National Water Conditions.” *Water Resources of the United States*. Retrieved on October 17, 2011. http://water.usgs.gov/nwc/explain_data.html.

[6] The turbine rehabilitation completed in 2007 increased total Project capacity by approximately 7 percent.