2009 Platte River Flow Routing Test: Results, Information Gleaned, Lessons Learned

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Developed Cooperatively by:
Platte River Recovery Implementation Program Executive Director's Office and the
U.S. Fish and Wildlife Service

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Executive Summary: Take-Home Points from this Report

In April 2009, the U.S. Fish and Wildlife Service (Service), in coordination with the Platte River Recovery Implementation Program (Program) and several key Program partners, implemented an initial 'flow routing test' in the Platte River as a first step toward preparing for short duration high flow releases in future years. A fundamental objective of this action was to test implementation and coordination. The test involved the release of water from the 'Environmental Account' (EA) in Lake McConaughy in coordination with other reservoir releases and re-regulation of water by Nebraska Public Power District (NPPD) and Central Nebraska Public Power and Irrigation District (CNPPID) to achieve elevated streamflows in the central Platte River at and downstream of Overton, Nebraska for several days. The key take-home points in this report include the following:

- **Planning and real-time coordination** of this event went very smoothly. While the Program should not count on such problem-free implementation of short duration high flow events in future years, our 2009 experience bodes well for future efforts.

- **The North Platte River at North Platte choke point** remains a serious constraint on the ability of the Program to use the Environmental Account to help achieve short duration high flows of the desired magnitude. The National Weather Service flood-stage capacity of this river reach appears to be in the neighborhood of 1,700 to 1,800 cubic feet per second (cfs), based on the published flood stage of 6.0 feet at the North Platte gage. The Program has further work to do to achieve the 3,000 cfs capacity it has committed to at this location.

- It appears safe to assume that the Program can implement **aggressive ramp-up rates of EA releases** from Lake McConaughy into the North Platte River in future years – on the order of 650 to 800 cfs/day or more – at least to the extent this is implemented prior to the irrigation season and in coordination with North Platte canal operators. (Safe ramp-up rates during times when these canals would be diverting flow are less certain.) The ability to ramp up at rates considerably faster than previously assumed is a very positive development for the Program; it implies substantially less expenditure of EA water to achieve maximum flow in the North Platte River.

- ***Phragmites* infestation** of the Platte River remains a serious problem. These invasive weeds contribute to choke-point problems around North Platte, Nebraska. Infestations may aggravate localized flooding problems in the mainstem Platte channel between North Platte and Lexington and they appear to result in slower travel times, higher transit losses, and greater peak-flow attenuation as augmented flow moves down the Platte River system.

- **Platte River safe-conveyance capacity between North Platte and Lexington** appears to be well in excess of 2,000 cfs, based on observations made during the 2009 test. Possible exceptions where flows of this magnitude highlighted potential concerns were overtopping at Cozad Canal's sand dam in the river channel upstream of the Gothenburg bridge near Brady and berm erosion at Overton Sand and Gravel Co.'s extraction pit downstream of the Overton bridge. Adequate freeboard was maintained at the sand dam. At the sand and gravel pit, the berm separating the pit from the Platte River channel suffered additional erosion during this event but did not breach. To address/avoid such potential concerns in the future close coordination with the owners of these facilities will be required.

- **Under present conditions**, and without substantial improvements in (a) the North Platte River at North Platte choke point capacity, (b) South Platte River inflows, (c) the conveyance efficiency of the Platte River through phragmites removal and/or (d) the implementation of projects that deliver additional Program water to the top of the habitat reach for several days when needed, **it appears unlikely that the Program can expect to create/augment peak flows in the central Platte in excess of 4,000 cfs**. At least one of the above constraints would need to be improved upon before higher flows could be reasonably expected. This also assumes the continued availability of NPPD's system to route EA water through their system and down the South Platte to maximize flows in the Platte River at the North and South Platte confluence.

- Implementation of the 2009 test highlights **several areas in which the Governance Committee may be able to develop improved tools, strategies, or options** for more effective future flow-release implementation. These may include:
    - Approving EA-bypass accounting methods that will allow bypassed EA water to be quantified on a multi-day *event* basis rather than *daily* basis;

    - Investigating the feasibility and potential advantages of establishing procedures to provide EA water in Lake McConaughy to NPPD in exchange for a South Platte River bypass at Korty Diversion during these events;

    - Supporting the calibration and improvement of flow routing and bank-storage modeling tools with these latest data to support improved prediction of the timing and attenuation of future short duration high flows in the central Platte River.

- Closer communications should be established with the **National Weather Service** (NWS) weather-forecasting staff for future Program-augmented short duration high flow events. This will ensure full Program awareness of the latest weather forecasts potentially affecting the Platte system.

2009 Platte River Flow Routing Test:
Results, Information Gleaned, Lessons Learned

The three-state Platte River Recovery Implementation Program (Program) has committed to releasing Program water to create or augment "short duration high flows" (SDHF) in the Platte River of central Nebraska on a periodic basis during the first 13-year increment of the Program.

In April 2009, the U.S. Fish and Wildlife Service (Service), in coordination with the Program and several key Program partners, implemented an initial 'flow routing test' in the Platte River as a first step toward preparing for these SDHF releases in future years. The test involved the release of water from the 'Environmental Account' (EA) in Lake McConaughy. EA water is dedicated to instream-flow uses, including uses to benefit the four threatened and endangered species that are a focus of the Program.

As part of this 'first step', some specific objectives were identified for the 2009 test:

- Test the coordination with the Central Nebraska Public Power and Irrigation District (CNPPID), the Nebraska Public Power District (NPPD), the Nebraska Department of Natural Resources (NDNR), canal operators, and the U.S. Geological Survey (USGS), among others
- Verify safe/acceptable EA-release ramp rates out of Lake McConaughy
- Assess the safe-conveyance capacity of the North Platte River at North Platte, Nebraska "choke point" and the potential for larger-magnitude releases in the future
- Test the re-regulation and bypass strategy:
  - Implement an 'intentional' bypass of EA water past CNPPID's Tri-County Canal (Supply Canal) Diversion Dam near North Platte for several days
  - Evaluate new Lexington gage information for timing of J-2 releases
  - Assess flow travel-times, losses, and peak attenuation
  - Evaluate provision of 6,000 acre-ft (af) of re-regulation space in Johnson Reservoir
- Assess flow travel times, losses, and peak attenuation:
  - CNPPID 's Supply Canal Diversion Dam at North Platte to Overton
  - Overton to Kearney to Grand Island
- Provide opportunities for those monitoring river habitat, morphology, sediment and/or vegetation to test monitoring methods and/or collect relevant data
- Provide opportunities to evaluate potential third-party "associated costs" (including downstream overbank-flooding concerns)

The Service and the Program recognized that the proposed flow routing test could not provide enough information to conclusively address all aspects of the above objectives, but it was anticipated this test would contribute a substantial amount of valuable information for future EA SDHF-release planning.

This report discusses details of what was implemented and observed relative to the above objectives.

1. Implementation and Coordination

A. Event Planning

Considerable pre-event planning took place beginning in late 2008 (building on preliminary planning episodes from the past several years). Details regarding the anticipated timing and quantities of water to be routed down the river and canal systems were summarized in a spreadsheet (Attachment A) that served as a planning tool for this event. It does not reflect actual event outcomes. That spreadsheet projected that:

- Releases of EA water from Lake McConaughy for this test would be made beginning on April 9 and continue through April 16, 2009.

- Roughly **22,000 acre-feet** (af) of EA water would be released over the course of those eight days. Most of this water (approximately 16,500 af) would be routed down the North Platte River channel, with the remainder (approximately 5,500 af) routed through NPPD's canal system and returned to the South Platte River channel above CNPPID's Supply Canal Diversion Dam.

- A joint agreement reached between the Service, NPPD, CNPPID and the Nebraska Game and Parks Commission during FERC license Article 405 2009-2010 waiver discussions required that 20,000 af of water be delivered out of the North Platte Hydro during the non-irrigation season. NPPD would begin diversions at the Keystone Diversion prior to the testing time period to assist with ramping rate limitations on the Sutherland Canal and prepare the Sutherland system for the return of much of the 20,000 af requirement and EA water from the North Platte Hydro to support building a peak flow over several days on the Platte River.

- CNPPID would work with the Service's EA Manager (EA Manager) to temporarily store and release up to 6,000 af of water in Johnson Reservoir and to intentionally bypass roughly 8,700 af of EA water, to generate several days of augmented streamflow in the Platte River near Overton of higher magnitude than could otherwise be achieved. For this test, a peak flow of around **3,200 cubic feet per second** (cfs) at Overton was projected on or about April 19.

B. Event Implementation

Implementation of this test required considerable planning and close coordination between the EA Manager, staff from CNPPID and NPPD, Nebraska DNR staff involved in water measurement, tracking and accounting, and the Program's Executive Director's Office (ED Office). Event planning was accomplished through a series of conference calls and meetings focused on reviewing and fine-tuning iterative drafts of the planning spreadsheet. Real-time coordination included:

- **CNPPID**: Make releases of EA water from Lake McConaughy in response to requests from the EA Manager; maintain communications with NDNR to determine and forecast EA and other water availability at CNPPID's Supply

Canal headgates on a daily basis; and temporarily store and release EA (or EA-reimbursed) water from Johnson Reservoir to maximize flows at and below Overton for approximately two-and-a-half days, consistent with the EA Bypass Agreement established between CNPPID and the Program.

- **NPPD**: Time requests for releases of non-EA water from Lake McConaughy to help maximize Platte River flows during days of interest; ramp-up diversions of EA water into the Keystone Canal during the test event consistent with pre-event plans; temporarily store and release EA water from the Sutherland/Maloney reservoir system to maximize flows at CNPPID's Supply Canal headgate during four key days of interest (*i.e.*, timed to coincide with the highest four days of flow in the North Platte River at North Platte).

- **NDNR**: Provide daily updates regarding the real-time measurement and accounting of streamflow at various points in the Platte River system (including the apportionment of flow between EA water, storage water, and 'natural flow' and estimation of reach-by-reach river gains and losses).

- **Program Executive Director**: Ensure that the activities planned and implemented were consistent with existing agreements and Program objectives; coordinate public outreach and communications.

- **EA Manager**: Make formal requests for EA or EA-reimbursed water releases from Lake McConaughy and Johnson Reservoir, and for EA water to be intentionally bypassed past CNPPID's Supply Canal Diversion Dam for approximately four days, in conformance with the EA Bypass Agreement, and in coordination with each of the above parties; oversee general event coordination activities, including chairing daily coordination conference calls; communicate with North Platte River and Platte River canal operators; jointly with ED document real-time issues/concerns regarding flows at choke points or other areas of concern.

During the flow routing test, the above responsibilities were coordinated through a daily conference call at 10 a.m. Central Time involving each of the above cooperators. This proved to be an effective means of sharing the latest river stage, streamflow, and weather information; for making daily diversion, storage, bypass, and release decisions; and identifying potential real-time problems or concerns. The planning spreadsheet was updated with actual values during the daily conference call.

C. Event Outcomes

Details regarding the actual timing and quantities of water that were routed down the river and canal systems are summarized in Attachments B and C. Attachment A, which was used for event planning, and Attachment B, actual event outcomes, turned out to be very similar, emphasizing the importance of strong coordination to a successful outcome.

Table 1 summarizes several key outcomes of the flow routing test relative to what was projected/predicted prior to the event. (Additional details specific to hydrology and flow behavior are presented later in this report).

Table 1: Key Outcomes

Aspect	Pre-event Projections	Event Outcome
Total Environmental Account release from Lake McConaughy	21,818 af	22,953 af
EA water diverted by NPPD	5,355 af	5,355 af
Intentional* EA bypass @ CNPPID Supply Canal headgates over 5 days	8,727 af	5,510 af (total bypassed was 12,615 af)
Re-regulated volume used in Johnson Reservoir to generate high flows	6,000 af	4,465 af
Peak flow at Overton stream gage	3,211 cfs	3,600 cfs
Timing of peak flow at Overton gage	April 19	April 19

*Intentionally bypassed water is only that EA water that could have been physically diverted by CNPPID, but was not at Service request.

D. Communications and Public Outreach

- **North Platte River irrigators:** The EA Manager, Program Executive Director, and NDNR staff met with representatives of four North Platte River irrigation districts on March 17, 2009: Keith Lincoln, North Platte Canal, Paxton-Hershey, and Suburban. A representative of a fifth canal, Cody-Dillon, was contacted by telephone on April 1, 2009. These districts all divert water from the North Platte River between Lake McConaughy and North Platte and have facilities, including river gates, which could be affected by event releases. A joint meeting was held in Paxton, NE, followed by site visits. At the joint meeting, planned specifics of the event were explained, and the Program's flow routing test announcement document (Attachment D) was provided. Site-specific considerations were discussed on-site with individual district representatives.

  Representatives were most interested in the planned day-to-day ramp rates of releases, the maximum flow rate expected at their location on the river, and the specific start and end dates of the event. Representatives did not express any concerns regarding the planned maximum ramp rate of 600 cfs per day, as long as they were contacted a few days in advance of when the actual date releases would begin (e.g. so that they could make sure river gates were opened, if not already open, and to plan when to meet on-site with the EA Manager). Consistent with discussions with these same districts in early 2008 when a similar meeting was held in anticipation of a March 2008 event, the representatives appreciated the opportunity to meet with Program representatives and did not express any significant concerns (e.g. with debris or sediment accumulation or flow magnitudes that might cause damage). Communication contact information was exchanged and arrangements were made to meet during the event's implementation.

During the event, the EA Manager met at least once with all representatives except for Cody Dillon. Meetings were timed so that the EA Manager could be on-site with the representative the first day EA releases reached the district's facilities and the day peak discharge was expected (although all representatives did not choose to make each meeting). Additionally, daily phone contacts were made until after peak discharge had occurred to ask if the representative had observed any problems or had concerns. The EA Manager informed all involved that he was documenting conditions around their facilities with digital photographs that would be provided at their request. No complaints or concerns were lodged by any of the representatives.

- **Platte River irrigators:** The Service EA Manager and Program Executive Director met with representatives of four Platte River irrigation districts on March 31, 2009 in Gothenburg: Thirty Mile Canal, Six Mile Ditch Company, Cozad Ditch Company, and South Side Irrigation District. Outreach regarding two other districts, Gothenburg Canal and Dawson County Canal, both operated by NPPD, was accomplished via NPPD staff members of the event planning team. At the Gothenburg meeting it was decided that on-site meetings would not be necessary. As with the North Platte irrigators, the flow routing test announcement document was provided and contact information exchanged. The EA Manager and Executive Director invited representatives to call with any concerns that developed during the event, but no on-site meetings or additional coordination calls were planned. Importantly, representatives did not believe there would be problems given the magnitude of expected discharge (well below NWS flood stage at all points between North Platte and Cozad). The only subsequent contact by any of these representatives concerned a "sand dam" between the Thirty Mile Canal and Gothenburg Canal (see description under Section 2.C. below).

- **National Weather Service**: The ED Office initiated communications with Kenny Roberg, Senior Meteorologist with NWS in North Platte in advance of the test flow release. The purpose of the contact was two-fold:
  1. To request that the ED Office be notified as far in advance as possible if forecasted weather conditions indicated the chance for significant rain in the Platte Basin between Lake McConaughy and Grand Island or if any other weather conditions might impact the test flow release.
  2. To make NWS aware of the release so that their hydrologists could monitor flow conditions in the river for flood alert or flood stage determination purposes.

- **Monitoring/Research Organizations:** The ED Office notified all contractors doing monitoring or research on the Platte for the Program (Short Elliott Hendrickson Inc. (SEH); HDR Engineering, Inc; Ayres Associates; and EA Engineering, Science, and Technology, Inc.) to ensure they were aware of the flow routing test. In addition the Nebraska section of the U.S. Geological Survey and the Nebraska Department of Environmental Quality were notified. Informing

monitoring agencies is important as the event could impact ongoing monitoring results and also serve as a monitoring opportunity.

- **Media outreach:** The ED Office issued a press release regarding the flow routing test on April 2, 2009 (Attachment D). The following newspapers received the press release: Omaha World Herald, Lincoln Journal-Star, Grand Island Independent, Kearney Hub, North Platte Telegraph, Keith County News, and Denver Post. The press release was also sent to two radio stations (KRVN and NET) and four television stations (KHAS Channel 5 in Hastings, NTV Channel 13 in Kearney, KGIN/KOLN Channel 11/10 in Grand Island and Lincoln, and KNOP Channel 2 in North Platte).

  The majority of the contacted newspapers printed articles about the flow routing test in the subsequent week. As a result of the press release three television stations conducted interviews with staff involved in the flow routing test. KHAS interviewed the Program's Executive Director, Jerry Kenny, and broadcast that interview on April 9, 2009. KNOP interviewed both Jerry Kenny and the EA Manager, Greg Wingfield, and broadcast those interviews on April 17, 2009. NTV interviewed Chad Smith and Cory Steinke and broadcast that interview on April 22, 2009. Jerry Kenny was interviewed by National Public Radio on April 15th and that interview was broadcast on the 16th and 17th.

- **General public**: The press release was also emailed to the Program Governance Committee and all sub-committees, including members, alternates and other interested parties. The Colorado Water Conservation Board also sent the press release to their membership and e-mail list.

- **Congressional Briefing**: The ED Office issued a Congressional Briefing regarding the flow routing test on April 2, 2009. The Briefing was e-mailed to the Congressional delegations in both Nebraska and Colorado (Attachment E).

E. NPPD Operations during event

As outlined in the Attachment A spreadsheet, NPPD anticipated and implemented an aggressive ramping-up of water diversions from Lake McConaughy through their canal system and through Sutherland and Maloney reservoirs. This included both EA and non-EA water. Returns were made to the South Platte River at North Platte via NPPD's North Platte Hydropower Station. These returns peaked at around 1,400 cfs over the four days coinciding with anticipated peak flows in the North Platte River at North Platte.

In addition to approximately 5,355 af of EA water that NPPD diverted and returned, minus losses as calculated by DNR, NPPD and CNPPID also adjusted their operations to release, divert, and return a large portion of approximately 20,000 af of non-EA water over a compressed timeframe.[1] This, combined with some temporary storage-and-release

[1] NPPD and CNPPID agreed, for this year only, to deliver this amount of non-EA water through NPPD's system, and (to the greatest extent feasible) manage that water to augment peak flows during the 2009 flow routing test. This commitment was made, in part, as a component of an agreement struck with the Service

of EA water in Sutherland Reservoir, supported maximum returns to the river over the course of four key days. Diversions into NPPD's system began on March 25th in anticipation of completion of repair work on a stilling-basin below Sutherland Reservoir. The stilling basin repair was completed and allowed flow-through operations beginning on March 30th.

As implemented, NPPD routed a total of 11,063 af of water back to the South Platte River channel over the crucial days of April 14 through 17 (equivalent to an average of about 1,394 cfs each day). 3,967 af of EA water was routing through NPPD's system during this period, and a total of 4,364 af of EA water was routing through from April 14 through 19. Together with other flows delivered down the North Platte and South Platte Rivers, this resulted in an average total flow of 3,057 cfs at the CNPPID Supply Canal headgate over those four days, of which an average of about 1,820 cfs was 'colored' (accounted for) as EA water.

F. CNPPID Intentional bypass-and-reregulation

CNPPID has the capacity to divert approximately 2,250 cfs of flow at its Supply Canal headgate. As anticipated, flows in the Platte River were greater than 2,250 cfs for about five days during the test, beginning late evening on April 14 and ending late evening on April 19, resulting in a flow of water down the mainstem Platte River (Attachment F, Photos 1 and 2). *In addition*, the EA Manager requested an 'intentional bypass' of approximately 800 cfs of water beginning around April 14 at 9:30 a.m. and continuing through midnight April 17 (intentional bypass continued until 5 am April 18 until CNPPID's Supply Canal gates could be adjusted to full-diversion positions), consistent with the EA Bypass Agreement between the Program and CNPPID.[2]

At the same time, also consistent with that Agreement, CNPPID managed Johnson Reservoir with an objective of vacating up to 6,000 af of reservoir volume over two or three days to coincide with the peak in bypassed flows arriving in the mainstem Platte River. Around 5 p.m. on April 17 CNPPID initiated an extended release from Johnson Reservoir to coincide with the rise in mainstem Platte River flow at and below the Lexington river gage. That J-2 release was maintained at around 2,000 cfs until 17:00 on April 20 when the releases were reduced to around 1,700 cfs.

CNPPID's actual operations corresponded closely to what was planned. They reported no indications of cavitation problems associated with releasing flows through J-2 at this higher-than-normal rate of around 2,000 cfs (the "normal" or peak efficiency release rate from J-2 is around 1675 cfs). Net change in Johnson Reservoir volume over the course

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and NGPC in exchange for support for a 2009 request to FERC for a waiver of other 2009 flow-release requirements under the existing FERC license. This 20,000 af of water diverted through the Keystone Canal and returned to the river essentially compressed minimum non-irrigation season diversion amounts largely into the month of April (a result of the combined factors of a conservation mode of operations, repairs to NPPD's facilities, and the agreed upon objective of support to the flow routing test).

[2] By definition, an 'intentional' bypass applies only to that portion of bypassed flow that CNPPID could have diverted within its 2,250 cfs capacity. Under the Agreement, the Program can call for the intentional bypass of EA water only. The actual amounts bypassed varied daily and sometimes hourly as adjustments were made to reflect real-time conditions, and as flows equilibrated to gate adjustments.

of the test release was about 4,465 af. Higher-than-anticipated inflows to CNPPID's canal system during this test (including EA water) precluded the need to utilize more than this amount of re-regulatory space for this event.

G. Tracking and Accounting for EA and non-EA water in real time

The Nebraska Department of Natural Resources (NDNR) runs the Platte Water Accounting Program (PWAP) on a daily basis to determine the amount of natural, storage, and EA flows in the North Platte and Platte Rivers. PWAP is primarily a tool for surface water administration and a method of accounting for allocations of storage and natural flow that occurred the day before the program is run. Using PWAP, NDNR tracks and protects EA water through the system. Inputs to PWAP include daily gage data from the rivers, tributary inflows, and canal diversions. PWAP divides the rivers into a series of reaches based upon an estimated one day travel time between reaches. Below McConaughy PWAP applies a one day time lag between the each of the following gages: Keystone, Sutherland, Maxwell, Cozad, Overton, and Kearney. The model applies a two day travel time from Kearney to Grand Island.

Prior to water-balance calculations, PWAP applies evaporation and conveyance losses to natural flow, storage, and EA flows based on their relative proportion of the total flow within the reach. To determine gains and losses, PWAP takes inputs to the reach and subtracts off gaged diversions. The difference between remaining flow and the gaged flow at the bottom of the reach is the gain or loss. Gains are added to natural flow in the reach. Losses are subtracted from natural flow, storage, and EA flows based on their relative proportion to total flow at the upstream end of the reach. After gains or losses are applied, natural and storage flows are allocated to canal diversions based on water right priority dates and permitted natural flow diversion rates, which are inputs to PWAP.

EA water is tracked in PWAP as if it were in the river. There are no provisions to store EA water in Sutherland Reservoir or Johnson Reservoir. For this flow routing test EA accounting sections of PWAP were computed manually to account for retiming of EA flows out of Sutherland and Johnson reservoirs. Other than retiming EA releases, NDNR followed their normal accounting procedures. Flows were checked and verified between NDNR gages and NPPD and CNPPID gages on the system. Attachment G is a table of NDNR's final EA accounting for the 2009 flow routing event.

2. System Constraints

A. Ramp-up rates for North Platte River below Keystone Diversion

The more rapidly that EA releases from Lake McConaughy can be ramped-up to the maximum rate, the less total EA water needs to be released to achieve desired maximum river flow. In the past, concerns were raised that ramping-up flow in the North Platte River channel too rapidly could damage canal headgates along this reach of the river due to mobilization of debris accumulated in the North Platte River since the previous high flow. In earlier years, an assumption was made that ramp-up rates for an initial flow routing test might need to be limited to 300 cfs/day.

In March 2009, the EA Manager and the Program Executive Director met with operators of the Keith-Lincoln, North Platte, Paxton-Hershey, and Suburban Canals along this river reach (communications with the Cody-Dillon were via telephone). Similar meetings had taken place in February 2008. None of these operators expressed concern that ramp-up rates of 800 cfs or more per day would present any problems, provided that they were not diverting water at the time (*i.e.*, headgates open to pass flow), and provided they were given advance notice in order to keep an eye on headgate conditions. Several noted that this event offered the potential benefit of flushing debris past their headgates, as well as wetting-up the river channel prior to their taking canal deliveries, reducing channel losses.

Due to timing the flow routing test before the irrigation season, none of the operators were physically ready to take diversions during the event. They were either postponing diversions to complete canal maintenance work or natural flows were too low to effectively "pool" water & allow diversion anyway. Nevertheless all canal operators agreed to postpone diversions to their canals until this flow test was completed. The EA Manager maintained frequent communication with the canal operators leading up to and during this flow test. Releases from Lake McConaughy passing the Keystone Diversion (*i.e.*, continuing down the North Platte River channel) were ramped up at a rate of about 600 to 650 cfs/day for the first two days of the flow test, and then stepped up approximately 100 cfs more on day four. No problems were observed nor reported with respect to these moderately aggressive ramp-up rates. Canal operators monitored their river gate facilities during the first 3-4 days that EA releases were expected to arrive and the EA Manager visited each facility during that same period (digital photo documentation of flow conditions were obtained).

B. North Platte River at North Platte 'Choke Point' Status

The safe flow-conveyance capacity in the North Platte River at North Platte, Nebraska, is of keen interest to the Program because this limits the maximum rate at which EA water can be routed down this channel to create or augment short duration high flows without generating out-of-channel flooding problems.

In April 2009, the National Weather Service-designated "flood stage" for the North Platte River at North Platte, Nebraska was 6.0 feet. This is measured at a gage located immediately downstream of the Highway 83 bridge near the Cody Park boat ramp. According to NWS[3], the "flood impacts" at 6.0 foot stage are:

> MINOR FLOODING OF LOW LYING AND AGRICULTURAL LAND BEGINS ALONG THE NORTH BANK OF THE NORTH PLATTE RIVER FROM HIGHWAY 83 TO APPROXIMATELY 4 MILES WEST OF HIGHWAY 83 SOUTH OF NORTH RIVER ROAD. MINOR WATER INSTRUSIONS INTO LOW LYING AREAS OF CODY PARK IN NORTH PLATTE BEGIN. CHILDREN SHOULD BE CAUTIONED AGAINST PLAYING IN THE WATER ALONG THE BANKS OF THE RIVER, ESPECIALLY NEAR CODY PARK.

At 6.2 foot stage ("moderate stage") NWS describes the impacts as:

[3] Website: www.crh.noaa.gov/ahps2/hydrograph.php?wfo=lbf&gage=nptn1, accessed June 2009.

MODERATE AND MORE WIDESPREAD OVERFLOWS INTO LOW LYING AND AGRICULTURAL LAND OCCUR ALONG THE NORTH BANK OF THE NORTH PLATTE RIVER FROM HIGHWAY 83 TO APPROXIMATELY 4 MILES WEST OF HIGHWAY 83 SOUTH OF NORTH RIVER ROAD. WATER ENCROACHMENT INTO SOME RESIDENCES PROPERTY BEGINS ALONG AND SOUTH OF NORTH RIVER ROAD. WATER ENCROACHMENT INTO LOW LYING AREAS OF CODY PARK WORSENS. CHILDREN SHOULD BE CAUTIONED AGAINST PLAYING IN THE WATER ALONG THE BANKS OF THE RIVER, ESPECIALLY NEAR CODY PARK.

Efforts were made to keep the North Platte river stage at no more than about 6.0 feet for the April 2009 flow release test. A stage of 6.0 feet or a fraction higher was recorded continuously at this location for a total period of about 60 hours, beginning at 18:30 on April 14 and continuing until 06:30 on April 16. Prior to this test, 1600 cfs was assumed to equate to the 6.0 foot flood stage. The observed peak flow at this location during the event is estimated to have been 1747 cfs. Note that the Program has committed to restoring safe-conveyance capacity at this choke point "by Year 3 of the Program's first increment" of at least 3,000 cfs. Efforts to this end are ongoing. Thus substantially greater safe-conveyance capacity is assumed in future years.

Many field observations were made in the vicinity of North Platte during the dates of April 14 through 16. We did not identify any sites of problematic inundation.

Photos 3 and 4 of Attachment F show the Cody Park riverfront and boat ramp area at about noon on April 15, at a river stage of 6.02 feet. A peak flow of 1,747 cfs occurred at 6:30 PM on April 16th with a corresponding stage of 6.08 feet. As illustrated in these photos, water rose into the lower riverfront area of the park, but was well below levels that could inundate any parking, picnicking, or recreational areas. A substantial portion of the unpaved boat ramp turnaround area was inundated, but access to and use of the boat ramp was not impaired. There was no detectable water velocity on the boat ramp or in the shallow inundated riverfront area of Cody Park. Risks to anyone recreating in or near the shallow water along Cody Park's riverfront would have been insubstantial. Public activities in Cody Park continued unabated. The majority of park users may have been oblivious to the unusually high river stage in the North Platte River.

Photo 5 illustrates a side-channel area on the north bank of the North Platte river taken approximately one mile upstream of the Highway 83 bridge on the Dishman Property. In recent years this has been a site of landowner-reported flooding problems at about 2,000 cfs flows. The area photographed was sprayed and cleared of phragmites preceding this test flow, and the channel illustrated was cleaned and opened to allow flow to return to the main North Platte River channel a few hundred yards downstream. Rocky Keehn, a hydraulic engineer with SEH, estimated approximately 25-30 cfs of flow was carried by this channel at the time of the photo. He also indicated that groundwater levels in the immediate vicinity had dropped by about 1.5 feet within weeks after this channel was opened earlier in the year. Local landowners did not report any flooding problems during this test event. Presumably, substantial inundation of landowner property would not occur until the left bank in Photo 5 is overtopped. Water tables in some adjacent upland areas may temporarily rise during an elevated river stage, however it is unclear how significant or extensive those effects could be. The clearing operations in early 2009

consisted of shredding about 10 acres of the 30 acres of phragmites sprayed in the fall of 2007. Topography and river conditions at the time of clearing operations limited shredding activities largely to a narrow strip corresponding roughly to this channel area. More extensive shredding and dicing operations will be performed in this area in the fall 2009.

C. Mainstem Platte River safe-conveyance capacity (North Platte to Overton)
The future creation or augmentation of short duration high flows in the central Platte River of the magnitude currently envisioned (6,000 to 8,000 cfs) may require that at least 4,000 to 6,000 cfs of this flow be transmitted through the mainstem Platte River itself, as opposed to supplemental flows released from storage at locations downstream. The safe-conveyance capacity of the Platte River channel from the CNPPID Supply Canal Diversion Dam near North Platte, Nebraska, to below Jeffrey Island some 70 miles downstream (*i.e.*, confluence of the mainstem Platte River and Johnson-2 Return) is of keen interest to the Program.

During the April 2009 test, the maximum instantaneous flow estimated at the Maxwell gage (*i.e.*, passing the CNPPID's Supply Canal Diversion Dam) was approximately 1,962 cfs. This was achieved around 16:30 p.m. on April 17. Peak flow at the Cozad gage was approximately 2,552 cfs at 20:00 a.m. on April 18.

Several sites that had been pre-identified as potentially vulnerable to overbank flooding were inspected during the flow release test. No significant inundation problems were observed. For example:

- **Sand dam between the 30-Mile Canal and Gothenburg Canal headgates**, near Brady: This 'sand dam' is in fact a very substantial dike, and it showed no signs of significant physical effects from a river flow of approximately 1,700 cfs during the time of our visit (see Photo 6).

- **Gothenburg KOA campground** (north bank of mainstem Platte River immediately upstream of the Highway 47 Bridge): The owners of this campground were visited on the morning of April 16. No imminent risk of campground-area flooding problems of the kind they've observed in the past could be identified.[4] No regularly-accessed areas appeared vulnerable to flooding from this event, neither in the camping area itself nor in the privately-accessed area immediately west. On the contrary, there appeared to be a freeboard of at least 1.5 to 1.75 feet around the campsite area (see Photo 7). Shallow flow across an unpaved access road behind a locked gate at the west end of the area was observed during peak flows, but this did not appear to hinder its use.

[4] The owners indicate that flooding of their campsites seemed to be a fairly regular occurrence from the time they acquired the property (1994) through 2000 or so. With the onset of basinwide drought and lower flows beginning around 2001-2002, they say no campground flooding has occurred. When they were informed that a flow of approximately 1,700 cfs was currently passing the site and that the river stage was unlikely to rise much higher, the owner appeared unconcerned and suggested that we "get back to him when the flow gets closer to 6,000 cfs".

One potential third-party impact that was not identified prior to this flow-release test was the potential impact on the operations at Overton Sand and Gravel Co.

Overton Sand and Gravel Co.: During the natural high flow event of May 2008, erosion to the river bank/berm[5] separating the sand and gravel pit from the Platte River channel occurred. Flows during this natural event peaked at 11,200 cfs, with daily maximum flows exceeding that of the flow routing test maximum during eight consecutive days. In April 2009, the pit owner obtained a 404 permit from the US Army Corps of Engineers to effect repairs to the berm. No action had been initiated toward actual repair prior to the test flow release. During the test flow release, additional erosion to the narrow berm was observed and brought to the attention of the ED Office (the morning of April 20th) (Photo 8). Late afternoon on April 20th, after multiple options were discussed, releases through the J-2 Return were reduced from about 2,000 cfs to about 1,700 cfs to reduce stress on the berm. Factors considered in making this decision included, but were not limited to, the following: flows in the Platte River above the J-2 Return were already in decline (the stage at the new Lexington gage was 0.7 foot less than the peak at about noon on April 19th); CNPPID's Supply Canal was full so reducing J-2 outflow to around 1,000 cfs or even to 0.0 cfs likely could not be maintained for more than one day; and reducing J-2 outflow significantly one day and then increasing it again the next day might potentially result in a situation more conducive to berm erosion than a smaller but steady reduction in outflow. Total flow at this location was rapidly reduced from about 3,500 cfs to 3,250 cfs and subsequently steadily dropped over a 30 hour period to at or below the regularly experienced peak hydrocycle flow level of 2,000 cfs. No repair work to the berm was undertaken during the course of the high flow period and the berm did not breach during the event. The berm ultimately did fail in mid-September, and no repairs have been initiated as of late October. Conditions at this location will be assessed prior to any future Short Duration High Flow release.

No other third-party concerns associated with elevated flow in the main-stem Platte River were identified.

3. Hydrologic Measurements, Observations, and Interpretations

The pre-flow routing test planning spreadsheet included a crude estimate of a likely peak flow in the Platte River at Overton in excess of 3,000 cfs for at least two days, with an average of 3,200+ cfs on the day of peak flow (predicted to be April 19). Gage locations with total EA and total flow volumes, travels times and peak flows during the flow routing test are illustrated in Attachment C.

Table 2 below provides flow routing test information including days when test flows were present, total flow volumes during the flow routing test and EA volumes and percent of flow volumes.

[5] Between 2006 and the natural high flow event in May 2008, the gravel pit was been expanded southward to very near the then high bank of the river and fill placed along the bank to create an elevated berm (see 2003-2008 aerial photograph mosaic on file with the ED Office).

Table 2: Estimated Total Flow and EA Volumes

Gage	Dates when Test Flows Were Present for Gage	Total Volume (AF)			%EA of Test Flows	% EA of Total Period
		Only when Test Flow Were Present (including any ramping up or down)	Complete Flow Routing Period (4/7 0:00 to 4/28 0:00)	EA Water		
NPPD's Keystone Diversion	----	----	45,939	5,355	----	12%
NPR Keystone	4/8 20:00 - 4/16 6:00	17,980	18,011	17,598	98%	98%
NPR Sutherland	4/9 18:00 - 4/27 12:00	23,199	23,837	22,193	96%	93%
CNPPID's Supply Canal	----	----	60,037**	8,168	----	14%
Maxwell	4/14 6:00 - 4/25 0:00	16,415	17,448*	12,615	77%	72%
Cozad	4/15 6:00 - 4/27 0:00	20,945	23,754*	10,384	50%	44%
J-2 Return	----	----	41,360**	7,946	----	19%
Overton	4/16 12:00 - 4/23 16:00	32,856	66,040**	14,985	46%	23%
Kearney	4/17 3:30 - 4/24 3:30	32,416	64,964**	13,589	42%	21%
Grand Island	4/18 9:00 - 4/25 19:00	35,587	68,050**	13,313	37%	20%

* The Maxwell and Cozad gages had erroneous gage reading (high spikes) for the 4/27 05:00 though 06:30 period followed by no readings from 7:00 through 23:30 on that same day. After reviewing a plot of gaged data, and discussing the data with NDNR, the spikes were removed and straight line interpolation used to estimate and fill in missing data.

** The Complete Flow Routing Period volumes for these locations include water diverted and released for hydrocycling.

Gage data for several locations for the period leading up to, during and after the flow routing event is provided in Figure 1. Smaller pulses before and after peak flows that can be seen for gages below the J-2 Return (Overton, Kearney, Grand Island and Duncan) is a result of hydrocycling through the J-2 Hydro as well as water that CNPPID had to evacuate from Johnson Reservoir before the pulse because inflows were higher than anticipated.

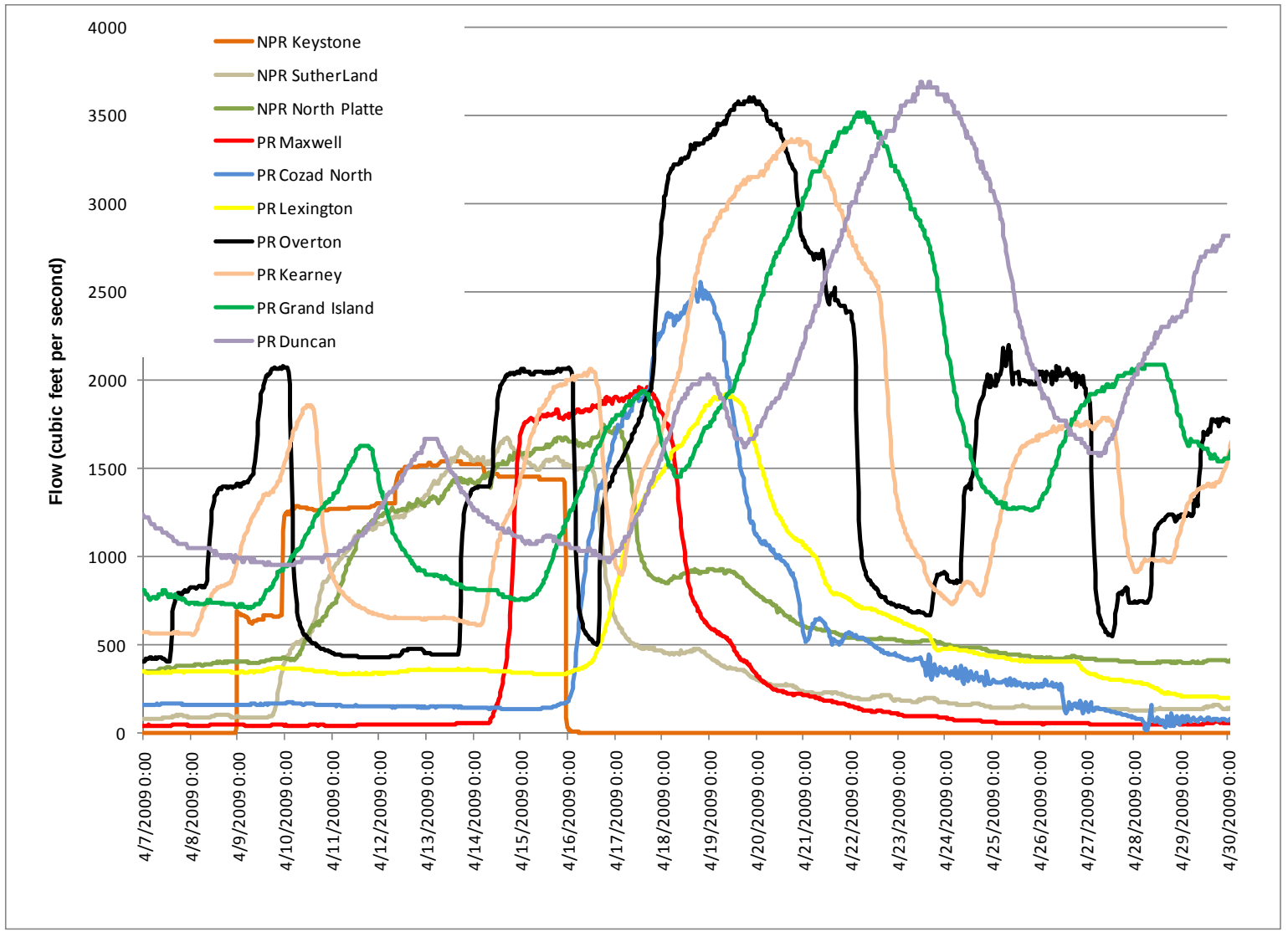

Figure 1: Flow Routing Event Gaged Streamflows (data source: NDNR and USGS)

A. Flow magnitudes

At the **Overton** gage, actual gage measurements indicate flows were sustained at or above 3,200 cfs for about 62 hours (5:00 a.m. April 18 through 7:00 p.m. April 20) with an instantaneous peak flow of around 3,600 cfs (late in the day April 19).

At the **Kearney** gage, flows at or above 3,200 cfs were sustained for about 28 hours (5:00 a.m. April 20 to 9:00 a.m. April 21) with a peak of around 3,360 cfs.

At the **Grand Island** gage, flows at or above 3,200 cfs were maintained for about 38 hours (9:00 a.m. April 21 to 10:30 p.m. April 22) with a peak of around 3,510 cfs.

B. Travel times

Based on an evaluation of the hydrographs at various Platte River locations, Table 3 provides approximate travel times estimated for the hydrograph "wave" as it moved downstream. Test flow travel time to North Platte at North Platte was faster than anticipated. Conversely, travel times below North Platte were slower than anticipated. Pre-event gains in the North Platte River between Lake McConaughy and North Platte were around 400 cfs; similarly gains in the mainstem Platte River between North Platte and Overton were around 300 cfs. It is important to note that pre-event channel conditions were relatively dry as illustrated in Figure 2 (pre- and post-event peaks at the Overton gage are a result of CNPPID hydrocycling). Under wetter conditions these travel times would presumably be shorter.

Table 3: Approximate Test Flow Travel Times

River Reach	Approx time from initial hydrograph rise at upstream gage to initial hydrograph rise at downstream gage	Approx time from peak to peak (or centroid of extended peak)
Passing Keystone to Sutherland	19 hrs	*
Passing Keystone to North Platte, NE	31 hrs	*
Maxwell (passing CNPPID's Supply Canal) to Cozad	39 hrs	32 hrs
Maxwell to Lexington	48 hrs	44 hrs
Maxwell to Overton	**	59 hrs
Overton to Kearney	**	21 hrs
Kearney to Grand Island	32 hrs	35 hrs
Grand Island to Duncan	34 hrs	32 hrs

* Not estimated due to sustained plateau of peak release from Lake McConaughy

** Not estimated due to dual source of Overton hydrograph rise (main channel and J-2 Return flows)

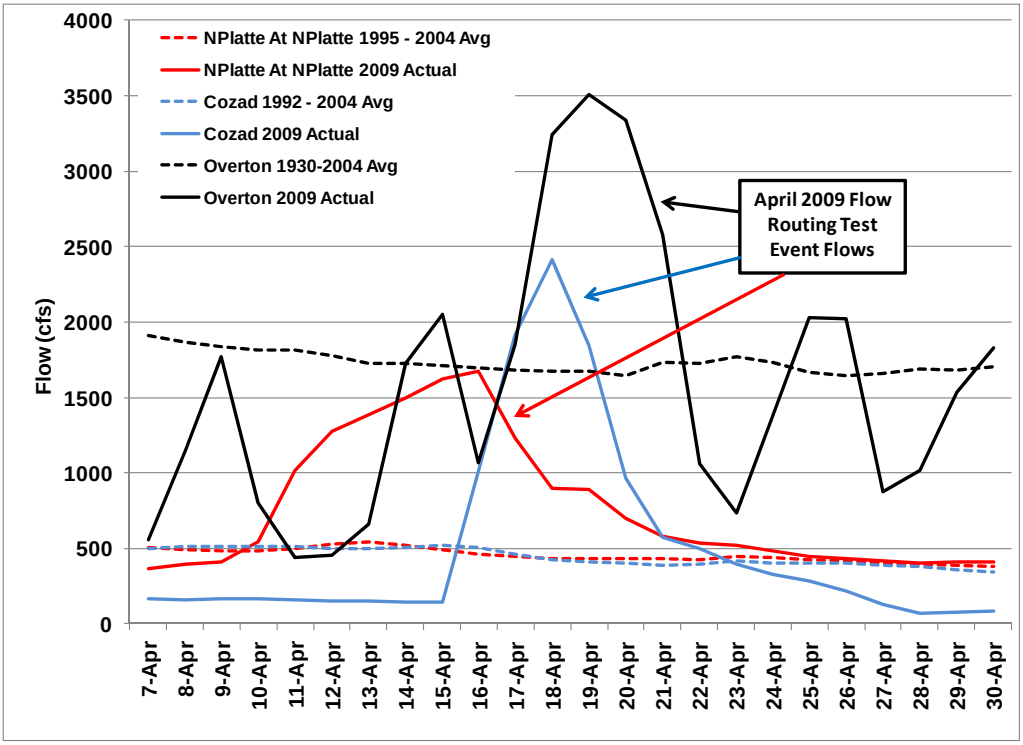

Figure 2: Average Daily April Average Flows and 2009 Gages Flows (data source: NDNR and USGS).

C. Conveyance Losses

In their accounting, NDNR estimated EA losses from Keystone on the North Platte River down to Grand Island on the mainstem of the Platte River. These calculations are based upon the data provided in Attachment G and described in section 1.G. above. NDNR's PWAP accounting model assigns losses and evaluates flows in NPPD's and CNPPID's systems as if they were in the river. Table 4 shows the losses incurred by EA water during the flow routing test from Keystone on the North Platte, including water in the river and being routed to NPPD's system, to various downstream gages. 35% of EA water was estimated to have been lost between Keystone and Overton and another 7% (for a total of 42%) down to Grand Island.

Table 4: Percent EA Loss during the 2009 Flow Routing Event (as calculated by NDRN)

Reach	% Loss
from Keystone to Sutherland*	3%
from Keystone to Maxwell	9%
from Keystone to Cozad**	19%
from Keystone to Overton	35%
from Keystone to Kearney	41%
from Keystone to Grand Island	42%

*Includes losses incurred in NPPD's system.
**Includes losses incurred in CNPPID's system.

D. Pulse Attenuation

This flow routing test provides data useful for assessing the attenuation of peak flows as they move through various reaches of the mainstem Platte River. Peak flows are attenuated by a combination of factors unique to each event, including opportunities for flow detention (channel storage; bank storage; backwater storage), channel roughness conditions (in-channel vegetation; bed and bank characteristics), and moisture conditions antecedent to and during the event (recent runoff events; bank moisture conditions; groundwater gradients adjacent to the stream channel; evaporation and evapotranspiration of flow). Finally, the greater the magnitude of the peak flow, and the shorter its duration, the greater the opportunities for peak attenuation.

In spite of many event-specific variables affecting peaks, the following discussion addresses the key questions below, at least relative to the Platte River conditions existing in April 2009[6]:

(1) For each additional 100 cfs of flow bypassing CNPPID's Supply Canal headgates at North Platte, how much additional peak flow can we expect to see in the Platte River near Overton?

(2) For each additional 100 cfs of peak magnitude achieved in the Platte River near Overton, how much added magnitude of peak flow can we expect to see at downstream gage locations (Kearney, Grand Island, and Duncan)?

1. Peak flow attenuation bypassing CNPPID's Supply Canal Headgates

Figure 3 below summarizes the percentage of daily flow passing CNPPID's Supply Canal headgates (as measured at the Maxwell gage which is approximately 9 miles downstream from CNPPID's headgates on the mainstem Platte River) estimated to contribute to corresponding daily mean flows at the Overton river gage approximately 59 hours later, as a function of the number of days of bypassed water.

[6] More accurate answers applicable to a broader range of river conditions are anticipated if these data are used to better calibrate unsteady flow routing models for various reaches of the Platte.

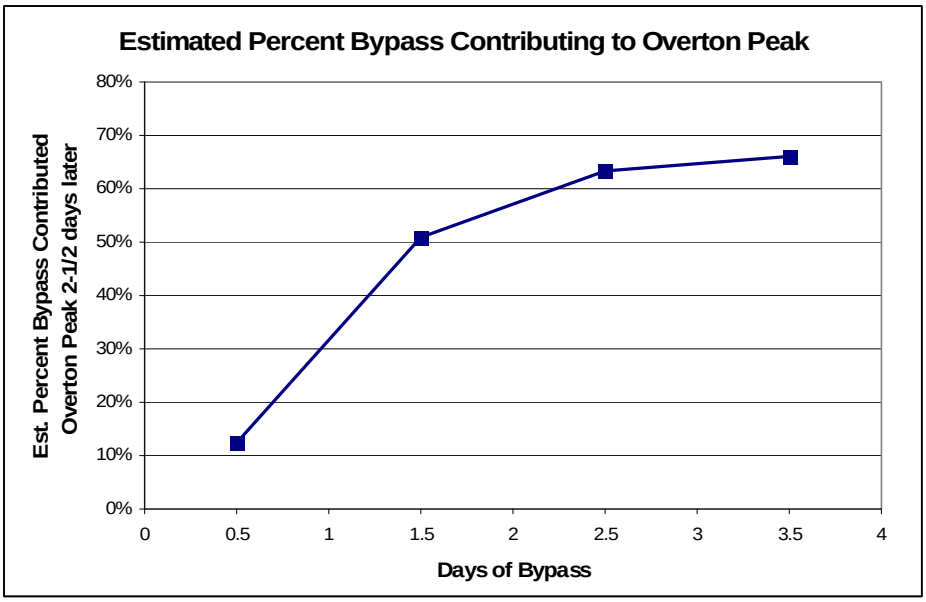

Figure 3: Estimated Total Flow and EA Volumes

Several assumptions are built into the above graph that imply at least plus-or-minus 5% uncertainty in each of the graphed points (see Attachment H). That said, this figure suggests that under conditions existing at the time of this flow routing test, each 100 cfs of flow bypassing CNPPID's Supply Canal headgates added around **60 to 70 cfs** to the peak flow magnitude at Overton when those bypasses were sustained for 2.5 to 3.5 days.

2. Peak flow attenuation downstream of Overton

Table 5 summarizes the translation of peak flow magnitudes downstream. Note that these estimated rates of attenuation correspond to a peak flow that was sustained for roughly 3.5 days; a shorter peak would have reduced the downstream percentages (i.e., greater attenuation); a longer peak may have increased these percentages.

Table 5: Percent of Overton Peak Flows Translated Downstream

River Gage	Pre-event flow	Peak flow	Test flows net added magnitude to peak	Percent of Overton peak translated downstream
Overton	503 cfs (4/16 15:00)	3600 cfs (4/19 20:30)	**3097 cfs**	--
Kearney	900 cfs* (4/17 03:30)	3360 cfs (multiple readings 4/20 18:00 through 22:00)	**2460 cfs**	**79%**
Grand Island	1450 cfs* (4/18 09:30)	3510 cfs (multiple readings 4/22 03:30 through 07:00)	**2060 cfs**	**67%**
Duncan	1620 cfs* (4/19 18:30)	3690 cfs (multiple readings 4/23 12:00 through 16:30)	**2070 cfs**	**67%**

*Pre-event flows as these locations included flows from CNPPID's hydrocycling that were still moving downstream. Pre-event flows without hydrocycling would have been lower.

E. Precipitation

Streamflow and precipitation in the Platte River basin of western Nebraska has generally been below normal since 2002, although 2008 and 2009 have been somewhat closer to "normal". Attachment I provides daily precipitation data from the High Plains Regional Climate Center at the University of Nebraska, Lincoln for the month of April 2009 at locations impacting flows in the central Platte River. Between approximately ¼ and ½ inch of precipitation was measured at various North Platte-area locations on April 9 and 10, and cumulative precipitation of 0.8 to 1.5 inch was measured at gauges in North Platte, Cozad, Gothenburg and Lexington on April 16 through 18. Total monthly precipitation was quite a bit higher than normal for the Lake McConaughy, North Platte and South Platte and normal for the Central Platte and associated habitat area.

F. Suspended Sediment Transport

Ayres Associates took advantage of the flow routing test to conduct depth-integrated suspended-sediment sampling for flows in excess of 1,000 cfs and 3,000 cfs at five bridge sites along the Platte River reach between Lexington and Grand Island. This was accomplished as part of implementing the broader Channel Geomorphology and In-Channel Vegetation Monitoring protocol for the Program. In addition to suspended-sediment sampling, Ayers also collected a bed material sample and surveyed a cross-section at each of the bridge sites for use in developing the hydraulic variables necessary to conduct modified-Einstein calculations for total sediment load. To date those total sediment load calculations have not been completed.

G. Gage Rating Curves

No existing rating curves were modified using data collected during the flow test. However measurements made at the new Lexington and Shelton gages, installed in 2008, helped define the rating curves for those sites.

4. Channel Vegetation Observations

The only specifically identified choke point that limited capacity is the North Plate choke point and downstream to CNPPID's Supply Canal Diversion Dam. In February 2009, a Program contractor completed 10 acres of phragmites shredding along the North Platte River upstream of the Highway 83 Bridge to improve conveyance through the North Platte choke point in advance of the Flow Routing Test. The test revealed that the North Platte choke point was able to accommodate 1,700 to 1,800 cfs at the North Platte gage, which was approximately 100 – 200 cfs more than had been anticipated. No downstream problems were identified as a result of remnant materials from the phragmites shredding.

Additional phragmites clearing in the North Platte between the Highway 83 bridge and CNPPID's Supply Canal Diversion Dam will be undertaken by the Program in collaboration with the West Central Weed Management Area to further improve flow conveyance through the choke point area. It is anticipated that this action will increase capacity to near 3,000 cfs at the flow stage gage height of 6.0 feet, presently NWS flood stage.

During the test it took longer for flows to get to Cozad than was anticipated, which is an indication that something, likely phragmites, is detaining flow. The Program, in collaboration with other organizations, will complete additional phragmites clearing from the river channel in 2010 and 2011 to improve conveyance efficiency from Kingsley Dam through the associated habitat to Columbus.

5. Lessons Learned and Considerations for Future Efforts

Based on our observations and experiences with the 2009 flow routing test, we propose the following recommendations and considerations for future planned short duration high flow events.

(1) The Program should recognize that implementation of future short duration high flows will not necessarily run as smoothly as this event.

The overall implementation of this flow routing test went about as smoothly as could be hoped. Flow diversions and releases were well-coordinated and generally well-timed. Operations generally proceeded without significant problems, weather conditions were moist in the days leading up to the event but did not include problematic storms during the event, unanticipated third-party concerns were few, and substantial amounts of non-Program water supplemented the central Platte peak flow while reducing "intentional bypass" costs to the Program.[7]

Such problem-free implementation can't be taken for granted in future years. Various unanticipated real-time problems can easily arise, and various projections could turn out to be erroneous. We did not attempt to time the flow routing test to coincide with a precipitation event or South Platte "natural flows" which may be the case for future events. Additionally, similar magnitudes of non-Program water as those involved in the flow routing test may or may not be available in future years. NPPD system conditions[8] and the agreement in place[9] provided the opportunity to release of an additional 20,000 af from Lake McConaughy through the NPPD system beginning around April 1. A release of this water, along with other operational releases significantly increased flow routing test flows. It is important to consider that the April 2009 event was made up of an extremely unique set of circumstances that allowed NPPD to optimize conditions to increase event flows. In the future this may not be the case though NPPD is committed to safely and efficiently cooperate to enhance EA releases. Program expectations for

[7] As discussed earlier, unique arrangements were made with NPPD and CNPPID in 2009 to ensure the delivery of additional, non-Program water at the desired place and time for this test. Similar arrangements cannot necessarily be assumed for future years. Moreover, should NPPD be operating in 'conservation mode' (as it has for several recent drought years), their system would not be available to the Program as a conduit for routing any water past the North Platte 'choke point' during a short duration high flow and much less for providing 1,400 cfs of supplemental flow as in this test.

[8] The NPPD Sutherland Project system was in a drought mode of operation so the canals and Lake Maloney were at lower than normal operating levels when the flow routing test was planned.

[9] An agreement reached between the Service, NPPD, CNPPID and the Nebraska Game and Parks Commission during FERC license Article 405 2009-2010 waiver discussions.

achieving targeted magnitudes and durations of short duration high flows should be tempered accordingly.

(2) Primary factors limiting the magnitude of 2009 peak flow at Overton: (a) Inflows from the South Platte River, and (b) North Platte choke point capacity.

Had we had 'perfect knowledge' of hourly flow and weather behavior, we may have been able to slightly add to the peak flow at Overton through more exact water management. This underscores the limitations currently faced by the Program in terms of achieving short duration high flows of desired magnitude and duration.

The factors that most constrained the ability to generate a peak flow of greater magnitude at Overton during the April 2009 event were:

a) *Minimal South Platte River inflows*. During the key days of this exercise, inflows from the South Platte River at North Platte, Nebraska, averaged around 120 to 150 cfs[10]. For every additional 100 cfs of inflow from the South Platte River at this time of year, one might expect over 94 - 99 cfs[11] of flow in the central Platte River several days later upon which augmented flow could build if not diverted.

b) *North Platte River at North Platte choke point capacity*. In this 2009 exercise, no more than about 1,700 to 1,800 cfs of flow could be comfortably pushed through this "choke point", as this raised the North Platte gage stage to 6.08 feet. One might reasonably estimate that for every additional 100 cfs of choke point capacity, peak flows at Overton several days later could be increased between 60 and 70 cfs during a bypass-and-reregulation event (this will vary with antecedent flow conditions and duration of the bypass). Thus, for this event, the ability to boost the peak flow at Overton by an additional 1,000 cfs (*i.e.*, into the neighborhood of 4,600 cfs total) likely would have required a safe-conveyance capacity at the North Platte choke point of approximately 3,000 to 3,500 cfs.

Other factors that limited the peak flow magnitude included:

c) Relatively dry basin and river-corridor conditions, which increases transit losses and aggravates peak flow attenuation;
d) Phragmites infestation of the Platte River channel below North Platte, which impedes flow velocity, contributes to transit losses, and aggravates peak flow attenuation; and

[10] For comparison, EIS modeling of the Program estimated an average 247 cfs of inflow during the month of April for the 25-percentile river condition, 336 cfs for the median condition. Presumably, Program water releases in the future could be better timed to coincide with natural short duration high flows in the South Platte River when they are available. The EIS evaluation simulated an average of 446 cfs of flow in the South Platte at Julesburg in months when short duration high flow Program releases are made.

[11] The Water Management Committee (WMC) water budget spreadsheet model (WMC Loss Model) was used to route 100 cfs to Overton.

e) Available EA volume, which controls/limits the feasible and reasonable duration of a flow release made for this purpose.[12]

(3) EA-bypass decisions made in real-time: existing constraints and a possible workaround

As noted above, 'perfect advanced knowledge' of hourly flows and weather conditions could have added additional water to the peak flow at Overton by allowing for more perfectly-tuned water management.[13] While perfect advanced knowledge will never be available, a modification in the way in which the Program accounts for 'intentional EA bypass' could allow for more effective use of the available EA water.

CNPPID can bypass any water but the EA Bypass Agreement only allows for reimbursement by the Program to CNPPID for intentional bypasses of water colored at "environment account" (EA) water. While this restriction is conceptually straightforward, NDNR's daily accounting procedures do not quantify the EA water at CNPPID's headgates *until the following day*. The effect of this restriction is to force CNPPID into making prudently cautious estimates of the EA water available in real-time. There is a strong incentive for CNPPID to minimize the risk of bypassing non-EA water for which they won't be reimbursed by erring on the side of *underestimating* available EA water on any given day. This reduces the amount that can be confidently bypassed for the Program.

One possible means of addressing this dilemma – without, in our opinion, undermining the intent of the EA Bypass Agreement – would be to allow EA water available for intentional bypass to be quantified on a *multi-day event basis* rather than a *daily basis*. Under this approach, the CNPPID facilities manager would be able to make daily intentional-bypass decisions based on best estimates of *multi-day* as well as *daily* EA accounting at CNPPID's Supply Canal headgates, rather than attempting to compensate for the daily uncertainties and 'noise' that is inherent in NDNR's reach-by-reach accounting procedures. On only the *final day* of a multi-day event would the CNPPID manager feel compelled to act with particular caution when assuming the available EA volume. An example is provided in Attachment J.

(4) Communication with NWS for monitoring of weather conditions

For this event, intense storm conditions developed near the tail-end of the exercise that raised concerns about the potential for localized flooding problems, particularly in the North Platte at North Platte "choke point" area. As roughly one-and-a-half to two days of travel time separates any decision to release water from Lake McConaughy from the

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[12] The EA volume in Lake McConaughy at the end of March was 110,373 acre-feet. EIS modeling of the first increment of the Program estimates an average expenditure of 47,500 acre-feet from the Environmental Account to augment each short duration high flow event.

[13] While lack of perfect knowledge reduced the potential peak, timely rainfall in the Overton-Grand Island area may have added 100-200 cfs or more to the peak – a favorable outcome that obviously cannot be predicted nor planned for in advance.

arrival of that water at North Platte, timely information about impending storm conditions is crucial for making wise decisions that minimize flooding risks in the choke-point area. While no problems arose from the April 2009 weather developments, communications with the National Weather Service forecast personnel could have been better.

(5) Jeffrey Return as an option for future reregulation-and-bypass implementation

For this 2009 exercise, an intentional planning decision was made to deliver all intentionally-bypassed EA water over CNPPID's Supply Canal headgate spillway. Physically, approximately 775 cfs of the bypassed water[14] could have been routed through CNPPID's canal system and returned to the river channel at the Jeffrey Return some 27 miles downstream. This would have offered the advantages of (1) reducing power-compensation costs paid to CNPPID and NPPD for intentionally-bypassed water[15], and (2) somewhat reducing the attenuation of bypassed flow in the Platte River by circumventing some 25 miles of *phragmites*-infested river channel.

The decision was made not to test this Jeffrey Return option in 2009 in order to learn as much as possible about channel-conveyance and flow behavior between North Platte and Brady. In future years, the Program may want to implement a Jeffrey Return option in order to assess the potential advantages identified above.

(6) South Platte inflows and possible future EA-exchange arrangements with NPPD @ Korty

As discussed earlier, low inflows contributed by the South Platte River during this event was a key limiting factor controlling the ultimate magnitude of the peak flow in the Platte River at Overton. In large part, South Platte inflows are determined by the vagaries of nature and cannot be controlled by the Program. However, when flows are elevated in the South Platte River upstream of NPPD's Korty Diversion, and when NPPD intends to divert what they can into Korty Canal, this presents a potential opportunity to provide EA water from Lake McConaughy to NPPD in exchange for passing South Platte water at their Korty Diversion. Under ideal conditions, this mechanism could augment South Platte at North Platte inflows during a short duration high flow event by as much as 850 cfs. Because these flows are not restricted by the North Platte choke point, their added contribution to cumulative flows could be particularly significant.

As of today, no agreed-upon procedures exist that allow the Program to provide this kind of EA water in exchange for a South Platte bypass. Considering such procedures raises issues such as the lead-time required to implement effectively, ability to protect water

[14] Jeffrey Return can release up to 1250 cfs, but CNPPID's diversion can only hold 2250 cfs. During the 2009 flow routing test, the Program could have only diverted an additional 775 cfs per day (water that was intentionally bypassed) into CNPPID's system for a few days and then returned the water at Jeffrey Return. In the future if the Program is intentionally bypassing 1250 cfs, or CNPPID's diversion is at 1000 cfs it may be possible to move that water into CNPPID's system and return it at Jeffrey Return.

[15] About 30% of the lost hydropower production associated with the Tri-County bypass could have been generated at the Jeffrey power station

diverted to NPPD storage under such an agreement when eventually released, and potential interference with downstream surface-water-rights holders and potential in Nebraska. Nevertheless, we recommend the Program further investigate the feasibility and potential advantages of establishing this alternative.

(7) Updated/improved planning-spreadsheet tools & assumptions

Hourly streamflow and weather data from this April 2009 exercise (along with data from other recent natural events) is expected to support the improved calibration of the HEC-RAS flow routing tool and associated bank-storage modeling for the central Platte River. This should aid the Program with more reliable forecasts of travel times, transit losses, and peak attenuation for future short duration high flow events. The ED Office will coordinate efforts to further develop and refine the appropriate tools.

(8) Peak Flow Potential for Future Short Duration High Flow Event

As stressed in Section 5(1) above, the 2009 test went exceedingly well and it should not be expected that future events will go so smoothly. However, the Program is making progress on various Water Action Plan projects and is improving choke point capacity. Based upon this work and conversations with NPPD, CNPPID and others, it may be possible to achieve peak flows of around 6,700 cfs at Overton within the next several years. This assumes that all system components are timed and operated optimally. Attachment K illustrates potential peak flow which could be sustained for several days given the following assumptions:

- No large natural precipitation event;
- North Platte choke point capacity of 3,000 cfs;
- NPPD and CNPPID's systems fully utilized to capacity;
- Water released through CNPPID's Jeffrey Return and from storage in Johnson Lake; and
- Regulation reservoirs or other projects online with ability to sustain 2,000 cfs of flow duration of peak flow.

(9) Coordinate with DNR in Advance Regarding Post-Event Data Needs

In 2009, the flow routing event occurred immediately before the irrigation season. This is an extremely busy time for DNR, during which the Program asked DNR staff to process data for numerous gages for use in developing this report. For future flow routing events, Program staff should work with DNR in advance to provide them with a list of data that will be requested to evaluate the event so that they can plan accordingly.

Attachments

Attachment A: Pre-Event Planning Spreadsheet Used to Guide Daily Decision-Making

Attachment B: Post-Event Spreadsheet Showing Actual Daily Flow and Routing Conditions

Attachment C: Event Flows and Travel Time Diagram

Attachment D: 2009 Flow Routing Test Press Release

Attachment E: Flow Routing Test Congressional Briefing

Attachment F: Flow Routing Test Photos: During the Event at Key Locations and Before and During Event Comparisons

Attachment G: NDNR 2009 Flow Routing Event Accounting Table

Attachment H: Percent Bypass Contributing to Overton Flow Table

Attachment I: April 2009 Daily Precipitation Data

Attachment J: Daily versus Event-Based EA Bypass Accounting Example

Attachment L: Peak Flow Potential for Future Short Duration High Flow Event Diagram

Attachment A

2009 Flow Routing Test Event Planning Spreadsheet: Timing and Quantity Estimates of EA and Non-EA Water Routed in River and Canal System

All values are planning estimates and not actual event outcomes, in units of cubic feet per second (cfs) with the exception of Johnson Lake Reregulation Storage which is in units of acre-feet (AF).

Date	S. Platte at North Platte	Lake Mac Total Release	EA Portion of Lake Mac Release	NPPD Total Keystone Diversion	EA Portion of NPPD Keystone Diversion	EA in N. Platte below Keystone Diversion	NPPD Total Return	EA Portion of NPPD Return	River Gains Keystone to N. Platte	N. Platte at N. Platte Total Flow	EA Portion of N. Platte at N. Platte Flow	N. Platte and S. Platte Confluence Total Flow	EA Portion of Confluence Flow	CNPPID Supply Canal Total Diversion	EA Portion of CNPPID Supply Canal Diversion	CNPPID Byass (water remaining in the Platte)	Intentionally Bypassed EA Water	Johnson Lake Inflow	EA Portion of Johnson Lake Inflow	Available Johnson Lake Reregulation Volume (AF)	J-2 Return Outflow	EA Portion of J-2 Return Outflow	River Gains N. Platte to Overton	CNPPID Bypass at Overton	Total Flow at Overton
4/7/2009	150	800	0	800	0	0	0	0	300	300	0	450	0	450	0	0	0	338	0			0	300	0	
4/8/2009	150	800	0	800	0	0	0	0	300	300	0	450	0	450	0	0	0	338	0			0	300	0	
4/9/2009	150	1,600	800	1,000	200	600	0	0	300	300	0	450	0	450	0	0	0	338	0			0	300	0	
4/10/2009	150	2,400	1,600	1,200	400	1,200	0	0	300	300	0	450	0	450	0	0	0	338	0			0	300	0	
4/11/2009	150	2,700	1,900	1,400	600	1,300	0	0	200	680	480	830	480	830	480	0	0	338	0			0	300	0	
4/12/2009	150	2,600	1,800	1,300	500	1,300	0	0	250	1,270	1,020	1,420	1,020	1,420	1,020	0	0	338	0		0	0	300	0	
4/13/2009	150	2,500	1,700	1,200	400	1,300	600	0	300	1,470	1,170	2,220	1,170	2,220	1,170	0	0	623	360		0	0	300	0	300
4/14/2009	150	2,400	1,600	1,100	300	1,300	1,400	500	300	1,535	1,235	3,085	1,735	1,150	0	1,935	1,100	1,065	765		0	0	300	0	300
4/15/2009	150	2,300	1,500	1,000	200	1,300	1,400	500	300	1,535	1,235	3,085	1,735	1,150	0	1,935	1,100	1,665	878	6,000	0	0	300	0	300
4/16/2009	150	900	100	900	100	0	1,400	500	300	1,535	1,235	3,085	1,735	1,150	0	1,935	1,100	863	0	5,926	900	0	100	387	1,387
4/17/2009	150	800	0	800	0	0	1,400	500	300	1,535	1,235	3,085	1,735	1,150	0	1,935	1,100	863	0	3,769	1,950	1,050	100	774	2,824
4/18/2009	150	800	0	800	0	0	1,000	100	700	700	0	1,850	100	1,850	100	0	0	863	0	1,612	1,950	1,000	100	968	3,018
4/19/2009	150	800	0	800	0	0	900	100	500	500	0	1,550	100	1,550	100	0	0	863	0	-546	1,950	1,000	100	1,161	3,211
4/20/2009	150	800	0	800	0	0	800	0	400	400	0	1,350	0	1,350	0	0	0	1,388	75		0	0	800	0	800
4/21/2009	150	800	0	800	0	0	700	0	350	350	0	1,200	0	1,200	0	0	0	1,163	75		0	0	600	0	600
4/22/2009	150	800	0	800	0	0	600	0	350	350	0	1,100	0	1,100	0	0	0	1,013	0		0	0	400	0	400
4/23/2009	150	800	0	800	0	0	500	0	350	350	0	1,000	0	1,000	0	0	0	900	0		0	0	300	0	300
4/24/2009	150	800	0	800	0	0	400	0	300	300	0	850	0	850	0	0	0	825	0				300		
4/25/2009	150	800	0	800	0	0	300	0	300	300	0	750	0	750	0	0	0	750	0				300		
4/26/2009	150	800	0	800	0	0	200	0	300	300	0	650	0	650	0	0	0	638	0				300		
4/27/2009	150	800	0	800	0	0	200	0	300	300	0	650	0	650	0	0	0	563	0				300		
Total AF	6,248	55,141	21,819	38,678	5,355	16,463	23,405	4,364	13,885	28,979	15,094	58,632	19,458	43,280	5,693	15,352	8,727	31,866	4,269	16,760	13,389	6,050	12,694	6,525	26,657

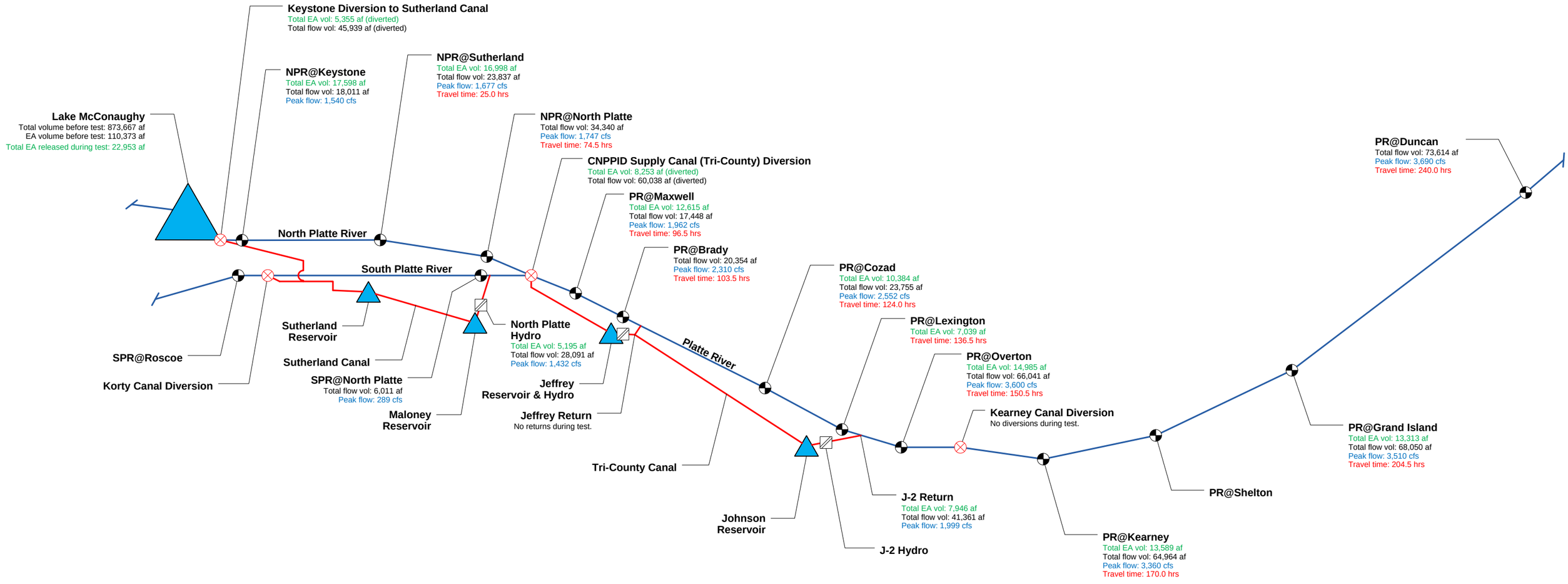
Attachment B

Event Outcomes: Average Daily Flows and EA Water (cubic feet per second)

Date	S. Platte at North Platte	EA Portion of Total Lake Mac Release	EA Portion of N. Platte at Keystone	NPPD Total Keystone Diversion	EA Portion of NPPD Keystone Diversion	N. Platte at Sutherland	Est. EA Portion of Sutherland Flow[1]	N. Platte at N. Platte Total Flow	NPPD Total Return	EA Portion of NPPD Return	EA in Platte at CNPPID's Diversion	CNPPID Supply Canal Total Diversion	EA Portion of CNPPID Supply Canal Diversion	Platte at Maxwell Total Flow	EA Portion of Maxwell Flow	Platte at Brady Total Flow	Platte at Cozad Total Flow	EA Portion of Cozad Flow	J-2 Return Outflow	EA Portion of J-2 Return	Total Flow at Overton	EA Portion of Overton Flow
4/7/2009	134	0	0	590	0	90	0	368	0	0	0	542	0	46	0	143	165	0	280	0	561	0
4/8/2009	136	0	0	1,036	0	97	0	396	0	0	0	547	0	47	0	170	162	0	923	0	1,148	0
4/9/2009	130	831	631	1,306	200	129	0	410	0	0	0	574	0	46	0	173	166	0	1,461	0	1,767	0
4/10/2009	131	1,633	1,233	1,438	400	617	598	546	0	0	0	689	0	46	0	177	167	0	2	0	804	0
4/11/2009	127	1,834	1,234	1,500	600	1,077	1,093	1,018	0	0	578	1,093	578	47	0	180	156	0	2	0	437	0
4/12/2009	129	1,861	1,361	1,496	500	1,246	1,221	1,272	0	0	1,036	1,466	1,036	52	0	184	151	0	2	0	455	0
4/13/2009	120	1,933	1,533	1,512	400	1,500	1,357	1,382	488	0	1,155	1,993	1,155	54	0	187	149	0	481	0	662	0
4/14/2009	112	1,774	1,474	1,568	300	1,587	1,528	1,498	1,387	550	1,398	1,878	920	387	478	198	142	0	1,504	0	1,723	0
4/15/2009	121	1,606	1,406	1,504	200	1,536	1,469	1,623	1,397	550	2,060	1,472	292	1,784	1,768	996	148	237	1,683	0	2,049	0
4/16/2009	136	100	0	1,411	100	1,295	1,304	1,672	1,396	550	2,008	1,485	180	1,845	1,828	1,866	1,012	1,010	538	0	1,071	228
4/17/2009	160	0	0	1,314	0	518	0	1,233	1,398	550	1,830	1,473	0	1,911	1,830	2,178	1,916	1,756	1,350	1,368	1,849	1,856
4/18/2009	186	0	0	1,231	0	460	0	896	1,015	419	456	2,177	0	1,131	456	1,585	2,411	1,779	1,999	2,025	3,241	3,239
4/19/2009	183	0	0	1,106	0	371	0	891	891	0	0	2,238	0	487	0	498	1,841	453	1,999	613	3,507	1,783
4/20/2009	189	0	0	971	0	275	0	700	690	0	0	1,773	0	253	0	347	968	0	1,911	0	3,340	449
4/21/2009	173	0	0	832	0	227	0	581	683	0	0	1,695	0	189	0	265	572	0	1,632	0	2,576	0
4/22/2009	157	0	0	746	0	202	0	535	672	0	0	1,470	0	130	0	230	501	0	2	0	1,061	0
4/23/2009	167	0	0	758	0	188	0	518	823	0	0	1,577	0	98	0	203	397	0	251	0	738	0
4/24/2009	156	0	0	767	0	164	0	487	828	0	0	1,539	0	74	0	184	328	0	1,215	0	1,372	0
4/25/2009	133	0	0	746	0	149	0	445	829	0	0	1,523	0	59	0	167	284	0	1,695	0	2,030	0
4/26/2009	126	0	0	701	0	149	0	430	833	0	0	1,545	0	59	0	169	215	0	1,627	0	2,023	0
4/27/2009	125	0	0	631	0	139	0	414	834	0	0	1,519	0	52	0	163	126	0	293	0	879	0
TOTAL (AF)	6,011	22,953	17,598	45,939	5,355	23,837	16,998	34,340	28,091	5,195	20,868	60,038	8,253	17,448	12,615	20,354	23,755	10,384	41,361	7,946	66,041	14,985

[1] NDNR accounts for all EA water in NPPD's system and in the river as if it were in the river at Sutherland. The portion of this EA water that was in the river at Sutherland was estimated.

ATTACHMENT C: EVENT FLOWS AND TRAVEL TIME DIAGRAM



Notes:

--“Total Flow Vol.” is total volume from 04/07/2009 00:00 through 04/28/2009 00:00.

--Lake McConaughy volumes given for March 31, 2009.

--Travel time calculated at peak flow from NPR@Keystone.

--Nebraska DNR tracks EA water in Sutherland Canal as if it were all in the North Platte River. The total EA reported at NPR@Sutherland by NDNR was adjusted for this diagram by decreasing it by the percentage of EA water that was diverted into NPPD’s system. This volume was then assigned to the North Platte Hydro.

Canal
River
Gage Station
Diversion
Reservoir
Hydropower Plant

N

Approximately to Scale:
1/16" ~ 1 mi

PLATTE RIVER
RECOVERY IMPLEMENTATION PROGRAM

0.0 mi. 15.0 mi. 25.0 mi. 50.0 mi.

Drawn by: JDB
Date: 10/30/09

Attachment D: 2009 Flow Routing Test Press Release

OFFICE OF THE EXECUTIVE DIRECTOR
PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM

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Press Release

Contact: Bridget Barron
Phone: (308) 237-5728

FOR IMMEDIATE RELEASE
April 2, 2009

2009 FLOW ROUTING TEST

KEARNEY, NE, APRIL 2, 2009: The U.S. Fish and Wildlife Service (USFWS) in coordination with the Platte River Recovery Implementation Program (PRRIP), plans to implement a "Flow Routing Test" using water releases from the Environmental Account (EA) stored at Lake McConaughy beginning April 9, 2009. The PRRIP is a cooperative basin-wide effort to assist in the recovery of threatened and endangered species in the Central and Lower Platte River. The EA is water dedicated to instream flow purposes, including benefit to the threatened and endangered species that the PRRIP focuses on.

The goal of this test is to implement the essential "first step" the PRRIP agreed upon to prepare for periodic "pulse flow" water releases in future years. The flow routing test is designed to provide information on flow travel-time and attenuation (diminished peak as water moves downstream) and coordination between the partners for the future pulse flows. The PRRIP will evaluate over the next several years the effectiveness of pulse flows in helping to create and maintain habitat for endangered and threatened species (whooping crane, piping plover, and least tern) in the Central Platte River. The pulse flows are intended to mimic the historic river rises that resulted from spring runoff that helped to remove vegetation from the Platte River

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and kept the river wide and shallow with bare stretches of sand. This provided a safe place for cranes and other birds to rest at night, allowing the birds to keep predators in sight, and provided sandbars for nesting terns and plovers. However, those conditions changed with water diversions and other changes in land use throughout the Platte River Basin.

The USFWS EA Manager (Greg Wingfield), PRRIP Executive Director (Jerry Kenny), Central Nebraska Public Power and Irrigation District (CNPPID) and Nebraska Public Power District (NPPD) staff will coordinate closely and be prepared to scale back or terminate releases if required. Weather conditions can change rapidly, so the partners will monitor weather and runoff conditions in order to minimize the risk of exceeding flooding stage. Although there are uncertainties in how releases will travel down the river, the following summarizes current expectations.

- EA releases will be made from McConaughy during the period of April 9 through April 16 (7 days).
- EA water traveling down the North Platte channel will be "ramped up" at 600 cfs/day for the first two days (i.e., 600cfs on Day 1 and 1200 cfs on Day 2) then more gradually for the next five days as the safe-conveyance capacity of the channel at North Platte is approached.
- This pattern is expected to result in flows in the North Platte River at North Platte that rise over a 3-4 day period to a peak of approximately 1,500 cfs for 3 days from about April 15 through April 17.
- The anticipated flow in the North Platte River at North Platte should remain under the designated flood stage of 6.0'.
- Releases from NPPD's system at North Platte will be timed to coincide with the 3-4 peak days of flow coming down the North Platte River but flows downstream of North Platte are expected to be significantly below flood stage in most locations.
- Of the total flow available at CNPPID's main supply canal diversion near North Platte during this 4-day period (April 14-17) an estimated 1,500-2,000 cfs will pass through the diversion dam and continue down the mainstem of the Platte River.
- As the 4 days of bypass flows approach Overton, CNPPID will time releases through the J-2 Hydro (3 to 4 days of 1,950 cfs capacity-level release) in an attempt to match peak flow coming down the Platte River.
- Flows at Overton and downstream will be significantly less than flows experienced in late May and early June 2008, which were the result of intense rainfall events. The river at Overton experienced around 10,000 cfs in May 2008, while flows during the test flow release are expected to be about 3,000cfs.

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- In the Overton to Grand Island reach of the river, the river level during the peak of the test flow release is expected to raise one foot or less above the level normally seen at this time of year
- We anticipate flows at Overton will return to near pre-release levels by April 20-22 and by April 22-24 at Grand Island.

The PRRIP has liability insurance in place in the event of any associated damages related to the flow routing test. The PRRIP is committed to restoration of the habitat for the endangered species in the Central Platte River, while at the same time protecting human health and safety and preventing damage to associated land along the river.

Contacts for more information:

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Attachment E: Flow Routing Test Congressional Briefing

Congressional Briefing Note April 2, 2009

From: U.S. Fish and Wildlife Service and the Platte River Recovery Implementation Program

Subject: 2009 Flow Routing Test in the Central Platte River

Topic: U.S. Fish and Wildlife Service (USFWS) in coordination with the Platte River Recovery Implementation Program (PRRIP or Program), plans to implement a "Flow Routing Test" using water releases from the Environmental Account (EA) stored at Lake McConaughy beginning April 9, 2009.

Background: On July 1, 1997, the governors of Nebraska, Colorado and Wyoming and the Secretary of the Interior entered into a Cooperative Agreement to address the needs of four threatened or endangered species using the Platte River Basin. The named species were the endangered whooping crane, least tern, pallid sturgeon and the threatened piping plover. The agreement proposed a framework for a long-term Recovery Implementation Program to aid these species. Negotiations regarding the details of that program took place from 1997 to 2006. In late 2006, the governors of Nebraska, Colorado, Wyoming, and the Secretary of the Interior signed the final program agreement, effective January 1, 2007. On May 8, 2008, the President signed into law legislation to implement the federal share of the PRRIP as part of the Consolidated Natural Resources Act of 2008. This authorized the federal funding for the Program. The PRRIP is intended to address the Endangered Species Act concerns including loss of habitat in Central Nebraska by managing key land and water resources in the central Platte region and in the process avoiding harm to the lower Platte River stretch.

Flow Routing Test: The goal of this test is to implement the essential "first step" the PRRIP agreed upon to prepare for periodic "pulse flow" water releases in future years. Pulse flows are intended to mimic the historic river rises that resulted from spring runoff that helped to remove vegetation from the Platte River and kept the river wide and shallow with bare stretches of sand. This provided a safe place for cranes and other birds to rest at night, allowing the birds to keep predators in sight. However, those conditions changed with water diversions and other changes in land use throughout the Platte River. The flow routing test is designed to provide information on flow travel-time and attenuation (diminished peak as water moves downstream) and develop coordination between the partners to enable future pulse flows. Over the next several years, the PRRIP will evaluate the effectiveness of pulse flows in helping to create and maintain habitat for the target species.

Key Considerations: There are several aspects of the flow routing test that differ from routine Lake McConaughy releases and Central Nebraska Public Power and Irrigation District (CNPPID) and Nebraska Public Power District (NPPD) operations in recent years. In addition, the invasion of phragmites (non-native vegetation) in the river has changed some North Platte and Platte River characteristics, causing uncertainties in both the magnitude/attenuation of flow and travel times down the river. Although there are uncertainties in how releases will travel down the river, USFWS and the PRRIP have taken precautions to avoid exceeding flood

stage at locations between Lake McConaughy and Grand Island, Nebraska. The following summarizes current expectations.

- EA releases will be made from Lake McConaughy during the period of April 9 through April 16 (7 days).
- Peak flows of approximately 1,500 cfs are anticipated for 3 days in the North Platte River at North Platte from about April 15 through April 17
- An estimated 1,500-2,000 cfs will pass through CNPPID's diversion dam near North Platte and continue down the mainstem of the Platte River
- Flows at Overton and downstream will be significantly less than the 10,000 cfs flows that resulted from an intense rainfall event experienced in late May and early June 2008. The test release flows are expected to be about 3,000cfs.
- In the Overton to Grand Island reach of the river, the river level during the peak of the test flow release is expected to raise one foot or less above the level normally seen at this time of year.
- We anticipate flows at Overton will return to near pre-release levels by April 20-22 and by April 22-24 at Grand Island.
- NPPD and CNPPID will coordinate operation of their systems, including timing releases from the North Platte and J-2 hydropower plants to assist in achieving peak flows.

Conclusions: The objectives of the flow routing test include assessment of several factors that are key to preparation for spring pulse flow releases in future years. The USFWS and PRRIP will utilize stage and discharge data collection, information after the event from existing gauging stations and photo documentation of select areas along the river to prepare a report following the flow routing test. The results from this report will be used in the planning of future pulse flows.

The PRRIP has liability insurance in place in the event of any associated damages related to the flow routing test. The USFWS and the PRRIP are committed to restoration of the habitat for the endangered species in the Central Platte River, while at the same time protecting human health and safety and preventing damage to associated land along the river.

Contacts for more information:

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Attachment F
Flow Routing Test Photos
During the Event at Key Locations and Before and During Event Comparisons

Photo 1. "Intentional bypass" of EA water immediately below CNPPID's Supply Canal headgates, looking east/downriver, 5:30 p.m. on April 14 (estimated bypass at this time was around 1500 cfs).

Photo 2. "Intentional bypass" of EA water immediately below CNPPID's Suppy Canalheadgates, looking north across the river, 5:30 p.m. on April 14 (estimated bypass at this time was around 1,500 cfs).

Photo 3. South bank of North Platte River below Highway 83 bridge, Cody Park riverfront, at 12 noon on April 15, 2009. The corresponding North Platte River gage height was 6.03 feet.

Photo 4. Boat ramp area at Cody Park, @ 12 noon on April 15, 2009. The corresponding recorded North Platte River gage height was 6.03 feet.

Photo 5. North Platte River side/drainage channel recently cleared on north side of main Platte River channel (Dishman property) about 1 mile upstream of Highway 83 Bridge. This had been a problematic area for private-property flooding in the past. Photo looking southeast, taken @ 11:30 a.m. on April 14, 2009. The gage height in the North Platte River at North Platte at this time was 5.98 feet.

Photo 6. "Sand dam" (dike) between 30-Mile Canal and Gothenburg Canal headgates. Photo taken at 5:00 p.m. April 15, 2009. Estimated Platte River flow of 1,600 cfs. Looking north along dam, 30-Mile Canal headgate behind photographer, and Gothenburg Canal headgate at distance ahead.

Photo 7. *Phragmites*-infested channel immediately north of Gothenburg KOA Campground. Photo taken @ 10:30 a.m. on April 16, 2009. Estimated freeboard of at least 1.75 feet at this location before flow in this channel would begin spilling over into 'upland' campground area.

Photo 8. Overton Sand and Gravel Co. berm which separates the pit from the Platte River channel taken from on top of the dike with the river towards the right (looking east). The six to eight foot vertical bank on the river side is where the river has been eroding and undercutting the berm over time. Additional erosion occurred during the flow routing test but the berm was not breached.

Photo comparison with and without flow routing test flow presence.

North Platte River at the Keith-Lincoln Canal diversion, looking upstream on March 17, 2009 at 11:45 a.m. Flow estimated at 125 cfs.

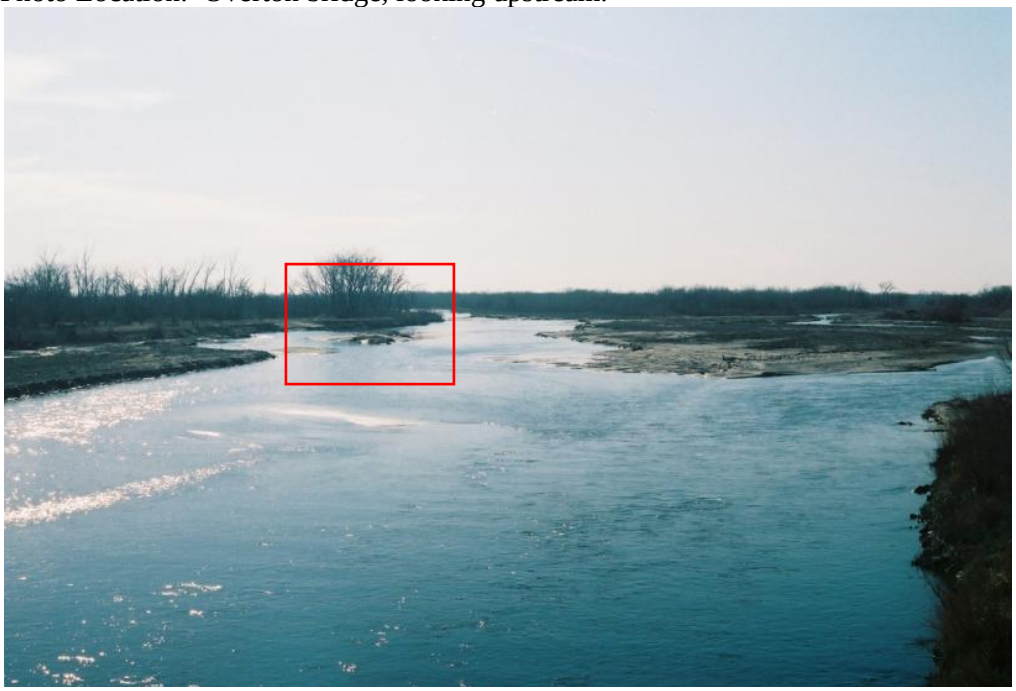
North Platte River at the Keith-Lincoln Canal diversion, looking upstream on April 10, 2009 at 10:45 a.m. Flow estimated at 1,200 - 1,250 cfs.

North Platte River at the Keith-Lincoln Canal diversion, looking north from south bank on March 17, 2009 at 11:45 a.m. Flow estimated at 125 cfs.

North Platte River at the Keith-Lincoln Canal diversion, looking north from south bank on April 10, 2009 at 11:45 a.m. Flow estimated at 1,200 – 1,250 cfs.

Photo comparison with and without flow routing test flow presence. Photos taken at Overton, Elm Creek, Odessa, Minden, Gibbon, and Shelton bridges. Red boxes indicate points of reference between photos.

Photo Location: Overton bridge, looking upstream.



Top: April 10, 2009. Approx. 500 cfs

Bottom: April 19, 2009. Approx. 3,600 cfs

Photo Location: Overton bridge, looking upstream.

Top: April 10, 2009. Approx. 500 cfs

Bottom: April 19, 2009. Approx. 3,600 cfs

Photo Location: Overton bridge, upstream side, looking south cross-channel.

Top: April 10, 2009. Approx. 500 cfs

Bottom: April 19, 2009. Approx. 3,600 cfs

Photo Location: Overton bridge, looking downstream.

Top: April 10, 2009. Approx. 500 cfs

Bottom: April 19, 2009. Approx. 3,600 cfs

Photo Location: Elm Creek bridge, looking upstream.

Top: April 10, 2009. Approx. 600-700 cfs

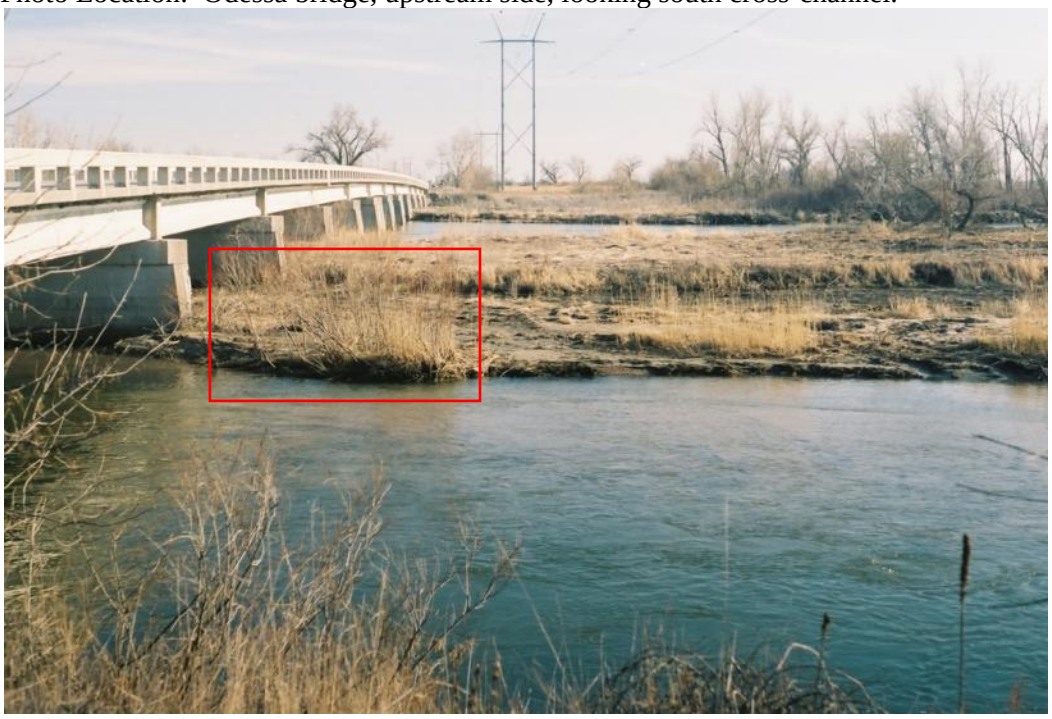
Bottom: April 19, 2009. Approx. 3,400-3,500 cfs

Photo Location: Elm Creek bridge, looking downstream.

Top: April 10, 2009. Approx. 600-700 cfs

Bottom: April 19, 2009. Approx. 3,400-3,500 cfs

Photo Location: Odessa bridge, upstream side, looking south cross-channel.



Top: April 10, 2009. Approx. 1,100 cfs

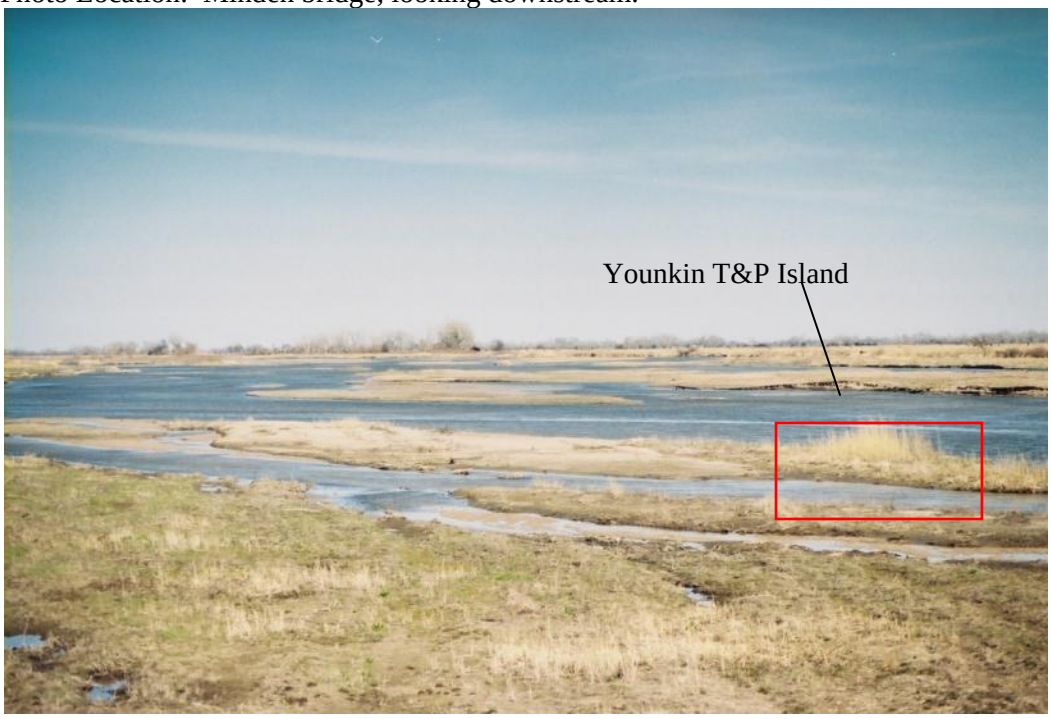
Bottom: April 20, 2009. Approx. 3,300 cfs

Photo Location: Minden bridge, downstream side, looking south cross-channel.

Top: April 14, 2009. Approx. 800-900 cfs

Bottom: April 20, 2009. Approx. 3,200 cfs

Photo Location: Minden bridge, looking downstream.



Top: April 14, 2009. Approx. 800-900 cfs

Bottom: April 20, 2009. Approx. 3,200 cfs

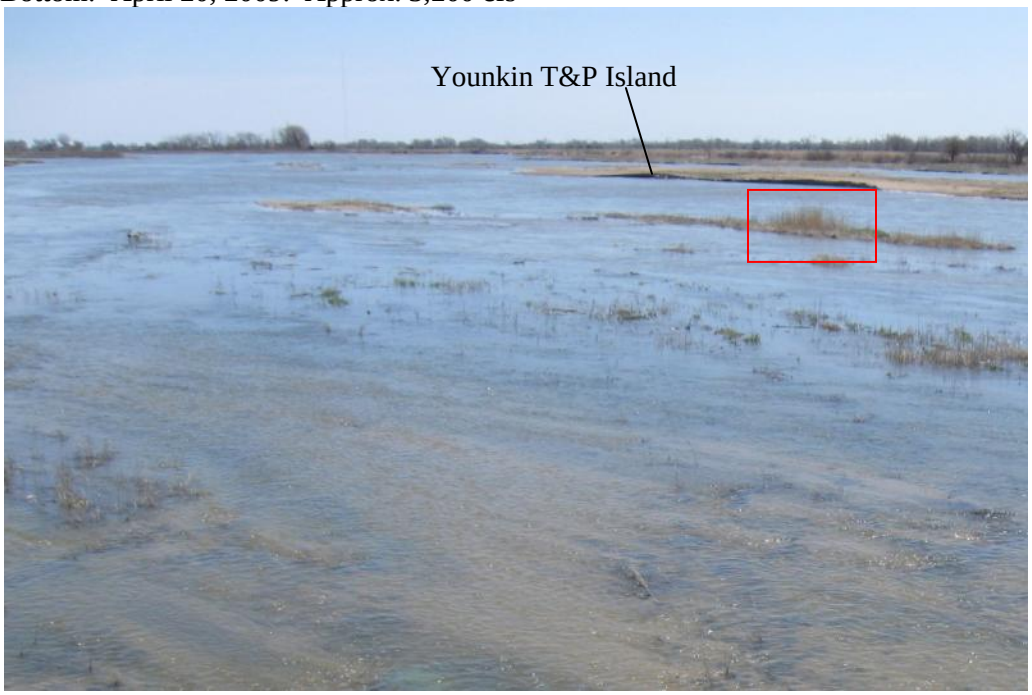
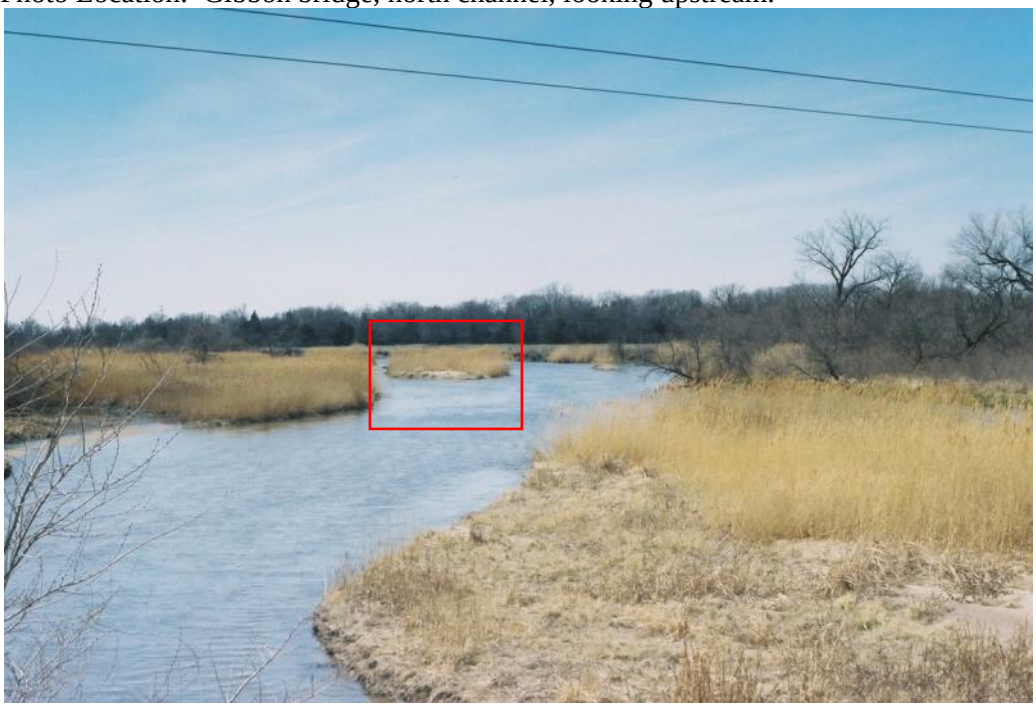


Photo Location: Gibbon bridge, north channel, upstream side, looking north cross-channel.

Top: April 14, 2009. Approx. 600-700 cfs (all channels)

Bottom: April 20, 2009. Approx. 3,100-3,200 cfs (all channels)

Photo Location: Gibbon bridge, north channel, looking upstream.



Top: April 14, 2009. Approx. 600-700 cfs (all channels)

Bottom: April 20, 2009. Approx. 3,100-3,200 cfs (all channels)

Photo Location: Gibbon bridge, main channel, downstream side, looking north cross-channel.

Top: April 14, 2009. Approx. 600-700 cfs (all channels)

Bottom: April 20, 2009. Approx. 3,100-3,200 cfs (all channels)

Photo Location: Gibbon bridge, main channel, looking downstream.

Top: April 14, 2009. Approx. 600-700 cfs (all channels)

Bottom: April 20, 2009. Approx. 3,100-3,200 cfs (all channels)

Photo Location: Shelton bridge, stream gage, note debris, note water relative to pipe elbow.

Top: April 14, 2009. Approx. 600-700 cfs (picture taken looking north from bridge)

Bottom: April 20, 2009. Approx. 3,100-3,200 cfs (picture taken from above)

Photo Location: Shelton bridge, looking upstream.

Top: April 14, 2009. Approx. 600-700 cfs

Bottom: April 20, 2009. Approx. 3,100-3,200 cfs

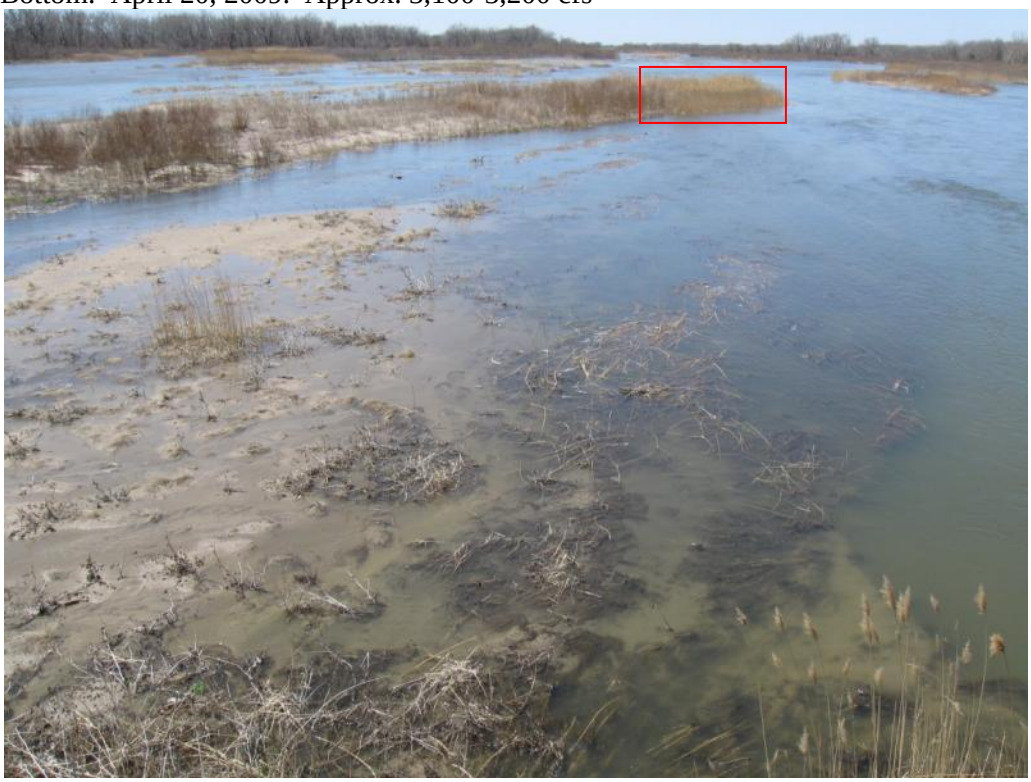


Photo Location: Shelton bridge, looking downstream.

Top: April 14, 2009. Approx. 600-700 cfs

Bottom: April 20, 2009. Approx. 3,100-3,200 cfs

Attachment G

NDNR Accounting of EA Water For the 2009 Flow Routing Event (Data presented are average daily EA flows in cubic feet per second)

	EA N Platte at Keystone	EA in Keystone Canal (NPPD's Diversion)	Total EA at Keystone		EA as if all in N Platte at Sutherland[1]		EA in CNPPID Suppy Canal (Tri-County Canal)	EA Platte at Maxwell		EA CNPPID Supply Canal (Tri-County Canal) 1 day down	EA Platte at Cozad		EA J-2 Return	EA Platte above J-2 Return	EA Platte at Overton		EA Platte at Kearney		EA Platte at Grand Island
8-Apr	0	0	0	**9-Apr**	0	**10-Apr**	0	0	**11-Apr**	0	0	**12-Apr**	0	0	0	**13-Apr**	0	**15-Apr**	0
9-Apr	631	200	831	10-Apr	787	11-Apr	578	0	12-Apr	569	0	13-Apr	0	0	0	14-Apr	0	16-Apr	0
10-Apr	1233	400	1633	11-Apr	1448	12-Apr	1036	0	13-Apr	1026	0	14-Apr	0	0	0	15-Apr	0	17-Apr	0
11-Apr	1234	600	1834	12-Apr	1815	13-Apr	1155	0	14-Apr	1145	0	15-Apr	0	0	0	16-Apr	0	18-Apr	0
12-Apr	1361	500	1861	13-Apr	1855	14-Apr	920	478	15-Apr	906	237	16-Apr	0	228	228	17-Apr	224	19-Apr	218
13-Apr	1533	400	1933	14-Apr	1927	15-Apr	292	1768	16-Apr	292	1010	17-Apr	1368	488	1856	18-Apr	1837	20-Apr	1801
14-Apr	1474	300	1774	15-Apr	1768	16-Apr	180	1828	17-Apr	180	1756	18-Apr	2025	1214	3239	19-Apr	2829	21-Apr	2784
15-Apr	1406	200	1606	16-Apr	1489	17-Apr	0	1830	18-Apr	0	1779	19-Apr	613	1170	1783	20-Apr	1569	22-Apr	1546
16-Apr	0	100	100	17-Apr	100	18-Apr	0	456	19-Apr	0	453	20-Apr	0	449	449	21-Apr	392	23-Apr	363
17-Apr	0	0	0	18-Apr	0	19-Apr		0	20-Apr	0	0	21-Apr	0	0	0	22-Apr	0	24-Apr	0
Total cfs	8872	2700	11572		11189		4161	6360		4118	5235		4006	3549	7555		6851		6712
Total AF	17598	5355	22953		22193		8253	12615		8168	10384		7946	7039	14985		13589		13313

[1] This includes EA water routed down the N Platte as well as through NPPD's system.

Attachment H

Estimated Percent Bypass Contributing to Overton Peak Flow (units are cfs unless otherwise noted)

	Overton	J-2 Outflow	J-2 Outflow minus 10% loss / attenuation to Overton[1]	Natural flow (gains) at Overton[2]	Net supplemental from mainstem Platte[3]	Average 24 hour flow at Maxwell (shifted 59 hours earlier)	Approx total days of bypass[4]	Percent of Maxwell flow contributing to Overton flow[5]
4/9/2009	1767	1461	1314					
4/10/2009	804	2	2			46		
4/11/2009	437	2	2			48		
4/12/2009	455	2	2	400		46		
4/13/2009	662	481	433	400		46		
4/14/2009	1723	1504	1353	400		49		
4/15/2009	2049	1683	1515	400		52		
4/16/2009	1071	538	484	400		55		
4/17/2009	1849	1350	1215	500	134	953	0.5	**14%**
4/18/2009	3241	1999	1799	500	942	1803	1.5	**52%**
4/19/2009	3507	1999	1799	500	1208	1872	2.5	**65%**
4/20/2009	3340	1911	1720	400	1220	1842	3.5	**66%**
4/21/2009	2576	1632	1468	400	707	760		**93%**
4/22/2009	1061	2	2	400	659	393		**168%**
4/23/2009	738	251	225	400	113	225		
4/24/2009	1372	1215	1094	400		166		
4/25/2009	2030	1695	1525	400		116		

[1] Assumed 10% loss/attenuation of J-2 returns to the Overton gage.

[2] Estimate of likely flows at Overton in the absence of recent J-2 returns or flow bypassing Central's Supply Canal headgages. Because 0.8 to 1.5 inches of precipitation was recorded at gauges in North Platte, Cozad, Gotherburg and Lexington on April 16, 17 and 18, an additional 100 cfs has been added to flows/gains for dates April 17, 18, and 19.

[3] *Overton* minus *J-2 Outflow minus 10% loss minus Natural flow at Overton* ; assumed contribution from flow bypassed at Central's headgates.

[4] Approximate total days of bypass. 4/17 is characterized as 1/2 day because the Maxwell gage *began* rising about 62 hours prior to 0:00 Apr 17, did not achieve its *maximum* rate of rise until about 51 hours prior, and did not begin to plateau until about 42-44 hours prior.

[5] *Net supplemental from mainstem Platte* divided by the *Average 24 hour flow at Maxwell*. Only dark values are considered meaningful as they correspond to a rising or sustained hydrograph at Overton; grey values include lagged flow returns during hydrograph fall.

Attachment I

High Plains Regional Climate Center Daily Precipitation Data (inches) for the Month of April 2009 by Station

Day of Month	JULESBURG	KINGSLEY DAM	NORTH PLATTE	PLATTE EXP FM	PLATTE RGNL AP	GOTHENBURG	COZAD	COZAD 2 S	LEXINGTON	KEARNEY 4 NE	KEARNEY MUNI AP	KEARNEY	SHELTON	GRAND ISLAND
1	0	0	0	0	0	0	0	***	0	0	0	0	0	0
2	0	0	0	0	0	0	0	***	0	0	0	0	0	0
3	0	0	0.1	0	0.01	0	0	***	0	0	0	0	0	0
4	0.25	0.06	0.22	0	0.46	0	0	***	0	0	0.53	0	0.23	0.17
5	0.19	0.48	***	0.26	0.01	***	***	***	***	0.3	***	***	***	0.16
6	0	0	***	0	0	***	***	***	***	0	0	***	***	0
7	0	0	***	0	0	***	***	***	***	0	0	***	***	0
8	0	0	0	0	0	***	***	***	***	0	0	***	***	0
9	***	0	0.27	0	0.42	0.26	0.31	***	0.2	0	0.23	0.3	0.03	0.47
10	0	0.39	0.01	0.27	0	0	0	0.16	0	0.56	0	0	0	0
11	0	***	0.01	0	0.01	0	0	***	0	0	0.02	0.01	0.01	Tr
12	0.03	***	0.15	0.06	0.13	0.1	0.07	***	0	0.2	0.16	0.16	0.07	0.09
13	0.24	***	0.04	0.16	0.02	0.04	0.01	***	0	0.16	0	0	0	0.02
14	0	0	0	0	0	0	0	***	0	0	0	0	0	0
15	0	0	0	0	Tr	0	0	***	0	Tr	0.01	0.01	0.02	0.04
16	0.52	0.08	0.38	Tr	0.17	0.08	0.21	***	0	0	0	0.01	0	0.01
17	0.72	***	0.78	0.46	0.71	0.58	0.25	***	0.34	0	0.03	0.04	0	Tr
18	0.92	1.16	0.29	1.08	0.34	0.43	0.43	0.84	0.45	0.45	0.45	0.42	0.16	0.29
19	0	0.32	0	0.01	0	0	0	***	0	0.02	0	0	0	Tr
20	0	***	0	0	0	0	0	***	0	0	0	0	0	0
21	0	0	0	0	0	0	0	***	0	0	0	0	0	0
22	0	0	0	0	0	0	0	***	0	0	0	0	0	0
23	0	0	0	0	0	0	0	***	0	0	0	0	0	0
24	0	0	0	0	0	0	0	***	0	0	0	0	0	0
25	0	***	0	0	0	0	0	***	0	0	0	0	0	Tr
26	Tr	0.19	0.18	0.24	0.3	0.08	0.25	0.24	0.1	0.03	0.03	0.05	0.04	0.1
27	0	***	0	0	0	0	0	***	0	0	0	0	0	0
28	0	0	0	0	Tr	0	0	***	0	0	0	0	0	Tr
29	0	0.01	0	0.04	0.01	0	0.03	***	0	0.22	0.29	0.27	0.15	1.12
30	0.21	0.95	0.26	0.18	0.25	0.51	0.42	0.24	0.89	0.45	0.49	0.46	0.37	0.09
Total	3.08	3.64	2.69	2.76	2.84	2.08	1.98	1.48	1.98	2.39	2.24	1.73	1.08	2.56
Normal[1]	1.63	1.87		1.93	1.97			***		2.43				2.61

Data Source: High Plains Regional Climate Center, University of Nebraska, Lincoln (http://www.hprcc.unl.edu)

*** = missing data

Tr = trace

[1] Normal = A 30-year average consisting of three consecutive decades. Currently the years 1961 through 1990 are used for calculating normals. Daily preciptation normals are computed by doing a spline-fit to the monthly normals.

Attachment J
Daily Versus Event-Based EA Bypass Accounting Example

Hypothetical example of forecast versus actual daily flows at CNPPID's Supply Canal headgate:

	Information available on day of bypass					Information available next day*			
	Forecast total flow (cfs)	Forecast EA portion of flow (cfs)	Forecast non-EA portion of flow (cfs)	Forecast EA available for bypass (cfs)*		Actual total flow (cfs)	Actual EA portion of flow (cfs)	Actual non-EA portion of flow (cfs)	Actual EA available for bypass (cfs)
	A	**B**	**C**	**D**		**E**	**F**	**G**	**H**
Day 1	2400	1700	700	1550		2400	1800	600	1650
Day 2	2500	2000	500	1750		2500	1800	700	1550
Day 3	2600	2100	500	1750		2600	2200	400	1850
Day 4	2400	1600	800	1450		2400	1500	900	1350

Columns D and H = CNPPID diversion capacity (2250 cfs) minus non-EA water (column C and G, respectively)
* For this example, actual total flow (Column E) matches the forecast, but the mix of EA (Column F) versus non-EA water (Column G) does not.

Scenario A: Simulated bypass decisions made on a *daily basis* during a four-day event (existing accounting method)

	Amount actually bypassed (cfs)	Bypassed EA in excess of (or short of) actual EA available for bypass (cfs)	Cumulative bypassed EA short of EA available for bypass	
			(cfs)	(AF)
	I	**J**	**K**	**L**
Day 1	1150	- 500	500	992
Day 2	1350	- 200	700	1388
Day 3	1350	- 500	1200	2380
Day 4	1050	- 300	1500	2975

Column I assumes conservative decision made to bypass 400 cfs less than the projected amount available for bypass, allowing a margin for error
Column J = Column I for same day minus Column H.
Columns K and L = Cumulative sum of Column J (signs reversed) in cfs and AF, respectively.

Scenario B: Simulated bypass decisions made on an *event-determined basis* for the same event (alternative accounting method)

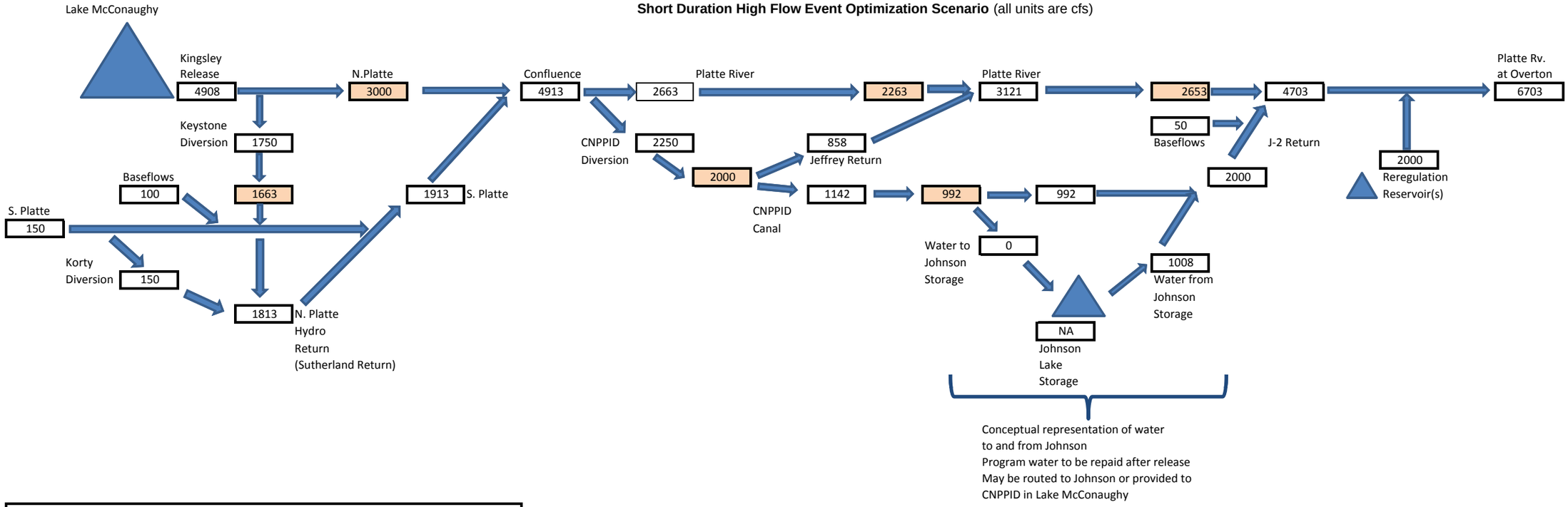
	Amount actually bypassed (cfs)	Bypassed EA in excess of (or short of) actual EA available for bypass	Cumulative bypassed EA short of EA available for bypass		**Added EA bypass compared to Scenario A**
			(cfs)	(AF)	
	M	**N**	**O**	**P**	**Q**
Day 1	1550	- 100 cfs	100	198	**+ 400 cfs**
Day 2	1750	200 cfs	-100	- 198	**+ 400 cfs**
Day 3	1750	- 100 cfs	0	0	**+ 400 cfs**
Day 4	1050	- 300 cfs	300	595	**0 cfs**

Column M assumes conservative decision made to bypass 400 cfs less than projected amount available for bypass only on the final day of event.
Column N = Column M for same day minus Column H.
Columns O and P = Cumulative sum of Column N (signs reversed) in cfs and AF, respectively.
Column Q = Column M minus Column I.

In the above example, approximately 2,380 acre-feet of available EA water was successfully bypassed under Scenario B that was not bypassed under Scenario A, yet CNPPID incurred no additional 'lost revenue' risk by bypassing this water.

Attachment K

Short Duration High Flow Event Optimization Scenario (all units are cfs)



NPPD & CNPPID Percent Loss per Reach	0.05		
Mainstem Percent Loss per Reach	0.15		
Loss to Jeffrey Reservoir	250	cfs	
Loss Jeffrey to Johnson	150	cfs	
N. Platte Choke Pt Capacity =	3000	cfs	
Kingsley Diversion Capacity =	1750	cfs	
S. Platte Flows =	150	cfs (typical)	
Sutherland Return Capacity =	1900	cfs	
CNPPID Diversion Capacity =	2250	cfs	
Jeffrey Return Capacity =	1250	cfs	
Johnson Release Max =	1008	cfs	(6,000 cfs/3 days)
J-2 Hydro Capacity =	2000	cfs	
Reregulation Res. Release =	2000	cfs	

No Phelps Canal diversions off of J-2 Return

= Loss Applied to get this flow