TO: CNPPID REREGULATING RESERVOIR WORKGROUP
FROM: ED OFFICE
SUBJECT: SCORE ANALYSIS FOR OLSSON'S OPTIONS 1 - 5 (FROM FEASIBILITY TASK 2.3)
DATE: JANUARY 11, 2012

I. SCORING BACKGROUND

In 2010, the ED Office worked with a Governance Committee (GC) Scoring Sub-Committee to investigate an appropriate methodology to score the J2 Reregulating Reservoir project toward the Program Water Plan First Increment Milestone of reducing shortages to U.S. Fish and Wildlife Service (FWS) target flows by 130,000 AF to 150,000 AF per year. The ED Office completed a J2 Reregulating Reservoir Scoring Case Study[1] to evaluate various scoring approaches and assumptions. The Case Study compared potential project "scores" for different OpStudy hydrology datasets, excess and shortage flow calculations, and target flow appendices from the Program Document using a daily continuous spreadsheet model developed by the ED Office. Based on the results, the Scoring Sub-Committee recommended a standard scoring approach for the J2 Reregulating Reservoir. The recommended assumptions and methodology were provided in a memo[2] to the GC and the GC approved the recommendations at the June 8, 2010 GC meeting[3]. The GC concluded the approved methodology should be used to score the final reservoir design, providing the design and operations remain consistent with the approved assumptions.

The Scoring Sub-Committee recommended an initial score for the J2 Reregulating Reservoir of 40,000 acre-feet (AF) based on the J-2 Reregulating Reservoir Scoring Case Study, which the GC also approved at the June 8, 2010 meeting. The Case Study showed a score range of 35,836 AF to 42,480 AF, which included model runs calculating excesses at Overton instead of Grand Island (the standard scoring approach uses Grand Island). The J2 Reregulating Reservoir score of 40,000 AF was based on the Case Study scenarios summarized in **Appendix A Scenarios A-K**.

As a follow-up to the Case Study and in support of Task 2.1 of the 1st Amendment to Olsson's base contract, the ED Office completed an Initial Sensitivity Analysis[4] to evaluate the score sensitivity to various reservoir design capacity and Phelps County Canal capacity combinations, as shown in **Appendix A Scenarios L-U**[5]. In general, the score is much more sensitive to the reservoir size than the Phelps County Canal capacity. In addition, a scoring analysis was completed using historical data from 1996-2008 instead of OpStudy hydrology from 1947-1994. This analysis showed using historical hydrology from 1996-2008 decreases the score. After the results were presented to the CNPPID Reregulating Reservoir Workgroup, the Workgroup requested follow-up scoring analyses to compare the daily scoring analysis to two methods of hourly scoring analyses. This was completed to evaluate whether daily average flows overestimate the project score because hourly peak flows can be greater than the Phelps County Canal capacity (as opposed to using an average that flattens the hydrograph). The analyses showed daily calculations may or may not over-estimate the score by up to 10% depending on the hourly

[1] "Water Action Plan Project Scoring Case Study: CNPPID Reregulating Reservoir" dated April 22, 2010 by the ED Office.
[2] Memo from Water Action Plan Scoring Sub-Committee to Governance Committee regarding "CNPPID Reregulating Reservoir Scoring Recommendation" dated May 12, 2010.
[3] See June 2010 GC Meeting Minutes.
[4] "CNPPID Reregulating Reservoir Feasibility Initial Program Yield Sensitivity Analysis" by the ED Office dated July 29, 2010.
[5] Presented at the CNPPID Reregulating Reservoir Workgroup Meeting August 10, 2010 (see Meeting Notes dated August 19, 2010).

methodology used; the hourly methodology that is similar to the methodology used by Olsson estimates a score comparable to the daily analysis. These results were presented in a memo from the ED Office to the Workgroup[6] dated September 17, 2010.

The current phase of the J2 Reregulating Reservoir Feasibility study considers combined reservoir operations for target flow operations[7], CNPPID hydrocycling mitigation, and CNPPID irrigation delivery regulation; however, the previous scoring methodology approved by the GC was based solely on target flow operations. The ED Office received input from the CNPPID Reregulating Reservoir Workgroup regarding the appropriate method to capture the impacts of combined reservoir operations in the scoring analysis, as this represents additional operations compared to the general approach previously approved by the GC. The following sections describe Olsson's target flow yield analyses and the ED Office scoring analyses of Options 1 – 5, including the assumptions to adjust scoring to reflect combined reservoir operations.

II. FEASIBILITY TASK 2.3

The J2 Reregulating Reservoir Feasibility Study is being conducted by Olsson per a scope of work described under the 1st and 2nd Amendments to their base contract. Under the previous Task 1.6 (2nd Amendment), Olsson investigated the impact to the target flow yield for a reservoir operational scenario conceptualized by CNPPID to use Area 2 to regulate irrigation deliveries, removing Area 2 from target flow use during the irrigation season from June 15th through August 31st. Olsson modeled the target flow yield for the J2 Reregulating Reservoir incorporating the combined reservoir uses of target flow releases, CNPPID hydrocycling mitigation, and CNPPID irrigation delivery regulation and concluded the reservoir can operate the combined uses without significant impacts to target flow yield; however, some reduction in yield occurs. Based on the results, CNPPID expressed interest in designing the reservoir for combined uses and the Workgroup recommended Olsson use these multi-operational design criteria moving forward into subsequent Feasibility Study tasks. The focus of this memorandum is on results provided by Olsson regarding Task 2.3 of the 1st Amendment, which was scoped to provide an "incremental storage versus construction cost evaluation to evaluate if the storage can be increased for a reasonable cost". The purpose of this task is to determine the optimal design configuration to be used moving forward for the remaining pre-design tasks.

Olsson provided the following design options for the J2 Reregulating Reservoir, referred to as Options 1 – 5, as part of Feasibility Task 2.3:

Option 1: Footprint matches Pre-Feasibility Study
Option 2: Dismissed option due to closure/re-routing CR 748
Option 3: Extended Area 1 West
Option 4: Optimization of Option 3; Extended Area 1 West & Reduced Earthwork
Option 5: Option 4 without Pumping; Extend Area 1 West, Reduced Earthwork & No Pumps

The ED Office ran scoring analyses for Options 1 – 5 using the previously recommended scoring methodology approved by the GC and updated the scoring analyses to reflect the combined reservoir operations. Olsson also evaluated the target flow yield of the options; however, the scoring analyses will be used to assign a score to the project.

[6] Memo from ED Office to CNPPID Reregulating Reservoir Workgroup regarding "Workgroup Meeting Follow-Up" dated September 17, 2010.
[7] Target flow operations are for the Program and the Nebraska DNR.

III. OLSSON YIELD MODELING ANALYSES

Olsson initially estimated a target flow yield for the J2 Reregulating Reservoir in the Pre-Feasibility Study[8] of 47,480 AF in a normal year for a reservoir capacity of 16,269 AF. It is important to note that this yield represents only one normal year, 1975, which was considered to be a representative normal year by Olsson in the Pre-Feasibility Study. Using the scoring model for the same scenario in 1975 (using OpStudy hydrology) produces a score of 49,454 AF, or approximately 4% more than Olsson's yield.

In the subsequent Feasibility Task 1.4, Olsson developed a continuous hourly model incorporating the combined reservoir uses of target flow shortage reductions and hydrocycling mitigation. Olsson's modeling analyses used historical hydrology from April 1st through August 31st each year and synthetic hydrology developed by CNPPID in the non-irrigation season for the 1997 through 2008 modeled time period. [9] In this task, Olsson also refined the Pre-Feasibility Study reservoir design based on better topographic data developed using LiDAR data. The footprint of Area 2 was revised to eliminate flow and sediment from the Plum Creek drainage. This revision provided a new total storage volume for Areas 1 and 2 of approximately 13,637 AF (compared to 16,269 AF in the Pre-Feasibility Study).The results from Olsson's continuous hourly model were presented in the Combined Operations Report[10], which was the main deliverable for Task 1.4.

Olsson's continuous hourly model was based on the daily scoring analysis methodology developed by the ED Office; however, there are some key differences between Olsson' yield model and the scoring model. Olsson updated an ED Office base spreadsheet to reflect hourly calculations and incorporate additional modeling criteria such as hydrocycling mitigation and structure release rate limitations, which are not modeled in the ED Office daily scoring analysis. In Olsson's model, hydrocycling releases were mitigated on a 24-hour daily basis but were not mitigated on a day-to-day basis, meaning there can be spiked releases to the river at midnight in between days. CNPPID indicated they believe these spikes can be smoothed during actual hydrocyling mitigation operations. The scoring analysis does not capture hourly hydrocyling impacts to the river since the time step approved by the GC is daily. [11] In addition, Olsson's model incorporates a weir flow equation to account for outlet gate release limitations based on the reservoir storage level. In the Combined Operations Report, Olsson evaluated the sensitivity of the gate size on the target flow yield and concluded the target flow yield is not sensitive to the gate sizes. The ED Office does not adjust the score to reflect gate size limitations.

Appendix B is a summary of the Olsson yield modeling results from Pre-Feasibility and Feasibility tasks to-date. Based on Olsson's modeling in the Combined Operations Report, the addition of hydrocycling mitigation as a reservoir use decreased the target flow yield by approximately 1%, assuming hydocycling mitigation could be achieved in most situations (Scenario #5). The WAC requested Olsson also evaluate the impact to the target flow yield if 100% hydrocycling mitigation was achieved (Feasibility Task 1.5). Olsson manually updated the continuous hourly model to achieve 100% hydrocyling mitigation during times of low storage in the reservoir. The 100% mitigation scenario showed an additional 2% reduction in

[8] "CNPPID Reregulating Reservoir: Elwood and J-2 Alternatives Analysis Project Report" dated February 18, 2010 by Olsson. See Appendix C in Report.
[9] ED Office sensitivity analyses showed using historical hydrology from 1996-2008 decreases the score in comparison to using OpStudy hydrology.
[10] "CNPPID J-2 Reregulating Reservoir Task 1 of Feasibility Study: Investigation of Reservoir Combined Operations" dated June 24, 2011 by Olsson. See Table 3 in Report.
[11] ED Office sensitivity analyses showed daily calculations may or may not over-estimate the score by up to 10% depending on the hourly methodology used; the hourly methodology that is similar to the methodology used by Olsson estimates a score comparable to the daily analysis.

the target flow yield (Scenario #7). CNPPID expressed interest in evaluating the impact to the target flow yield if CNPPID uses Area 2 during the irrigation season to regulate irrigation deliveries, effectively removing Area 2 from target flow uses. Olsson evaluated the impact to the target flow yield if CNPPID uses Area 2 during the irrigation season, which is approximately from June 15th through August 31st (Feasibility Task 1.6). Olsson's model showed a 6% decrease in target flow yield due to CNPPID's irrigation season use of Area 2 (Scenario #8). Based on the results, CNPPID expressed interest in moving forward with a reservoir design that incorporates the combined operations of target flow releases, hydrocyling mitigation and irrigation delivery regulation. To compensate for the reduction in available storage for target flow uses during irrigation season, Olsson evaluated alternative reservoir designs to increase the storage in Area 1. Option 1 is the reservoir design from Task 1.6 and Olsson provided the ED Office with a total of three additional feasible reservoir design options, Options 3, 4 and 5. Option 2 was dismissed because it would require rerouting a county road.

Olsson modeled the yields for Options 1, 3, 4 and 5 using the same outlet gate sizes from the Combined Operations Report (Area 1 and Area 2 of 40 feet and 30 feet, respectively). As part of Feasibility Task 2, Black & Veatch refined the reservoir outlet gate designs and concluded the appropriate gate widths are 36 feet and 20 feet for Area 1 and Area 2, respectively, for each of the options. After reviewing Olsson's initial yield and cost results for Options 1 – 5 in Task 2.3, the ED Office, CNPPID and DNR recommended evaluating Options 4 and 5 closer, as these options provide the lowest life cycle costs. For Options 4 and 5 only, Olsson updated the yield models to reflect the actual gate sizes designed by Black & Veatch. Based on Olsson's yield modeling, Option 3 provides a 3% lower yield than Option 1 (Scenario #10), Option 4 provides a 1% greater yield (Scenario #11) and Option 5 provides a 2% lower yield (Scenario #12) than Option 1. Removal of the pumps in Option 5 (compared to Option 4), decreases the target flow yield by approximately 3% (Scenario # 11 versus #12). The score does not significantly decrease with removal of the pumps because the reservoir does not completely empty each year to reduce shortages; therefore, a larger reservoir volume does not significantly increase the yield.

IV. SCORING OPTIONS 1 - 5

The ED Office developed analyses to score Options 1 – 5 using a base spreadsheet[12] from previously accepted ED Office modeling. The model run in the Initial Sensitivity Analyses by the ED Office was updated to reflect changes in the Phelps County Canal capacity, reservoir storage capacity and removal of the Area 2 storage volume from June 15th through August 31st to reflect CNPPID's use of the reservoir for regulating irrigation delivery operations. The Phelps County Canal capacity was evaluated for 1,000 cubic feet per second (cfs) and 1,675 cfs and the beneficial storage capacities from each reservoir design in Options 1 – 5 were modeled. The analyses using a Phelps Canal Capacity of 1,000 cfs represent the scores if the canal remains at the current capacity and the analyses using a capacity of 1,675 cfs represent the scores if the canal is widened. In both scoring analyses, the water stored in Area 2 before the irrigation season was removed from use starting on June 15th through August 31st and added back into storage on September 1st for target flow use. Per the CNPPID Reregulating Reservoir Workgroup recommendation, the scoring analysis results do not include impacts from hydrocyling mitigation. Please refer to Section VI below for more information regarding the Workgroup recommendation and the impact of hydrocycling mitigation.

The ED Office model does not take into account outlet gate sizes and weir flow equations which govern the rate at which water can be released from the reservoir. The model assumes all the water in the reservoir can be released at the maximum rate when needed to reduce target flow shortages.

[12] From Initial Sensitivity Analysis (see footnote 4) Scenario B: J-2 no Elwood, Phelps 1,400 cfs, J-2 Reservoir 14,320 AF, OpStudy Hydrology.

Based on Olsson's sensitivity analysis in the Combined Operations Report, the target flow yield is not sensitive to the outlet gate sizes for Areas 1 and 2. Olsson has indicated the gate size flow limitations are also minimal on target flow yield. The main scoring components are listed in **Table 1**.

Table 1: Scoring Components

Component	Data
Hydrology	OpStudy Present Condition with Three State Projects (without pulse flows)
Analysis Period	1947-1994
Time Step	Daily
Excesses/Shortages	Grand Island
Target Flows	Appendix 5, Column 4
Phelps Canal Capacity	1,675 cfs (results also shown for 1,000 cfs)
Irrigation Season Operation	Area 2 removed from target flow use Jun 15 – Aug 31 (target flow water stored in Area 2 is carried over)

The scores for Options 1 – 5 are summarized in **Table 2** below and include the beneficial storage volumes for each design. An extended summary is in **Appendix C**.

Table 2. Storage and Score (with CNPPID uses) in Acre-Feet

Option No.	Area 1 Beneficial Storage	Area 2 Beneficial Storage*	Total Beneficial Storage	Score *(Phelps Cap = 1,675 cfs)*	Score *(Phelps Cap = 1,000 cfs)*
Option 1	8,604	5,033	**13, 637**	**39,588**	**38,972**
Option 2	-	-	**-**	**-**	**-**
Option 3	10,829	4,810	**15,639**	**43,382**	**42,556**
Option 4	10,473	4,810	**15,283**	**42,739**	**41,957**
Option 5	10,473	3,486	**13,959**	**40,800**	**40,104**

*Only available for Target Flow Operations from September 1st through June 14th each year.

Based on the scoring analysis, the removal of Area 2 during the irrigation season for CNPPID's use results in a 4% reduction in the target flow score for Option 1 (Olsson's yield modeling showed a 6% reduction). Olsson increased the beneficial storage of Area 1 in Options 3 and 4 to compensate for CNPPID's use of Area 2 during the irrigation season. The increase in capacities in Options 3 and 4 resulted in increased scores by 5% and 4%, respectively. The layout in Option 5 is similar to Option 4, except Option 5 does not include a pump station, which decreases the beneficial storage available. The ED Office calculated a 1% reduction in score for Option 5 (with CNPPID irrigation delivery regulation) in comparison to the Option 1 baseline, which does not include irrigation season regulation by CNPPID. Option 5 has the lowest 50-year lifecycle cost based on Olsson's analysis and the estimated score remains approximately 40,000 AF/year, the pre-feasibility accepted score by the GC.

V. SCORING FOR TARGET FLOW OPERATIONS ONLY

The previous yield and scoring analyses in Section III (Olsson Yield Modeling Analyses) and Section IV (Scoring Options 1-5) were completed assuming combined reservoir operations with CNPPID. There has been an inquiry regarding the overall impact to the project score when CNPPID uses are incorporated in the reservoir operations. To address this inquiry, the ED Office completed a scoring analysis assuming the reservoir was operated for target flow purposes only, without CNPPID's irrigation delivery regulation.

Through the process of optimizing the various reservoir designs in Options 1 - 5, Olsson determined Option 5 is the design with the lowest life cycle cost. Since this option has the lowest life cycle cost, the ED Office modeled the impact to the Option 5 score resulting from the addition of CNPPID uses to determine the general sensitivity of combined operations on target flow scoring. The ED Office modeled the Option 5 score assuming the reservoir was operated for target flow operations only, and then compared this to the score for Option 5 assuming CNPPID combined reservoir operations to estimate the impact of a combined project with CNPPID. These scores are not entirely comparable as Olsson evaluated the Option 5 reservoir design/cost based on design criteria for combined operations, which may be different than the design criteria for Program/NDNR purposes only.

The ED Office ran scoring analyses for Option 5 with and without CNPPID's irrigation delivery regulation for both of the Phelps Canal capacity scenarios of 1,000 cfs and 1,675 cfs. The scoring analyses showed the addition of CNPPID's operations results in approximately a 2% to 3% total reduction in the target flow score, depending on the canal capacity. Most likely, the Program/NDNR would not upgrade the Phelps Canal capacity to 1,675 cfs if operating the reservoir for target flow operations and SDHF only; therefore, the Phelps Canal capacity would remain 1,000 cfs. On the contrary, Olsson's feasibility-level modeling analyses indicate hydrocycling mitigation is most successfully accomplished using an increased Phelps County Canal capacity of 1,675 cfs (compared to the current canal operating capacity of around 1,000 cfs). It is assumed CNPPID would require an increased Phelps Canal capacity to successfully operate hydrocycling mitigation. Assuming the reservoir was constructed for target flow purposes only and the Phelps Canal capacity remained 1,000 cfs, the score would be approximately 41,052 AF, which is in the ballpark of the accepted score of 40,000 AF. Comparing this score to the score incorporating CNPPID's combined uses and an increased Phelps Canal capacity of 1,675 cfs, the addition of CNPPID's uses results in a 1% reduction to the above score, or a score of 40,800 AF. **Appendix D** is a summary of the results.

VI. WORKGROUP DESIGN RECOMMENDATION TO GC

The CNPPID Reregulating Reservoir Workgroup of the Water Advisory Committee held a conference call on December 13, 2011[13] to discuss the design recommendation GC in the Three-Party Agreement with CNPPID, NDNR and the Program. The purpose of the call was for the Workgroup to provide an opinion to the GC on the recommended reservoir design to move forward into the final design phase. During the call, the ED Office also requested the Workgroup's input on how to address CNPPID's uses of the reservoir in the scoring analysis.

As discussed in previous sections, Olsson developed five reservoir design alternatives using two Phelps County Canal capacity alternatives (existing capacity and upgrade to 1,675 cfs). Of the five alternatives, Option 4 and Option 5 were identified as the optimal alternatives with the lowest probable capital costs and 50-year life cycle costs. Olsson completed additional modeling for these alternatives and the Workgroup recommended a final design based on review of this information. The Workgroup recommended moving into the final design of the CNPPID Reregulating Reservoir using the design alternative referred to as Option 5, with a reservoir capacity of 13,959 acre-feet and Phelps County Canal capacity upgrade to 1,675 cfs. Throughout the feasibility phase, the Workgroup reviewed several reservoir and canal sizing alternatives and recommend this alternative as it provides the lowest probable cost, the optimal combined reservoir operations, and Program/NDNR yield similar to the pre-feasibility study. The Phelps County Canal capacity improvements will aid CNPPID in hydrocyling mitigation while providing additional yield to the Program/NDNR, offsetting the impact CNPPID operations would otherwise have on the yield.

[13] See conference call minutes for more information regarding discussions during the call.

The ED Office requested the Workgroup's input regarding whether a reduction in score should be applied to capture the impact from hydrocycling mitigation, estimated to be up to 3% based on Olsson's hourly modeling yield results. CNPPID intends to use the J2 Reregulating Reservoir to mitigate hydrocycling impacts to the Platte River year-round to smooth the release pattern from the J2 Hydropower Plant in order to remove large fluctuations to the river, which are of concern to the FWS. CNPPID has indicated that it can likely eliminate this 3% modeling phenomenon in real time operations because they will be able to anticipate the amount of water in the system a couple of days in advance.

The Workgroup recognized mitigating the impact of hydrocyling on the Platte River is a benefit to the Program species and recommended the Program not be penalized for this reservoir use on the project score. Although the impact is relatively small for the purpose of this project and does not significantly decrease the project score, the Workgroup suggested the GC consider a "no penalty" concept as a policy precedent for the final project scoring. The Workgroup did not recommend reconvening the Scoring Sub-Committee of the GC to review the revised modeling assumptions, as the key assumptions remain the same as the GC approved methodology. The Workgroup recommended a score of 40,000 AF and up to 40,800 AF based on the ED Office preliminary scoring analysis, as shown in **Table 3** below. The Workgroup provided these recommendations to the GC in a memo[14] dated December 20, 2011 for use in the Three-Party Agreement negotiations meeting on December 29, 2011.

Table 3: Project Scores

Scenario	Score
Pre-feasibility project score approved by GC in 2010	40,000 AF
Preliminary feasibility project score for combined operations	40,000 AF
Preliminary feasibility project score, no hydrocyling mitigation penalty (Workgroup recommendation)	**40,800 AF**

[14] Memo to GC from ED Office entitled "CNPPID Reregulating Reservoir Feasibility Level Design Information for Three-Party Agreement Terms".

APPENDIX A - J2 REREGULATING RESERVOIR FEASIBILITY STUDY
SCORE COMPARISONS COMPLETED BY THE ED OFFICE
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Scenario	Hydrology Type	Pulse/EA Hydrology	Excesses/Shortages Calcs	Target Flows	Time Period	Time step	Reservoir Capacity	Phelps Inlet Capacity	Hydro Mitig	Score*	Notes
A	OpStudy	With Pulse, With EA Flows	Grand Island/Grand Island	A-5 Col 4	1947-1994	Daily	14,320	1,000	no	42,181	
B		Without Pulse, With EA Flows								41,556	Recommended hydrology by Scoring Subcommittee
C		Without Pulse, Without EA Flows in J-2 Return but With EA flows at Grand Island								41,295	Recommended hydrology by Scoring Subcommittee (depends on project)
D		Without Pulse, Without EA Flows								38,670	
E		With Pulse, With EA Flows		A-5 Col 4						42,181	= Scenario 1, Recommended target flows by Scoring Subcomm
F				A-5 Weighed Monthly Col 8						37,976	
G				E Fixed Daily						42,046	
H			Grand Island/Grand Island	A-5 Col 4						42,181	= Scenario 1
I			Min (Grand Island, Overton)/Grand Island							35,836	
J			Overton/Grand Island							37,614	
K			Overton/Overton							42,480	
L		Without Pulse, With EA Flows	Grand Island/Grand Island				14,320	1,000		41,661	
M							14,320	1,400		42,369	
N							8,000	1,000		29,121	
O							8,000	1,400		29,499	
P							20,000	1,000		50,141	
Q							5,000	1,000		21,589	
R							25,000	1,000		56,284	
S	Historical	n/a			1947-2008		14,320	1,000		37,520	Compare to Scenario 12 w/Opstudy. '47-94 historical hydrol decreases score from same period w/Opstudy.
T	OPStudy	Without Pulse, With EA Flows			1947-1994		15,787	1,000		44,055	
U							15,787	1,400		44,934	
V	Historical	n/a			1996-2008	Hourly A	14,320	1,675		27,973	Method A evaluates hourly J-2 Return flows against daily GI excess flows (constant thru day).
W						Hourly B				30,933	Method B turns daily GI excess flows into daily total volumes (AF) and stores this volume in the res over the day. Similar to Olsson method.
X						Daily				30,964	

*Score is average for all years in time period and routed to Grand Island except for Scenario 11, which is scored at Overton.

Notes:

Scenarios A-D: Pulse/EA Flow Sensivity, Case Study Table 2. Removing pulse flows had approx. 1% decrease in score and removing both pulse and EA had a 7% decrease in score. Data without pulse flows but with EA flows at Grand Island recommended for future project scoring.

Scenarios E-G: Target Flow Sensivitiy, Case Study Table 3. There is 0.5% difference between A-5 Col 4 and E. There is a 10% difference in A-5 Col 4 and Col 8.

Scenarios H-K: Excess/Shortage Calc Sensitivity, Case Study Table 4. Using a combination of the two gages resulted in lower scores.

Scenarios L-U: Res/Phelps Capacity and Hydrol Sensitivity, Yield Sensitivity Analysis Attachment A Tables. Increasing Phelps capacity from 1000 to 1400 cfs has a 2% increase in score (14320 AF res). Scores are closely related to reservoir sizes with a generally linear increase with increasing capacity. Historical hydrology from 1947-2008 decreased the Opstudy score by 10%.

Scenarios V-X: Hourly Calc Sensitivity, EDO Memo RE: Workgroup Meeting Follow-Up. These scenarios also calculated for Phelps Capacity of 1000 and 1400 cfs (not included). Daily calculations may or may not over-estimate score by 0-10% (depends on method used for hourly calcs). The more recent dry periods (1995-2008 historical hydrology) decrease the score.

APPENDIX B - J2 REREGULATING RESERVOIR FEASIBILITY STUDY

TARGET FLOW YIELD COMPARISONS FOR VARIOUS OPERATING SCENARIOS

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Scenario	Hydrology	Operations Mode		Phelps Capacity (cfs)	Area 1 + 2 Storage Capacity (AF)	Normal Year		Model Period Average		Scenario Comparison	Documentation	Option
		Irrigation Season	Non-Irrigation Season			Target Flow Yield (AF)	Percent Reduction	Target Flow Yield (AF)	Percent Reduction *			
1	Representative historical Normal, Wet, and Dry year	Target Flow Ops Only	Target Flow Ops Only	1,000	16,269	47,480		-			Pre-Feasibility Study [1]	
2	1997-2008: historical Apr 1 - Aug 31; synthetic non-irrigation season	Target Flow Ops Only	Target Flow Ops Only	1,000	13,637	41,452		35,258		*[Baseline for Scenario 4]*	Feasibility Task 1.4 [2]	
3	1997-2008: historical Apr 1 - Aug 31; synthetic non-irrigation season	Target Flow Ops Only	Target Flow Ops Only	1,400	13,637	45,657		37,608		*[Baseline for Scenario 5]*	Feasibility Task 1.4 [2]	
4	1997-2008: historical Apr 1 - Aug 31; synthetic non-irrigation season	Target Flow Ops & Hydro Mitigation	Target Flow Ops & Hydro Mitigation	1,000	13,637	41,564	0%	34,838	1%	2 vs 4	Feasibility Task 1.4 [2]	
5	1997-2008: historical Apr 1 - Aug 31; synthetic non-irrigation season	Target Flow Ops & Hydro Mitigation	Target Flow Ops & Hydro Mitigation	1,400	13,637	45,272	1%	37,062	1%	3 vs 5	Feasibility Task 1.4 [2]	
6	1997-2008: historical Apr 1 - Aug 31; synthetic non-irrigation season	Target Flow Ops & Hydro Mitigation	Target Flow Ops & Hydro Mitigation	1,675	13,637	47,177		37,649		*[Baseline for Scenarios 7-12]*	Feasibility Task 1.5	
7	1997-2008: historical Apr 1 - Aug 31; synthetic non-irrigation season	Target Flow Ops & Hydro Mitigation	Target Flow Ops w/ 100% Hydro Mitigation	1,675	13,637	44,784	5%	36,899	2%	6 vs 7	Feasibility Task 1.5	
8	1997-2008: historical Apr 1 - Aug 31; synthetic non-irrigation season	Area 2 - CNPPID Use; Area 1 - Target Flow Ops & Hydro Mitigation	Target Flow Ops & Hydro Mitigation	1,675	13,637	46,648	1%	35,421	6%	6 vs 8	Feasibility Task 1.6	Op 1
9	1997-2008: synthetic irrigation and non-irrigation season	Area 2 - CNPPID Use; Area 1 - Target Flow Ops & Hydro Mitigation	Target Flow Ops & Hydro Mitigation	1,675	13,637	TBD	TBD	TBD	TBD	6 vs 9	TBD	
10	1997-2008: historical Apr 1 - Aug 31; synthetic non-irrigation season	Area 2 - CNPPID Use; Area 1 - Target Flow Ops & Hydro Mitigation	Target Flow Ops & Hydro Mitigation	1,675	15,640	49,499		38,665	-3%	6 vs 10	Feasibility Task 2.3	Op 3
11	1997-2008: historical Apr 1 - Aug 31; synthetic non-irrigation season	Area 2 - CNPPID Use; Area 1 - Target Flow Ops & Hydro Mitigation	Target Flow Ops & Hydro Mitigation	1,675	15,283	49,090		37,998	-1%	6 vs 11	Feasibility Task 2.3	Op 4
12	1997-2008: historical Apr 1 - Aug 31; synthetic non-irrigation season	Area 2 - CNPPID Use; Area 1 - Target Flow Ops & Hydro Mitigation	Target Flow Ops & Hydro Mitigation	1,675	13,959	47,620		36,761	2%	6 vs 12	Feasibility Task 2.3	Op 5

*Negative represents increase in yield.

Model Version Notes:

Pre-Feasibility Study model used for Scenario 1 with higher storage capacity and modeled for one representative normal year (1975); EDO Scoring Case Study resulted in preliminary program score of 40KAF using OpStudy hydrology.

Pre-Feasibility Study model was updated for Scenarios 2 and 3 to reflect lower storage capacity and continuous model simulation; hydro mitigation logic was added for Scenarios 4, 5, and 6.

Hydro mitigation logic was manually optimized for Scenario 7.

Area 2 was removed during the irrigation season of June 15-August 31 for Scenarios 8 through 12. If CNPPID uses Area 2 from April 1-August 31, the target flow yield reduction would be 11.8% comparing Scenario 8 to Scenario 6 (instead of 6%).

The gate sizes used in Olsson's model for Scenarios 11 and 12 are: Area 1 outlet gate width = 36 feet, Area 2 outlet gate width = 20 feet, which are the current gate designs. The gate sizes used in Olsson's model for Scenarios 2-10 are: Area 1 outlet gate witdth = 40 feet, Area 2 outlet gate width = 30 feet, which were based on the Combined Ops Report. Based on Olsson's Combined Ops Report, the yield is not sensitive to gate size.

[1] *"CNPPID Reregulating Reservoir: Elwood and J-2 Alternatives Analysis Project Report" dated February 18, 2010.*

[2] *"CNPPID J-2 Reregulating Reservoir Task 1 of Feasibility Study: Investigation of Reservoir Combined Operations" dated June 24, 2011.*

APPENDIX C - EDO SCORING SCENARIOS

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			Score (Phelps Improvements)			Score (No Phelps Improvements)		
Option	**Option Description**	**Beneficial Storage Capacity**	**Score - With Phelps Improvements**	**% Change from Baseline***	**Olsson Scenario Comparison in Table 2**	**Score - No Phelps Improvements**	**% Change from Baseline***	**Notes**
		Phelps Canal Capacity:	**1,675 cfs**			**1,000 cfs**		
Baseline	Footprint Matches Pre-Feasibility Study	13,637 AF	41,292	-	6	40,495	-	Baseline score using previous scoring analysis with updated storage and Phelps capacities. Includes 3% reduction in score due to hydrocycling.
Op 1		13,637 AF (no Area 2 during irrig season)	39,588	-4%	8	38,972	-4%	Removal of Area 2 during irrigation season.
Op 2	*Dismissed due to closure/re-routing CR 748*							
Op 3	Extend Area 1 West	15,639 AF (no Area 2 during irrig season)	43,382	5%	10	42,556	5%	Larger reservoir capacity to compensate for removal of Area 2 use during irrigation season.
Op 4	Extend Area 1 West, Less Earthwork	15,283 AF (no Area 2 during irrig season)	42,739	4%	11	41,957	4%	Similar layout to Option 3 but with changes in design to reduce earthwork.
Op 5	Extend Area 1 West, Less Earthwork, No Pumps	13,959 AF (no Area 2 during irrig season)	40,800	-1%	12	40,104	-1%	Same scenario as Option 4 but smaller reservoir capacity because pumps were removed.

*Negative represents decrease in score.

Scoring Notes:

Area 2 storage is removed during irrigation season from June 15-August 31. OPStudy hydrology '47-'94.

Hydrocycling impacts are not included in the score per the Workgroup's recommendation during a conference call on 12/13/2011.

Options 1 -5 are based on Olsson's designs in Feasibility Task 2.3.

Option Descriptions:

Option 1 (Pre-Feasibility Study)

Area 1 footprint matches conceptual study.
Assumes a clay liner protected with 12" of soil/vegetal cover
Entire bottom slopes towards outlet gates
Area 2 will require pumps

Option 3 (Extend Area 1 West)

Area 1 footprint extended west, up to the east bank of the un-named stream.
Assumes a clay liner protected with 12" of water
Entire bottom is flat so that it can be protected with a 12" deep dead pool
Results in fill in northeast corners of Areas 1 & 2, results in cut in southwest corners of Area 1 & 2
Results in a large amount of earthwork to level entire area
Area 2 will require pumps

Option 4 (Extend Area 1 West w/Less Earthwork)

Area 1 footprint extended west, up to the east bank of the un-named stream.
Assumes a clay liner protected with 12" of water
A portion of the bottom is flat so that it can be protected with a 12" deep dead pool
Fill in the bottom was limited to 12" thick for construction of a clay liner
The deal pool is deeper than 12" in the northeast corners of Area 1 & 2
The volume of dead pool is larger than Option 3
The higher ground in the southwest corner of Area 1 is not excavation
30% less earthwork than Option 3 but only 3% less storage
Area 2 will require pumps

Option 5 (Extend Area 1 West w/Less Earthwork and No Pumps)

Same design as Option 4 but without pumping and smaller Area 2 beneficial storage

APPENDIX D - EDO SCORING SCENARIOS FOR OPTION 5 WITH AND WITHOUT COMBINED OPS

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Option	Beneficial Storage Capacity	Score (Phelps Improvements)		Score (No Phelps Improvements)	
		Score - With Phelps Improvements	% Impact to Score by adding CNPPID Uses	Score - No Phelps Improvements	% Impact to Score by adding CNPPID Uses
	Phelps Canal Capacity:	**1,675 cfs**		**1,000 cfs**	
Option 5 without CNPPID Use [1]	13,959 AF	41,886	-	41,052	-
Option 5 with CNPPID Use [2]	13,959 AF (no Area 2 during irrig season)	40,800	-3%	40,104	-2%

*Negative represents decrease in score.

IMPACT TO SCORE FROM COMBINED OPERATIONS AFTER UPGRADING THE PHELPS CANAL FOR CNPPID USE

	Score	% Impact to Score by adding CNPPID Uses
Option 5 without CNPPID Use [1] using Phelps capacity at 1,000 cfs	41,052	-1%
Option 5 with CNPPID Use [2] using Phelps capacity at 1,675 cfs	40,800	

*Negative represents decrease in score.

Scoring Notes:

[1] This scenario is for target flow operations only.

[2] This scenario is for combined operations with CNPPID using the reservoir for irrigation delivery regulation. Area 2 storage is removed during irrigation season from June 15-August 31. Hydrocycling impacts are not included in the score per the Workgroup's recommendation during a conference call on 12/13/2011.

Options 5 is based on Olsson's design in Feasibility Task 2.3.

Scores using OpStudy hydrology '47-'94.