TO: SCORING SUBCOMMITTEE

FROM: EXECUTIVE DIRECTOR'S OFFICE

SUBJECT: PHELPS COUNTY CANAL GROUNDWATER RECHARGE RECOMMENDED SCORE AND SCORING ANALYSIS

DATE: NOVEMBER 27, 2013 (PRELIMINARY ANALYSIS MEMO DATED JULY 22, 2013)

I. EXECUTIVE SUMMARY

The Platte River Recovery Implementation Program (Program) ad-hoc Scoring Subcommittee was formed to advance Water Action Plan Project scoring towards the Program's First Increment milestone of reducing shortages to U.S. Fish and Wildlife Service target flows by 50,000 to 70,000 acre-feet per year (AFY). The Scoring Subcommittee recommended a general methodology for calculating project score during the J-2 Regulating Reservoir score discussions, which the Governance Committee (GC) accepted in 2010. The Phelps County Canal Groundwater Recharge (Phelps recharge) project is the second Water Action Plan project to be evaluated for a score. The Executive Director's Office (ED Office) of the Program has been providing technical assistance to the Scoring Subcommittee during the process. The Phelps recharge project has been successfully operating for two seasons (2011-2012 and 2012-2013) and is currently operating in season three (2013-2014).

The Phelps recharge score analyses utilized the general methodology accepted by the GC in 2010, with additional assumptions made for this specific project. The lagged accretions reaching the Platte River from the recharge project were estimated using a site-specific numerical groundwater model developed for the Program. A portion of the lagged accretions from the canal return to the river below the Overton, Nebraska streamflow gage due to the location of the canal and the movement of groundwater in the area. The Scoring Subcommittee agreed to apply a linear reduction in the score (or habitat adjustment) for the proportion of the reach from Overton to Grand Island that is not impacted by the accretions.

During the scoring process, various alternatives were considered for the Phelps County Canal Groundwater Recharge score. **The Scoring Subcommittee recommends a score for the Phelps recharge project of 1,800 AFY for the Program.** The recommended score includes an impact on the Phelps recharge project to account for combined operations with the J-2 Regulating Reservoir, as both projects utilize excess flows available in The Central Nebraska Public Power and Irrigation District's system. The 1,800 AFY score represents the Program's 50% of the project yield, as the Nebraska Department of Natural Resources may claim up to 50% of the project.

II. INTRODUCTION

The Platte River Recovery Implementation Program (Program) ad-hoc Scoring Subcommittee was originally formed in 2010 to advance discussions regarding scoring analyses for proposed Water Action Plan (WAP) projects, specifically for the J-2 Regulating Reservoir project at that

time. The Executive Director's Office (ED Office) worked with the Subcommittee to develop a J-2 Regulating Reservoir Scoring Case Study[1]. Based on the findings of the Case Study, the Subcommittee proposed a WAP scoring methodology to the Governance Committee (GC)[2], and the GC approved the recommended methodology in June 2010[3]. The methodology approved by the GC was intended for use in future scoring of WAP projects in order to maintain consistency. However, the Scoring Subcommittee and GC also recognized that additional assumptions and variations in the scoring methodology may need to be addressed for other WAP projects.

To the extent possible, the ED Office used the previously approved scoring methodology to complete scoring analyses for the Phelps County Canal Groundwater Recharge (Phelps recharge) project. The ED Office completed preliminary score analyses and provided the results to the Scoring Subcommittee in a memorandum dated 7/22/13. Subsequent analyses were completed to test the sensitivity of various recharge configuration alternatives. This final memorandum is an updated version of the preliminary 7/22/13 scoring memorandum and provides information on the subsequent analyses. The Scoring Subcommittee evaluated the various alternatives and agreed upon a recommended score for the Phelps recharge project of 1,800 acre-feet per year (AFY) for the Program. This score is based on the Program's 50% of the total Phelps recharge project yield and includes combined operations between the recharge project and the J-2 Regulating Reservoir. This memorandum provides information on the data and assumptions used in the final score recommendation analyses. Additional sensitivity analyses and information reviewed by the Scoring Subcommittee are also provided as appendices to this memorandum. These documents have been updated as requested by the Subcommittee, to provide certain clarifications discussed during Subcommittee conference calls.

III. PROJECT DESCRIPTION

The Reconnaissance-Level WAP[4] identified the Dawson County Canal and Gothenburg Canal as potential Nebraska Groundwater Recharge sites, with a projected combined yield of 2,600 AFY of accretions at the river (note that this is not the "score"[5]). Per the WAP, Nebraska Groundwater Recharge would divert surface water from the Platte River into canals during the non-irrigation season, which was assumed to operate from October through April. The water diverted into the canals would seep and percolate into the alluvium, which would recharge the groundwater aquifer and enhance flows in the Central Platte.

[1] "Water Action Plan Project Scoring Case Study: CNPPID Reregulating Reservoir" dated April 22, 2010 by the ED Office.
[2] Memo from Scoring Subcommittee to GC regarding "CNPPID Reregulating Reservoir Scoring Recommendation" dated May 12, 2010.
[3] See June 2010 GC meeting minutes.
[4] The Reconnaissance-Level WAP is in Attachment 5 (Water Plan) of the Final Platte River Recovery Implementation Program Document dated October 24, 2006.
[5] A project score is in reference to the Program's First Increment Objective of reducing shortages to USFWS target flows by an average of 130,000 to 150,000 AF per year (WAP projects are 50,000 to 70,000 AF of that total). Note that the WAP states Nebraska may claim a portion of the credit for Nebraska Groundwater Recharge, in which case, the credit toward the Program Objective would subsequently be adjusted to reflect a deduction for the score credited directly to Nebraska.

In 2010, the ED Office, Water Advisory Committee (WAC), Hahn Water Resources, LLC (Special Advisor) and Ann Bleed and Associates, Inc. (Special Advisor) prepared a Nebraska Groundwater Recharge Pre-Feasibility Study[6] to determine the most feasible recharge configurations for the Program based on project yield and cost. The Pre-Feasibility Study evaluated several canals as potential recharge locations in the Central Platte region, in addition to the Gothenburg and Dawson County Canal sites listed in the WAP. Based on the Pre-Feasibility Study findings, the Gothenburg, Dawson County and Phelps County Canals were identified as the most feasible groundwater recharge sites. The Gothenburg Canal South of the Golf Course site and the Phelps County Canal to Mile Post 9.7[7] site were recommended for additional analyses for the feasibility phase, as these recharge locations generally provided a combination of higher yields and lower unit costs. The WAC and GC supported advancing the groundwater recharge project into the feasibility phase with a focus on the Phelps County Canal for a pilot demonstration project. The Phelps County Canal is located within The Central Nebraska Public Power and Irrigation District's (CNPPID) system in Phelps and Gosper Counties, Nebraska. It was decided that other sites, such as the Gothenburg Canal, may be evaluated further at a later date but not as part of the pilot demonstration project.

A pilot-scale demonstration recharge project was completed during the 2011-2012 non-irrigation season as part of the Nebraska Groundwater Recharge Feasibility Study[8]. Excess flows[9] were recharged in the Phelps County Canal to Mile Post 9.7 as well as at a constructed recharge basin for a total of 99 days between late September 2011 and early January 2012. Mile Post 9.7 is a canal check location, which enables the canal to function similarly to a recharge basin by impounding water behind the check structure. The Final Report on the Nebraska Groundwater Recharge Feasibility Study, which was approved at the September 2012 GC meeting, recommended advancing the Phelps recharge project, but postponing recharge in constructed recharge basins indefinitely or until land is more affordable. The Phelps recharge project can be successful without a constructed basin as a significant amount of recharge occurs within the canal.

The data collected during the pilot-scale demonstration project was used to plan a second year of recharge operations in the Phelps County Canal during the 2012-2013 non-irrigation season. Given the favorable results of the 2011-2012 pilot-scale project, and the willingness of CNPPID, the 2012-2013 recharge operations were extended from Mile Post 9.7 to Mile Post 13.3. Mile Post 13.3 is another canal check location that allows the canal to act similarly to a recharge basin. The ED Office prepared a summary report[10] on the 2012-2013 recharge operations.

[6] "Platte River Recovery Implementation Program: Nebraska Ground Water Recharge Pre-Feasibility Study" dated August 2010 by the ED Office, WAC, Hahn Water Resources LLC and Ann Bleed and Associates Inc.
[7] 9.7 refers to the approximate distance in miles in the Phelps County Canal from the canal headgate to the site location.
[8] "Pilot-Scale Recharge Report for Nebraska Groundwater Recharge Feasibility Study, Platte River Recovery Implementation Program" dated July 2012 by EA Engineering, Science and Technology, Inc. and Daniel B. Stephens & Associates, Inc.
[9] Excess flows are considered unappropriated flows greater than the U.S. Fish and Wildlife Service target flows and the Central Platte NRD/Nebraska Game and Parks Commission instream flows.
[10] "Nebraska Groundwater Recharge: 2012-2013 Phelps County Canal Recharge Report" dated June 2013 by the ED Office.

Consistent with the WAP and Feasibility Study, the Phelps recharge project involves conducting recharge operations during the non-irrigation season using excess flows as a water supply[11]. During the irrigation season, CNPPID uses the Phelps County Canal to deliver irrigation water to customers and does not use the canal during winter months. CNPPID has indicated that intentional recharge operations in the Phelps County Canal will likely be from approximately mid-September through mid-April, which is slightly different from the operating period of October through April used in the WAP. Excess flows available in CNPPID's system[12] during the winter months would be diverted into the Phelps County Canal. The general assumptions, considerations and score results are described in further detail in the following sections of this memorandum.

IV. GENERAL METHODOLOGY

The ED Office completed scoring analyses for the Phelps recharge project terminating at Mile Post 13.3, as it is anticipated recharge operations will continue to Mile Post 13.3 in the future. A map of the system is provided in **Appendix A**. The Phelps recharge WAP project score will ultimately depend upon the Scoring Subcommittee's recommendations, GC approval, and U.S. Fish and Wildlife (USFWS)/Program policy decisions. Note that the accepted groundwater recharge scoring methodology may be carried forward into other WAP projects, such as Water Leasing or Water Management Incentives.

The ED Office completed part of the scoring analyses on a daily basis and part on a monthly basis. A daily analysis was completed to determine the volume of excess flows available to divert into the canal and recharge the aquifer (or the infiltration volume). The daily analysis is better able to capture the recharge operations, as it is difficult in a monthly analysis to capture the canal fills and subsequent recharge that occurs from canal storage during shortage months. The daily volume of infiltration was summed on a monthly basis and converted to acre-feet for subsequent analysis of the lagged groundwater returns to the river. The lagged returns to the river and the scoring analyses were then completed on a monthly time step. The monthly lagged accretions at the river were routed to Grand Island and credited to shortages using monthly hydrology data (not daily). The general scoring methodology and assumptions used for scoring of the Phelps recharge project are listed in **Table 1**.

[11] Environmental Account (EA) releases from Lake McConaughy may be available as a supplemental water supply; however, it was assumed that river accretions resulting from the recharge of EA water should not be counted as part of the recharge project's score. Note that EA water was diverted into the Phelps County Canal during the 2012-2013 recharge season as there were no excesses to target flows.

[12] Excess flow diversions for recharge in Phelps County Canal must be physically available at CNPPID's Johnson No. 2 (J-2) Return structure.

Table 1. Key Scoring Assumptions.

Component	Data
Hydrology	OpStudy Adjusted Present Condition with Three State Projects (without pulse flows). EA flows included at Grand Island, but not available for recharge.
Analysis Period	1947-1994
Recharge Volume Time Step	Daily (recharge operations)
Lagged Accretion Time Step	Monthly (reductions to shortages)
Excesses/Shortages Calculation	@ Grand Island
Target Flows	Appendix A-5, Column 4 or 8, depending on daily/monthly time step[13]
Routing	WMC Loss Model[14]
Accretion Modeling Method	Numerical Model[15]

V. ALTERNATIVES EVALUATED FOR EFFECT ON SCORE

The Scoring Subcommittee evaluated various alternatives in the Phelps recharge score analyses, resulting in a range of potential scores to consider. The alternatives represent project-specific assumptions that were not considered during the J-2 Regulating Reservoir, as the alternatives were not applicable to a reservoir project. A summary of the score model assumptions and alternatives are described in this section.

A. Canal Recharge Rate

The canal recharge rate is assumed to represent the amount of water that infiltrates into the aquifer underlying this area. For the purpose of scoring, a daily average recharge rate was used to develop the score for the recharge project to Mile Post 13.3. The average rate was based on measured data from the Feasibility Study pilot demonstration (2011-2012) project and the second year of recharge operations (2012-2013). The average was considered the average unit infiltration rate (cfs/mile) from both seasons multiplied by the miles of Phelps County Canal with recharge (13.3 miles). This assumes the canal has a uniform recharge rate, although CNPPID has suggested infiltration rates could be lower below Mile Post 9.7. The ED Office evaluated whether to use a varied recharge rate by location and throughout the season; however, there is not sufficient information to confidently distribute the recharge rate in this manner.

The 2011-2012 pilot-scale demonstration recharge project was conducted on the segment of the Phelps County Canal beginning at the J-2 Return (considered the headgate location in Appendix A) and extending to Mile Post 9.7. The project operated from approximately late September through early January. The recharge rates during the pilot-scale demonstration varied throughout

[13] Based on Column 4 or 8 of Appendix A-5 in Attachment 5 of the Program Document. For the daily canal diversion analysis, Column 4 (target flows in "cfs") values were used to estimate the total excess flow diversions into the canal. For the monthly scoring analysis, Column 8 (target flows in "average cfs") values were summed on a monthly basis and converted to acre-feet as a monthly target flow volume.
[14] WMC Loss Model is referenced in the Water Management Study (2008) by Boyle Engineering Corporation.
[15] MODFLOW model of the Phelps County Canal developed in conjunction with Hahn Water Resources, ED Office Special Advisor.

the season with higher recharge rates observed at the beginning of the test and lower rates towards the end of the test. During the second year of recharge operations in 2012-2013, the Program extended operations to Mile Post 13.3 and operated from mid-December through mid-March. The 2012-2013 recharge rates[16] were lower on a per mile basis relative to the 2011-2012 rates. This may be explained, in part, because the recharge operations spanned a period of colder water temperatures and the higher viscosity of water may have reduced the infiltration rate. Also, CNPPID has reported canal seepage rates are likely lower beyond Mile Post 9.7. Both CNPPID and Nebraska Public Power District (NPPD) have noted more canal seepage in 2011 on their systems as compared to other years. In summary, the 2011-2012 recharge season started in late September and concluded in early January, extended to Mile Post 9.7, and resulted in variable recharge rates during the season. The 2012-2013 recharge season started in mid-December and concluded in mid-March, extended to Mile Post 13.3, and resulted in a more consistent recharge rate that was lower than observed in the 2011-2012 season. A comparison of the recharge rates during the two years of recharge operations is shown in **Figure 1**.

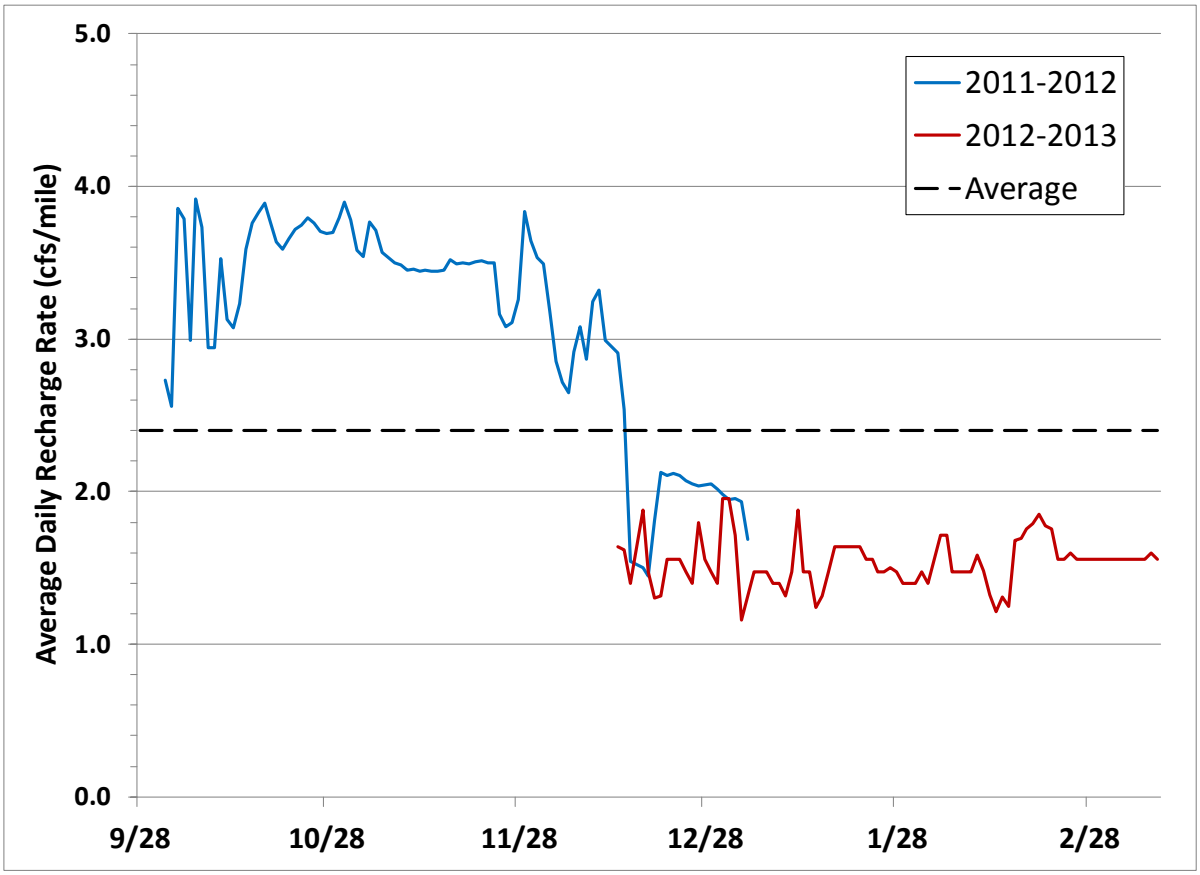

Figure 1. Comparison of Recharge Rates for Year 1 and Year 2 of Recharge.

The ED Office calculated a unit recharge rate based on measurements of water passing through the Mile Post 1.6 flume. After the initial fill of the canal in the beginning of the season, the daily

[16] 2012-2013 recharge rates were calculated by adjusting the diversions into the Phelps County Canal to account for evaporative losses and precipitation inputs based on the methodology that was used in the Feasibility Study.

recharge rate was assumed to be the diversion amount each day to keep the canal full. The ED Office distributed the diversion amount throughout the canal on a cfs/mile basis to determine a unit recharge rate. The unit recharge rate was then applied from the Phelps County Canal headgate to Mile Post 13.3 to determine the total recharge in the canal, including the projected recharge in the 1.6 miles from the headgate to the flume. Based on the daily recharge rates observed during the two seasons of recharge, the average rate was calculated as 2.4 cfs/mile, or an average rate of 32 cfs from the headgate to Mile Post 13.3 (2.4 cfs/mile × 13.3 miles).

The recharge season was assumed to be from September 15th through April 15th, based on CNPPID's operations (see **Appendix B** for additional information on the recharge season). Diversions into the canal could only occur during excesses; however, recharge into the aquifer could occur during excess and shortage days as long as water was available in the "canal storage pool" for recharge. The excesses available in the Phelps County Canal for diversion into recharge were calculated using the methodology from the J-2 Regulating Reservoir daily scoring analysis. It was assumed diversions into the canal were the minimum of the daily excesses or the maximum canal diversion rate. The maximum canal diversion rates used in the analyses were either 115 cfs or 300 cfs[17]. The 115 cfs rate was based on the diversion rates to fill the canal in the two years of recharge testing, as shown in **Table 2**. CNPPID had indicated that a higher diversion rate into the canal could likely occur each day; however, the 115 cfs was used to be conservative in the preliminary score analysis runs. After receiving data on the initial fall 2013 recharge deliveries, a 300 cfs rate was selected for additional analyses. The 300 cfs rate is less than the maximum diversion rate in 2013[18] and is the approximate average of the two-day canal fill occurring on 9/20/13 and 9/21/13. The 300 cfs maximum diversion rate is less than the rate listed on the permit application CNPPID submitted to the NDNR in 2012, which was 350 cfs (permit currently pending).

Table 2. Average Daily Canal Diversions during Recharge Operation Commencement.

Recharge Season	Date	Avg Daily Diversion (cfs)
Year 1 (2011-2012)	9/28/11	169.3
	9/29/11	136.1
	9/30/11	66.5
	10/1/11	57.2
Year 2 (2012-2013)	12/10/12	138.0
	12/11/12	119.0
	12/12/12	131.0
	12/13/12	103.0
Average:		115.0

*In Years 1 and 2 of recharge, the canal filled in approximately four days.

[17] Note that that the actual maximum canal capacity rate is 1,000 cfs; however, it was assumed excesses would be diverted at a lower rate during the non-irrigation season recharge operations.
[18] Maximum diversion rate during the fall 2013 initial fill was 485 cfs on 9/20/13.

The average recharge rate of 32 cfs was assumed to occur each day when sufficient water was available in the "canal storage pool". The canal was modeled like a reservoir (inputs – outputs)[19] with a canal storage pool ranging from 890 AF[20] to 1,160 AF. The 890 AF canal storage capacity represents the canal section from the approximate proposed inlet location for the J-2 Regulating Reservoir[21] to Mile Post 13.3 and the 1,160 AF capacity represents the entire canal section from the headgate to Mile Post 13.3. CNPPID calculated a canal storage of 1,160 AF from the headgate to Mile Post 13.3 based on the canal geometry. The ED Office proportionally reduced this volume by the section of the canal that will be used to deliver water to the J-2 Regulating Reservoir to estimate a storage capacity of 890 AF[22]. A storage pool of 1,000 AF[23] was used in the preliminary scoring analysis (memorandum to Scoring Subcommittee dated 7/22/13) based on the canal storage estimate provided in the Feasibility Study to Mile Post 9.7. The 1,000 AF is also consistent with the approximate canal fill volume in the beginning of the two years of recharge operations[24]. CNPPID was able to provide the updated canal storage volumes based on the geometry after the preliminary calculations. Score analyses were completed using canal storage volumes of 890 AF, 1,000 AF and 1,160 AF.

The total volume of water recharged in the Phelps County Canal calculated in the preliminary scoring analysis during the 48-year simulation period ranged from 9,244 to 9,617 AFY, based on the range of diversion rates and canal storage volumes shown in **Table 3**. These volumes assume the Phelps recharge project is scored as an "independent" project, without impact from other WAP projects utilizing excess flows. Note that 50% will be available for the Program, or 4,631 to 4,809 AFY.

Table 3. Independent Phelps Recharge Project Score Analysis Calculated Diversions.

Analysis	Maximum Diversion Rate (cfs)	Canal Storage Volume (AF)	Total Diversions into Recharge (AFY)	Program's Portion of Diversions into Recharge (AFY)
Preliminary Analysis (7/22/13)	115	1,000	9,261	4,631
Revised Option #1	300	890	9,244	4,622
Revised Option #2	300	1,160	9,617	4,809

During the 2011-2012 and 2012-2013 recharge seasons approximately 5,558 AF and 4,089 AF, respectively, were diverted into the canal for recharge in total (50% would be available for the Program). Note that in both years, recharge occurred for approximately half of the typical

[19] The input is considered the excess flows diverted into the canal and the output is considered the recharge from the canal storage.
[20] CNPPID has indicated the storage to Mile Post 9.7 is 850 AF and the storage to Mile Post 13.3 is 1,160 AF. The ED Office estimated a proportional storage from the proposed J-2 Regulating Reservoir inlet to Mile Post 13.3.
[21] Approximate location of proposed J-2 Regulating Reservoir inlet is at Mile Post 3.1.
[22] Calculation: 1,160 AFY ÷ 13.3 × (13.3 – 3.1) = 890 AF
[23] The 1,000 AF is the estimated storage volume to Mile Post 9.7; therefore, this is a conservative estimate for use in the analysis to Mile Post 13.3. CNPPID has indicated the storage to Mile Post 9.7 is closer to 850 AF and the storage to Mile Post 13.3 is 1,160 AF.
[24] First year of recharge operations (2011-2012) went to Mile Post 9.7 in the canal and second year of recharge operations (2012-2013) went to Mile Post 13.3 in the canal.

recharge season[25]. The total volume of diversions into the Phelps County Canal at the Mile Post 1.6 flume from year 1 and year 2 of recharge are shown in **Figure 2**.

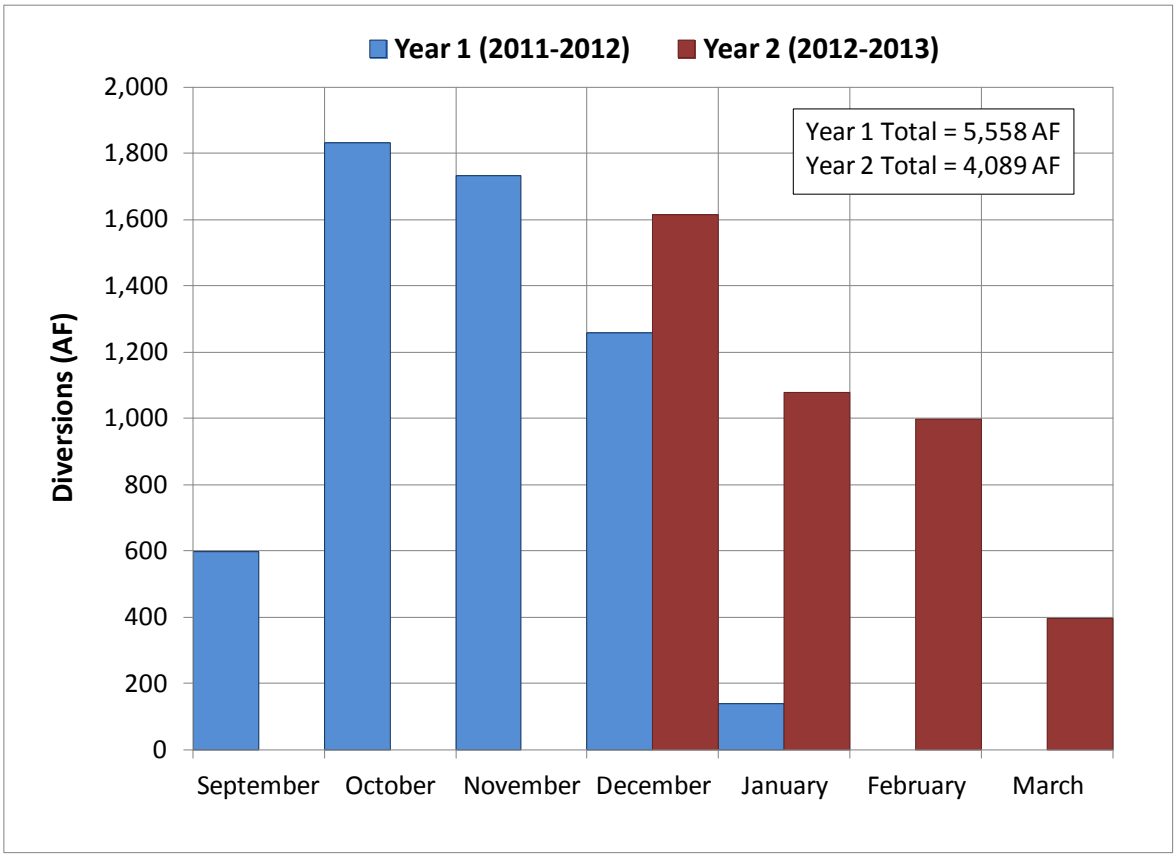

Figure 2. Monthly Deliveries at Mile Post 1.6 Flume for Recharge (2011-2013).

B. Excess Flow Availability and Target Flow Shortages

Similar to the J-2 Regulating Reservoir scoring analysis, hydrology from the OpStudy "Adjusted Present Condition with Three States Projects, without Pulse Flows" model run for 1947 to 1994 was used as the basis for the Phelps County Canal scoring analysis. EA flows were included when calculating excesses and shortages to target flows at Grand Island; however, EA flows estimated to be present in the J-2 Return[26] were not diverted for recharge purposes, which is consistent with the J-2 Reservoir scoring analysis. Excess flows identified at Grand Island also had to be physically available in the OpStudy modeling of the J-2 Return in order to be diverted into the Phelps County Canal for recharge purposes. The groundwater recharge project was modeled using a monthly analysis due to the delayed nature of groundwater return flows and accretion modeling considerations. However, the water recharged in the canal was calculated on

[25] It is anticipated the canal will be used for recharge for full seasons in the future (approximately mid-September through mid-April) and therefore, the project was scored using this assumption.

[26] EA flow in the J2 Return is not an OpStudy output. Monthly values were estimated by subtracting the EA volume at Overton from the EA volume at Cozad. The difference was assumed to have been returned to the river through the J2 Return.

a daily basis, similar to the J-2 Regulating Reservoir. The daily analysis was completed to determine the infiltration from storage in the canal when excess flows are not able to be diverted. This differs from the monthly analysis, in which, each month has either a net target flow excess or shortage, which eliminates the potential to divert excesses for recharge purposes during a net shortage month (even if there are days with excess during the month).

The determination of excess flows available for recharge is based on the maximum of the USFWS's target flows and instream flow rights held by Central Platte Natural Resources District (CPNRD) and Nebraska Game and Parks Commission. However, the calculation of accretions at Grand Island during times of shortages is based on the Program's monthly target flows listed in Column 8 of Appendix A-5 in Attachment 5 of the Program Document. A monthly summary of excesses and shortages to target flows at Grand Island is provided in **Appendix C**. The target flows in Appendix A-5 of the Program Document are also included in Appendix C.

C. Lagged Accretions at the River

The recharge of the underlying aquifer that results from infiltration along the bed and banks of the canal eventually enhances flows in the Platte River, and is referred to as the "river accretion". The timing of river accretions is dependent on aquifer characteristics, the distance between the point of recharge and the river, and the degree to which recharged water is intercepted by intervening surface water features such as drains. River accretions to the Platte River resulting from recharge in the Phelps County Canal were simulated using a numerical model developed in conjunction with Hahn Water Resources, LLC (Special Advisor). The model included representations of the principal hydrologic and geologic attributes of the canal and recharge area, including aquifer properties, drain properties, canal properties, time-varying recharge and evapotranspiration. The model was calibrated to water levels, estimates of canal seepage and measurement of drain flow data collected as part of the Feasibility Study.

In 2011, the ED Office and Hahn Water Resources, LLC evaluated the use of Stream Depletion Factors (SDFs) to lag accretions to the river and it was determined that the SDF method and the numerical model produced similar results for modeling to Mile Post 9.7. However, since that time, the model has been updated, recalibrated using data from the Feasibility Study and run to Mile Post 13.3. During the preliminary scoring analysis, it was determined that the SDF method produced results that were consistently lower than the numerical model when evaluating returns through the 48-year study period. The numerical model provides a more detailed representation of the Phelps County Canal; therefore, the ED Office used the numerical model results in the scoring analysis. For additional information regarding the numerical model and SDF method results, see **Appendix D** for information provided by Hahn Water Resources, LLC (Special Advisor). Note that the numerical model was run for only one scenario, utilizing diversions into recharge based on 115 cfs rate and a canal storage volume of 1,000 AF. Although the diversions into recharge were based on a daily analysis, the lagged accretion modeling and comparison to target flow shortages were completed on a monthly basis.

The volume of lagged accretions at the Platte River from the numerical model output averaged approximately 8,384 AFY. This is a 9% reduction in the volume of water recharged in the canal of approximately 9,261 AFY for the 115 cfs diversion rate and 1,000 AF canal storage volume

model run, as discussed in Section V.A. A portion of the water recharged in the canal does not return to the river within the 48-year simulation period due to the lagged nature of returns. In addition, there are other losses incurred in the recharge process, including increased losses to evapotranspiration as a result of raised groundwater levels. The numerical model was not re-run for the other canal storage volumes and maximum diversion rate, as the volumes diverted into recharge do not significantly change (see Table 3).

D. Routing of Lagged Accretions to Grand Island

The Phelps County Canal groundwater recharge yield[27] accruing to the river was entered into the scoring model and routed to Grand Island using the WMC Loss Model. As with the scoring of the J-2 Regulating Reservoir project, the WMC Loss Model was used to calculate the loss per mile for each month for water years 1975 – 2006. The transit losses were calculated for the Overton to Grand Island reach, which is at the top of the "Overton to Odessa" reach in the WMC Loss Model. The transit loss factors were applied to the river accretions to determine the volume of flow reaching Grand Island. On average, approximately 88% of recharge accretions reach Grand Island, or 12% per month is lost in a normal year due to routing. The percentage of water arriving at Grand Island was then averaged by month and year type as shown in **Table 4**. The losses from the numerical model's eastern return and Grand Island are the same or within 1% of the values in Table 4. Additional information regarding the WMC Loss Model is included in **Appendix E.**

Table 4. Average Percentage of River Accretions at Overton Reaching Grand Island, based on WMC Loss Model.

Month	Wet Yr	Normal Yr	Dry Yr
Jan	89%	89%	85%
Feb	92%	93%	91%
Mar	98%	97%	95%
Apr	96%	97%	95%
May	97%	95%	94%
Jun	96%	93%	68%
Jul	96%	79%	41%
Aug	88%	77%	27%
Sep	84%	74%	36%
Oct	91%	84%	54%
Nov	92%	87%	74%
Dec	92%	88%	85%
Avg	**93%**	**88%**	**70%**

[27] The yield refers to the amount of recharge accretions at the river. Note that the score is the portion of the yield routed to Grand Island that occurs during shortages to USFWS target flows.

E. Habitat Scoring Adjustment

During the J-2 Regulating Reservoir scoring exercise, the USFWS indicated some reduction of score should be contemplated in cases where the entire habitat reach (or at least the Overton to Duncan portion) does not benefit from the flow improvements[28]. The numerical model projected approximately 60% of river accretions accrue to the Platte River above the Overton gage and the remaining accretions accrue between the gage and the model's eastern boundary, which is approximately 5.5 miles downstream of the Overton gage, as shown on the map in Appendix A.

Since a portion of the accretions return to the Platte River below Overton, the ED Office completed scoring analyses to incorporate an adjustment for returns that accrue below Overton. During initial conversations regarding scoring of the J-2 Regulating Reservoir, USFWS had suggested that WAP project scores could be reduced linearly based upon the percent of the habitat impacted below Overton, with a score of zero for projects returning flows more than halfway down the Overton to Grand Island reach (which is below the Kearney gage). Since that time, the USFWS has updated their suggestion[29] to apply a linear reduction to all projects from Overton to Grand Island, allowing projects below the halfway point of the reach to receive partial credit. This allows projects below Kearney to receive a score towards the Program Milestone, although the score is reduced linearly based on the percent of the habitat impacted.

For the Phelps recharge project, a 4% habitat adjustment was applied to the accretions occurring between the Overton gage and the model's eastern boundary. The adjustment was based on the mid-point of the Overton to eastern boundary reach divided by the Overton to Grand Island reach (3 miles/72 miles = 4%). However, the impact of the habitat adjustment on the score was only 2%[30]; this was due to lower routing loss values applied to the accretions occurring between Overton and the eastern boundary return. A habitat discount has a relatively small impact on the score of the Phelps recharge project. The Scoring Subcommittee agreed that a habitat adjustment is appropriate for projects that reduce target flow shortages, such as the Phelps recharge project[31]. The Scoring Subcommittee meeting minutes are provided as **Appendix F.** The approximate reach locations and reduction percentages are shown in **Figure 3**. Figure 3 also shows the approximate locations of the Phelps recharge project accretions.

[28] See Section IV.D.4. in "Water Action Plan Project Scoring Case Study: CNPPID Reregulating Reservoir" dated April 22, 2010 by the ED Office.
[29] In an email from Mike George (USFWS) to Jerry Kenny (ED) on April 3, 2013.
[30] The 2% impact represents the 4% habitat adjustment applied to the 60% of accretions occurring below Overton; the routing losses applied to the 60% of accretions below Overton were less than the Overton to Grand Island routing loss values in Table 4.
[31] See minutes from 10/28/13 Scoring Subcommittee conference call.

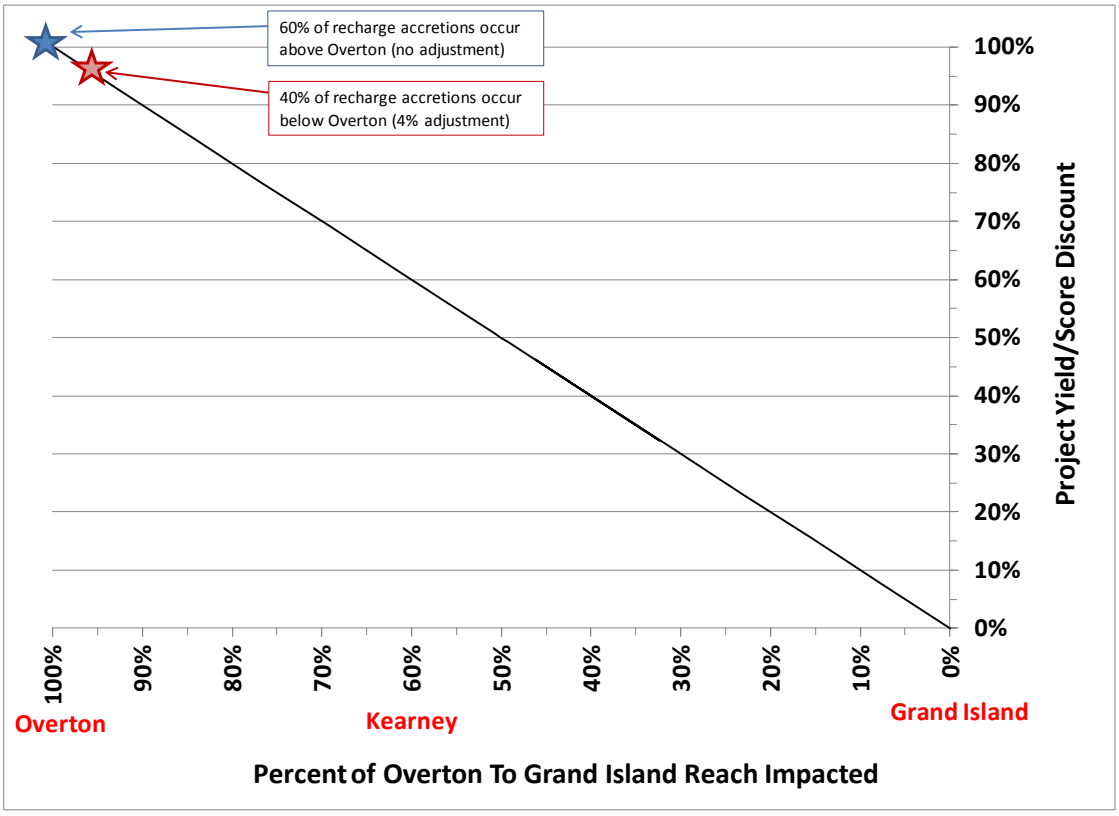

Figure 3. Potential Adjustment of Project Score Based Upon Percent of Habitat Impacted.

F. Combined Operations with J-2 Regulating Reservoir and CPNRD Canal Recharge

The ED Office completed analyses to determine the interaction of projects that utilize excess flows as a water supply. The J-2 Regulating Reservoir will divert excess flows available in CNPPID's system into the Phelps County Canal. Combined scoring analyses were performed for the J-2 Regulating Reservoir and the Phelps recharge projects, assuming the reservoir has the priority to divert excess flows[32]. The diversions into the Phelps recharge project were reduced by approximately 38% when restricted by the reservoir. The analysis is in the memorandum provided in **Appendix G**. The ED Office also completed analyses with the CPNRD canal recharge project, which would divert excess flows into the Orchard-Alfalfa, 30-Mile and Cozad Canals during the irrigation shoulder season. For the combined operations, it was assumed that the J-2 Regulating Reservoir had the first priority for diversions and then the CPNRD's recharge project had the second priority for diversions of excess flows and the Phelps recharge project could divert the remaining excesses. Per the analysis, the Phelps recharge score was not sensitive to CPNRD's recharge project.

After reviewing the results in the combined operations memorandum, the Scoring Subcommittee was interested in evaluating whether the J-2 Regulating Reservoir and Phelps recharge projects

[32] The J-2 Regulating Reservoir is more efficient than the Phelps recharge project (as the water supply is controlled and released during shortages only); therefore, it was assumed to be the diversion priority.

could be operated in a way to reduce the impact calculated in the combined scoring analysis. The ED Office evaluated an event-based score analysis, in which the Phelps recharge project was prioritized over the J-2 Regulating Reservoir during high flow events when the reservoir was known to fill. This allows diversions into recharge to occur earlier in the season, when normally diversions would have been delayed to account for the J-2 Regulating Reservoir fill period.

Two difference scenarios were evaluated in this analysis. The first scenario involved a new operating rule in the J-2 Regulating Reservoir score model that assumed if the reservoir was going to fill on the current day or following three days, the Phelps recharge project would take priority of the diversions. This was based on the assumption that during runoff periods, the reservoir would still be able to fill with a delay in diversions. The second scenario was a forecasted flow analysis for representative wet, normal and dry years. Due to time constraints, the second scenario was only completed for the representative years, not the full 48-year OpStudy period. During the Scoring Subcommittee conference call on 11/15/13, CNPPID indicated the representative year analysis with flow forecasting is more likely during actual operations than a shorter 3-day forecasting operation. See **Appendix H** for the memorandum provided to the Scoring Subcommittee. On the 11/15/13 call, the Scoring Subcommittee agreed to use the representative year weighted-average methodology presented in Appendix H Table 2 but requested the ED Office complete analyses of an additional set of representative years to see if the results were consistent (see meeting minutes in Appendix F).

VI. SCORE ANALYSIS RESULTS

The Phelps recharge project scores were calculated assuming the Phelps recharge project operated as "independent" project, without the impact of other WAP projects diverting excess flows, and as a combined project with the J-2 Regulating Reservoir.

A. Independent Analysis Scores

The ED Office completed scoring analyses with the alternatives described in the previous Sections V.A. through V.E. above. Summary tables by month are included in **Appendix I** for the score model run using a maximum canal diversion rate of 115 cfs and a canal capacity of 1,000 AF. This model run represents the only calculated "score model" in which the numerical model's calculated lagged accretions at the river were routed using the WMC Loss Model to Grand Island and credited to target flow shortages only. Since the numerical model was not re-run for all of the alternatives evaluated, a 40% "score efficiency" was used to calculate a score for the other scenarios presented in **Table 5**. The "score efficiency", or the score divided by the volume recharged in the canal, is 40% in this model run with a habitat adjustment applied to accretions below Overton (3,729 AFY ÷ 9,261 AFY = 40%). The scores for the independent project analyses range from 1,861 AFY to 1,936 AFY, as shown in Table 5.

Table 5. Independent Analysis Preliminary Project Scores at Grand Island.

Scenario	Max Canal Diversion (cfs)	Canal Storage Volume (AF)	Recharged Volume (AFY)	Returns to the River (AFY)	Score (AFY)	Program Score (AFY)
(A) 100% Return Flows at Overton	115	1,000	9,261	8,384	3,787	1,894
(B) Return Flows w/Habitat Adj. (1,000 AF)	115	1,000			3,729	1,865
(C) Return Flows w/Habitat Adj. (890 AF)	300	890	9,244	-	3,722	1,861
(D) Return Flows w/Habitat Adj. (1,160 AF)	300	1,160	9,617	-	3,872	1,936

Notes: Scores based on mid-September through mid-April recharge period. The numerical model run was completed using a diversion rate of 115 cfs and a canal storage volume of 1,000 AF only [as shown in Rows (A) and (B)]. The scores in Rows (C) and (D) were estimated using a score efficiency of 40%[33]. The NDNR may utilize up to 50% of the score, leaving the remaining 50% for use by the Program.

B. Combined Analysis Scores

Two sets of representative year analyses were completed to demonstrate combined operations between the Phelps recharge project and the J-2 Regulating Reservoir. Alternative canal diversion rates and canal storage volumes for the recharge project were considered.

i. Representative Year Analysis (Set #1)

The ED Office completed an initial evaluation of combined scoring for the J-2 Regulating Reservoir and Phelps recharge project (see Appendix H) for a set of representative wet, normal and dry years. The years were selected based on analyses completed by Olsson Associates in the J-2 Regulating Reservoir Pre-Feasibility Study[34]. The original representative year analysis (11/5/13 memorandum, presented in Appendix H) was revised to use a 300 cfs diversion rate and a range of canal storage capacities from 890 AF to 1,160 AF, as discussed in Section V.A. of this memorandum. The results are shown in **Table 6.** The Program scores listed in the table are based on the Program's 50% proportion of yield, and a score efficiency of approximately 40% (based on the "score efficiency" discussed in Table 5).

[33]The score efficiency of 40% is based on Row (B) in the table; Row (B) represents the score with a habitat adjustment for returns accruing to the river below Overton. The score efficiency is considered the Score ÷ Recharged Volume. Calculation = 3,729 AFY ÷ 9,261 AFY = 40.26%. Since the numerical model was not re-run for Rows (C) and (D), the score was calculated using the 40.26% efficiency value. Calculation example = 9,244 AFY × 40.26% = 3,722 AFY.

[34] "CNPPID Reregulating Reservoir: Elwood and J-2 Alternatives Analysis Project Report" by Olsson Associates and Black & Veatch in 2010.

Table 6. Summary of Representative Year Analysis (Set #1) for Combined Operations.

WY	Year Type	Max diversion rate (cfs)	Canal Storage Volume (AF)	Independent Analysis Recharge (AFY)	Optimized Analysis Recharge (AFY)	Number of Yrs in Period	Weighted Average (AFY)
890 AF Capacity							
1964	Dry	300	890	4,317	4,299	12	1,075
1975	Normal	300	890	4,260	2,889	20	1,204
1986	Wet	300	890	6,539	5,713	16	1,904
Total	-	-	-	-	-	48	4,183
						Program score (AFY):	1,684
1,160 AF Capacity							
1964	Dry	300	1,160	4,452	4,434	12	1,109
1975	Normal	300	1,160	4,535	3,024	20	1,260
1986	Wet	300	1,160	6,737	5,848	16	1,949
Total	-	-	-	-	-	48	4,318
						Program score (AFY):	1,739

Notes:
Independent Analysis Recharge = diversion into recharge (or volume recharged) in independent analysis, where recharge is always the priority to divert the excess flows.
Optimized Analysis Recharge = diversions into recharge (or volume recharged) in combined operations event-based analysis, where recharge is prioritized over J-2 Regulating Reservoir diversions during reservoir-fill periods.
Number of Years in Period = number of dry, normal and wet hydrologic condition years during the 1947-1994 modeling period.
Weighted Average = weighted average score based on the proportion of hydrologic condition years and the recharge diversions in the combined operations event-based analysis.

ii. Representative Year Analysis (Set #2)

The ED Office evaluated combined scoring with additional representative years, which were selected based on previous work completed by the ED Office and Olsson Associates during the J-2 Regulating Reservoir Pre-Feasibility Study. The representative year selection was based on comparisons of the average monthly total flow at Overton for all normal years and for specific years, similar to the Pre-Feasibility Study. **Figure 4** shows the three normal years that best match the average flow of all the normal years during the 1947-2006 period used in the Water Management Study[35]. Water Year (WY) 1975 was selected as the representative normal year for the Pre-Feasibility Study. The ED Office utilized WY 1969 as the second representative normal year, as the pattern matched well with the average. The graphs for the wet and dry years are provided in **Appendix J**. The selected representative years span the OpStudy modeling period. The weighted average scores are provided in **Table 7**. The score is based on the Program's 50% of the recharge yield and a score efficiency of 40%.

[35] Note that the OpStudy modeling period is from 1947-1994.

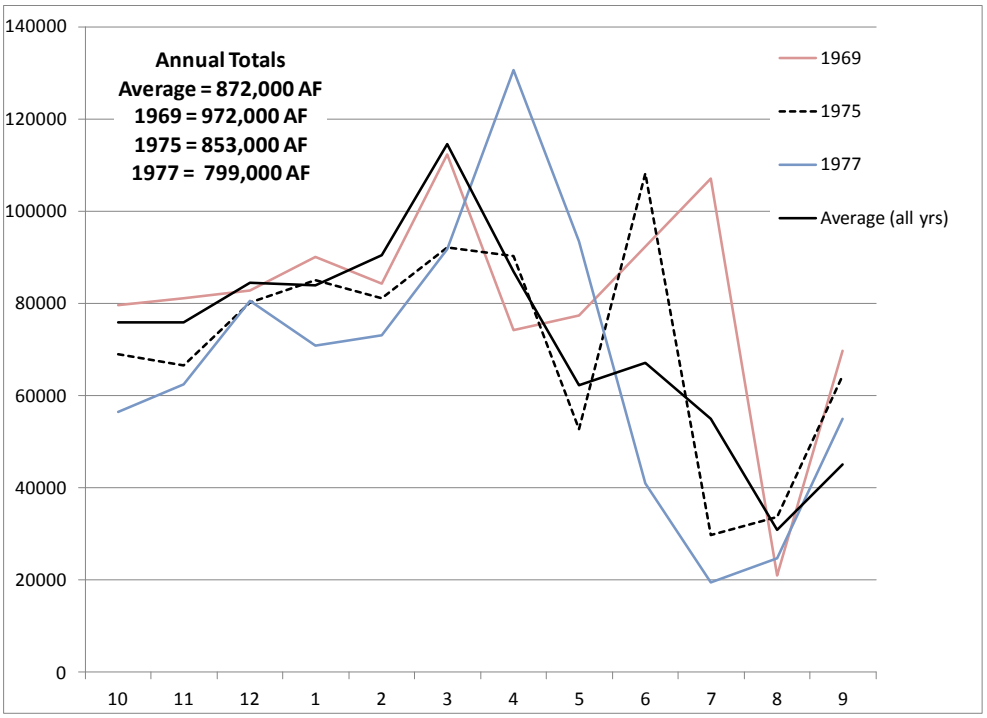

Figure 4. Representative normal year flows at Overton.

Table 7. Summary of Representative Year Analysis (Set #2) for Combined Operations.

WY	Year Type	Max diversion rate (cfs)	Canal Storage Volume (AF)	Independent Analysis Recharge (AFY)	Optimized Analysis Recharge (AFY)	Number of Yrs in Period	Weighted Average (AFY)
890 AF Capacity							
1954	Dry	300	890	4,755	3,460	12	865
1969	Normal	300	890	4,983	3,498	20	1,458
1987	Wet	300	890	6,284	6,284	16	2,095
Total	-	-	-	-	-	48	4,417
						Program score (AFY):	1,779
1,160 AF Capacity							
1954	Dry	300	1,160	4,890	3,595	12	899
1969	Normal	300	1,160	5,504	3,903	20	1,626
1987	Wet	300	1,160	6,419	6,419	16	2,140
Total	-	-	-	-	-	48	4,665
						Program score (AFY):	1,878

Notes:
Independent Analysis Recharge = diversion into recharge (or volume recharged) in independent analysis, where recharge is always the priority to divert the excess flows.
Optimized Analysis Recharge = diversions into recharge (or volume recharged) in combined operations event-based analysis, where recharge is prioritized over J-2 Regulating Reservoir diversions during reservoir-fill periods.
Number of Years in Period = number of dry, normal and wet hydrologic condition years during the 1947-1994 modeling period. [continued on following page]

Weighted Average = weighted average score based on the proportion of hydrologic condition years and the recharge diversions in the combined operations event-based analysis.

The average between the first and second set of representative year analyses using the 890 AF canal storage capacity is 1,732 AFY[36]. The average between the analyses for the 1,160 AF capacity runs is 1,809 AFY[37]. The average of these scores is approximately 1,771 AFY[38], which rounded to the nearest hundred is 1,800 AFY.

VII. ADDITIONAL CONSIDERATIONS DISCUSSED

A. Preferential Use of Accretions at Times of Shortage and/or Above Overton

As noted in the WAP, a Nebraska-based Program partner, such as Tri-Basin NRD, may use a portion of the river accretions resulting from groundwater recharge for addressing Nebraska New Depletion Plan (NNDP) requirements. The Scoring Subcommittee discussed whether it would be possible to maximize the Program's portion of the project (50%) by claiming the recharge project accretions that that occur during shortage periods only, or accretions that occur above Overton. This would mean the remaining 50% of project accretions available for the NNDP would occur during the excess periods (as the Program would claim accretions during shortages) or lower in the reach (as the Program would claim the accretions above Overton). The Scoring Subcommittee decided that the Program cannot preferentially use accretions from the Phelps recharge project during shortages[39].

B. Protection of Flows

During the February 2013 WAC meeting, concerns were raised regarding the ability to protect WAP accretions to the Platte River from diversion by other water users. The WAP noted that it may be possible to protect accretions to the Platte River resulting from groundwater recharge projects under Nebraska State Statute Section 46-252; however, the feasibility of this approach has not been evaluated. The Scoring Subcommittee does not believe recharge accretions can be protected at this time. Other projects that release water directly to the river, such as the J-2 Regulating Reservoir, should be protected from other water users[40].

VIII. RECOMMENDED SCORE

The Phelps recharge project scoring analyses produced results ranging from **1,861 acre-feet AFY to 1,936 AFY** when scored as an independent project, without impacts from other WAP projects. This score range represents a best-case scenario and assumes the Phelps recharge project is the diversion priority at all times. Analyses were completed to combine the operations of the Phelps recharge project and the J-2 Regulating Reservoir, as both projects utilize excesses available in the Phelps County Canal. When combining the anticipated operations of the Phelps recharge project and the J-2 Regulating Reservoir, the Phelps recharge scoring analyses results ranged from approximately **1,684 AFY to 1,878 AFY,** based on analyses using representative

[36] Calculation: (1,684 AFY + 1,779 AFY) ÷ 2 = 1,732 AFY.
[37] Calculation: (1,739 AFY + 1,878 AFY) ÷ 2 = 1,809 AFY.
[38] Calculation: (1,732 AFY + 1,809 AFY) ÷ 2 = 1,771 AFY.
[39] See minutes from 10/28/13 Scoring Subcommittee conference call.
[40] See minutes from 10/28/13 Scoring Subcommittee conference call.

wet, normal and dry years[41]. The range of scores also incorporates different canal diversion rates and canal storage volumes. The maximum diversion rates in the canal ranged from 115 cfs to 300 cfs, based on actual delivery data during the three seasons of operations. The canal storage volume ranged from 890 AF to 1,160 AF, based on the canal geometry and the location of storage available within the canal[42].

The Scoring Subcommittee recommends a Phelps recharge project score of 1,800 AFY[43] for the Program. This is the score rounded to the nearest hundred, based on the two sets of representative year analyses with combined operations, which averaged 1,771 AFY (Section VI.B.). The recommended score accounts for an impact to the Phelps recharge yield from combined operations with the J-2 Regulating Reservoir but assumes that during the majority of times, both projects can operate together with minimal impact to the Program's score. The Phelps recharge score was estimated using various alternatives and sensitivity analyses and does not represent a single model run but a compilation of several score model runs. The recommended score by the Subcommittee will be presented to the GC so a final WAP project score may be assigned for the Phelps recharge project. The memorandum provided to the GC for the December 2013 meeting is provided as **Appendix K**.

IX. LIST OF APPENDICES

Several appendices are included to provide additional technical detail:

Appendix A: Location Map

Appendix B: Memorandum – Recharge Season Information

Appendix C: Table 1 – Excesses and Shortages at Grand Island Using Monthly OpStudy Hydrology; Table 2 – Target Flows

Appendix D: Numerical Model vs. SDF Method Results Description

Appendix E: Memorandum – Comparison of Reach Gains/Losses

Appendix F: Scoring Subcommittee Meeting Minutes

Appendix G: Memorandum – Combined Scoring Analysis for J-2 Reservoir, CPNRD Recharge and Phelps Recharge

Appendix H: Memorandum – Evaluation of J-2 Reservoir and Phelps County Canal Recharge Event-Based Scoring

Appendix I: Tables (1 through 4) – Initial Score Analysis Summary

Appendix J: Representative Years Description

[41] The full OpStudy simulation period was not modeled for these analyses due to time constraints. Two sets of representative years were modeled for the purpose of sensitivity evaluation with the J-2 Reservoir operations.
[42] The 1,160 AF capacity represents the storage capacity of the canal for the full 13.3 miles of canal with recharge operations. The 890 AF capacity represents the storage volume from the proposed J-2 Reservoir inlet to Mile Post 13.3, assuming there are times when the first section of the canal will not be available for excess flow storage.
[43] This score is for the Program's 50% of the project. The NDNR or other Nebraska-based Program partner may claim up to 50% of the total project yield.

Appendix K: Memorandum – Score Recommendation for Phelps County Canal Groundwater Recharge Project

APPENDIX A:

LOCATION MAP

Cozad
Lexington
Overton
Elm Creek
Tri-County Supply Canal
Buffalo Creek
Platte River
Spring Creek
Dawson County
Buffalo County
Gallagher Lake
Johnson Lake
Phelps Headgate
Overton Stream Gage
Model Eastern Return
Frontier County
Gosper County
E-65 Canal
E-67 Canal
Plum Creek
Phelps County Canal
Phelps County
Elwood Reservoir
Mile Post 9.7
Mile Post 13.3

PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM

PROJECT LOCATION IN NEBRASKA

Legend

- Check Location
- Numerical Model Eastern Return Location
- Overton Return Location
- CNPPID Irrigation Canals
- Phelps County Canal

N

0 1 2 4 Miles

APPENDIX A

NEBRASKA GROUNDWATER RECHARGE

Date: 7/3/2013
By: SWS

APPENDIX B:

MEMORANDUM - RECHARGE SEASON INFORMATION

TO: SCORING SUBCOMMITTEE
FROM: ED OFFICE
SUBJECT: RECHARGE SEASON INFORMATION
DATE: NOVEMBER 13, 2013

The Scoring Subcommittee had a conference call on 10/28/13. The Scoring Subcommittee asked whether the assumed recharge season in the preliminary scoring analysis (Sep. 15 through Apr. 15) is appropriate, considering there may be times when the canal is being repaired and the season is delayed.

For the purpose of discussion on the next call on 11/15/13, the ED Office evaluated how often diversions into the canal take place in the preliminary score analysis model. The recharge season was assumed about 7 months; however, the recharge project can only divert water during periods of excess, which is approximately half of the time period (or 3.5 months of the 7 month recharge season, on average). Below is a brief summary:

Monthly summary from the preliminary score analysis (based on daily data):
September – 42% of years have 0 recharge diversions
October – 40% of years have 0 recharge diversions
Sep. 15 – Apr 15. season– recharge diversions occur 49% of the days

Table 1 shows how many days per month, on average during the modeling period, there are no diversions into the canal for recharge. So for example, during April, recharge diversions are 0 for 23 days of the month, meaning recharge diverts about 7 days in the month.

Table 1. Average number of days per month with zero recharge diversions.

Jan	Feb	Mar	Apr	Sep	Oct	Nov	Dec
7	17	20	23	24	25	14	8

Based on the monthly summary and Table 1, it appears there are often days in the shoulder season (Sep-Oct, Mar-Apr) when there are no diversions into recharge. It is anticipated that in most years, CNPPID will be able to schedule canal improvements without an impact to recharge. Because there are often no diversions in the early recharge season (Sep & Oct), the recharge season seems to be appropriate to accommodate for years when maintenance needs to be completed.

APPENDIX C:

TABLE 1 – EXCESSES AND SHORTAGES AT GRAND ISLAND USING MONTHLY OPSTUDY HYDROLOGY

TABLE 2 – TARGET FLOWS

APPENDIX C, TABLE 1:
EXCESSES AND SHORTAGES AT GRAND ISLAND USING MONTHLY OPSTUDY HYDROLOGY

Values in KAF. Positive values represent excesses, negative values represent shortages.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yr Type
1947	52.7	3.5	-10.3	14.8	-1.3	85.2	237.1	-24.0	-17.5	-5.5	41.4	66.5	Normal
1948	61.4	23.6	117.8	-13.3	-10.4	-87.0	-23.3	-39.8	-51.3	-49.1	-10.2	18.7	Normal
1949	16.1	-48.6	36.7	42.6	-14.4	120.8	109.2	-24.3	-16.9	1.3	26.1	20.8	Wet
1950	42.7	19.8	-10.7	-28.6	-1.9	-87.2	5.2	-27.0	-9.4	37.7	-5.2	23.7	Normal
1951	23.3	-16.1	-73.2	-28.3	-22.2	-4.5	40.1	-27.4	163.4	24.8	46.6	54.9	Wet
1952	70.8	36.6	79.0	61.8	-22.1	-86.7	-15.1	-24.2	-17.4	-81.7	-23.7	42.7	Wet
1953	101.4	16.5	10.7	37.3	81.7	12.5	-18.0	-6.8	-11.9	-34.6	19.1	40.6	Dry
1954	39.3	29.7	-34.6	-24.7	57.2	-6.4	-29.6	-10.0	-9.3	-46.5	-7.9	16.2	Dry
1955	17.9	-34.6	-32.5	-55.3	-24.5	-5.0	-18.0	-21.4	-18.0	-77.0	-31.0	2.5	Dry
1956	21.4	-46.0	-71.6	-61.6	-12.9	-32.3	-24.8	-26.7	-17.1	-67.1	-32.7	2.2	Dry
1957	-16.0	-39.0	-59.4	-28.1	86.3	150.0	22.0	-8.1	6.3	6.1	22.3	35.3	Dry
1958	45.6	-56.2	-27.9	2.0	23.1	8.2	38.8	-24.2	-17.6	-16.3	-7.6	19.9	Normal
1959	13.7	-14.0	41.8	41.3	56.1	12.5	-5.5	-21.1	-27.8	-14.1	32.9	46.0	Dry
1960	14.3	-30.1	29.4	-2.3	-26.8	-55.7	-23.4	-42.7	-24.0	-53.3	-10.1	13.3	Normal
1961	50.5	6.3	-14.7	-5.9	53.3	66.3	0.0	-16.2	-36.1	-19.4	39.3	34.9	Dry
1962	23.5	0.1	18.5	-43.5	-82.2	52.6	24.7	-12.1	-35.6	-35.8	-5.8	7.0	Normal
1963	28.6	60.0	21.0	5.5	62.7	12.3	-38.0	-33.9	-13.7	-15.0	15.2	17.1	Dry
1964	45.8	-18.6	-15.3	16.9	34.2	-7.9	-21.2	-23.2	-29.4	-43.5	-14.9	6.9	Dry
1965	-13.8	-88.9	-77.9	-43.6	-81.2	35.1	143.4	-28.5	69.1	32.3	26.0	61.9	Wet
1966	16.3	4.2	-9.5	-9.1	-38.0	-107.4	-39.5	-44.9	-58.2	-47.1	-10.9	-1.7	Normal
1967	10.7	-54.8	-84.8	-76.3	-81.8	165.9	95.5	-33.9	-35.5	-39.1	-4.2	8.3	Normal
1968	32.9	-37.8	-72.3	-37.6	-77.3	-87.2	-24.2	-20.9	-35.6	-45.0	6.2	-3.0	Normal
1969	23.7	-40.9	8.4	-23.1	-1.4	-25.4	100.0	-24.3	-17.8	-14.9	39.4	63.9	Normal
1970	53.8	25.9	-32.5	13.3	-22.2	-60.7	34.2	-24.2	-17.7	-51.5	-9.6	-6.9	Wet
1971	15.0	-24.7	-27.9	-1.3	-22.2	240.0	42.3	-24.5	-17.6	-32.6	50.0	60.9	Wet
1972	3.5	24.6	-9.5	-20.4	-22.5	-86.7	-24.9	-14.3	-35.5	-60.0	-5.4	23.6	Wet
1973	67.7	17.1	-19.3	81.1	588.1	517.3	-0.4	-24.0	19.7	191.3	130.7	139.7	Wet
1974	144.6	98.6	28.5	208.4	-19.3	-70.4	-23.6	-41.0	-17.6	-36.2	-10.4	3.1	Wet
1975	31.0	-44.3	-56.7	-38.5	-1.4	-39.9	-23.3	-35.5	-35.6	-35.6	-0.2	67.4	Normal
1976	64.6	32.5	1.2	12.7	81.6	0.0	-24.1	-26.7	-25.8	-38.3	-14.8	3.6	Dry
1977	-26.2	-74.5	-82.5	-11.8	-22.5	-89.2	-23.6	-34.6	-38.0	-34.9	-5.3	5.9	Normal
1978	-16.9	-71.1	47.5	-21.8	-14.9	-87.0	-48.7	-44.0	-39.0	-78.2	-43.0	-27.3	Normal
1979	-25.0	-90.7	-8.8	-26.6	-26.3	55.7	63.2	-23.6	-17.6	-47.5	2.0	74.4	Normal
1980	31.7	12.6	37.0	-4.7	294.5	199.8	-24.9	-24.6	-17.7	-39.0	-35.0	2.4	Wet
1981	24.1	-38.0	-32.6	-29.9	0.9	9.0	-8.3	4.3	-11.9	-38.3	-2.2	15.1	Dry
1982	-13.7	-71.3	-88.7	-55.7	-62.5	-87.0	-23.8	-42.7	-36.1	-16.2	-20.7	20.2	Normal
1983	61.6	8.7	-11.2	38.6	310.2	954.5	652.9	-24.0	5.3	154.8	63.7	63.3	Wet
1984	196.0	157.3	102.3	325.5	842.3	548.7	103.6	-24.0	30.2	64.4	140.7	134.2	Wet
1985	64.1	68.9	33.7	86.1	-16.7	-39.0	-25.3	-27.3	27.9	-5.7	-6.0	55.5	Wet
1986	96.3	29.7	-9.7	27.7	31.1	163.3	-18.7	-24.6	14.5	15.7	38.3	89.0	Wet
1987	70.8	15.9	77.5	128.5	2.8	73.6	35.3	-24.4	16.1	0.8	35.4	42.8	Wet
1988	47.3	54.9	-10.2	-18.2	-1.4	-99.1	2.2	-30.4	-17.7	-26.2	1.6	19.2	Normal
1989	17.0	-60.2	-60.4	-68.2	-45.5	-96.2	6.1	-47.5	36.7	-50.3	-24.8	-28.4	Normal
1990	46.3	-57.5	-70.4	-72.2	-42.1	-86.8	-50.1	-46.7	-43.9	-93.8	-49.5	-34.6	Normal
1991	5.6	-4.8	-34.3	-51.9	0.6	36.6	-17.4	-23.9	-21.1	-52.8	-7.9	13.3	Dry
1992	2.0	-68.3	-83.7	-94.9	-115.6	-131.3	-18.6	-73.8	-65.5	-59.5	-37.8	0.6	Normal
1993	7.6	-84.0	89.9	-44.1	-103.2	-87.4	108.7	7.0	12.8	-54.5	-23.8	7.4	Wet
1994	-8.1	-75.7	-32.0	-39.4	-27.5	-105.8	15.6	-37.4	-34.7	-59.7	-10.8	-3.1	Normal

Based on monthly OpStudy hydrology and target flows from Appendix A-5 Column 8 in Attachment 5 of the Program Document.

APPENDIX A-5 (PAGE 1)

"Wet" Instream Flow Recommendation Hydrograph

Month	Begin	End	cfs	# Days	Kaf	Total Kaf	Average cfs
Jan	1	31	1,000	31	61.5		
Jan						61.5	1,000
Feb	1	14	1,800	14	50.0		
Feb	15	28	3,350	14	93.0	143.0	2,575
Mar	1	15	3,350	15	99.7		
Mar	16	22	1,800	7	25.0		
Mar	23	31	2,400	9	42.8	167.5	2,724
Apr	1	30	2,400	30	142.8		
Apr						142.8	2,400
May	1	10	2,400	10	47.6		
May	11	19	1,200	9	21.4		
May	20	26	4,900	7	68.0		
May	27	31	3,400	5	33.7	170.8	2,777
Jun	1	20	3,400	20	134.9		
Jun	21	30	1,200	10	23.8	158.7	2,667
Jul	1	31	1,200	31	73.8		
Jul						73.8	1,200
Aug	1	31	1,200	31	73.8		
Aug						73.8	1,200
Sep	1	15	1,200	15	35.7		
Sep	16	30	1,000	15	29.8	65.5	1,100
Oct	1	31	2,400	31	147.6		
Oct						147.6	2,400
Nov	1	15	2,400	15	71.4		
Nov	16	30	1,000	15	29.8	101.2	1,700
Dec	1	31	1,000	31	61.5		
Dec						61.5	1,000
Total Kaf						**1,367.5**	

"Average" Instream Flow Recommendation Hydrograph

Month	Begin	End	cfs	# Days	Kaf	Total Kaf	Average cfs
Jan	1	31	1,000	31	61.5		
Jan						61.5	1,000
Feb	1	14	1,800	14	50.0		
Feb	15	28	3,350	14	93.0	143.0	2,575
Mar	1	15	3,350	15	99.7		
Mar	16	22	1,800	7	25.0		
Mar	23	31	2,400	9	42.8	167.5	2,724
Apr	1	30	2,400	30	142.8		
Apr						142.8	2,400
May	1	10	2,400	10	47.6		
May	11	19	1,200	9	21.4		
May	20	31	3,400	12	80.9	150.0	2,439
Jun	1	20	3,400	20	134.9		
Jun	21	30	1,200	10	23.8	158.7	2,667
Jul	1	31	1,200	31	73.8		
Jul						73.8	1,200
Aug	1	31	1,200	31	73.8		
Aug						73.8	1,200
Sep	1	15	1,200	15	35.7		
Sep	16	30	1,000	15	29.8	65.5	1,100
Oct	1	31	1,800	31	110.7		
Oct						110.7	1,800
Nov	1	15	1,800	15	53.6		
Nov	16	30	1,000	15	29.8	83.3	1,400
Dec	1	31	1,000	31	61.5		
Dec						61.5	1,000
Total Kaf						**1,291.9**	

"Dry" Instream Flow Recommendation Hydrograph

Month	Begin	End	cfs	# Days	Kaf	Total Kaf	Average cfs
Jan	1	31	600	31	36.9		
Jan						36.9	600
Feb	1	14	1,200	14	33.3		
Feb	15	28	2,250	14	62.5	95.8	1,725
Mar	1	15	2,250	15	66.9		
Mar	16	22	1,200	7	16.7		
Mar	23	31	1,700	9	30.3	114.0	1,853
Apr	1	30	1,700	30	101.2		
Apr						101.2	1,700
May	1	10	1,700	10	33.7		
May	11	31	800	21	33.3	67.0	1,090
Jun	1	30	800	30	47.6		
Jun						47.6	800
Jul	1	31	800	31	49.2		
Jul						49.2	800
Aug	1	31	800	31	49.2		
Aug						49.2	800
Sep	1	15	800	15	23.8		
Sep	16	30	600	15	17.9	41.7	700
Oct	1	31	1,300	31	79.9		
Oct						79.9	1,300
Nov	1	15	1,300	15	38.7		
Nov	16	30	600	15	17.9	56.5	950
Dec	1	31	600	31	36.9		
Dec						36.9	600
Total Kaf						**775.8**	

APPENDIX D:

NUMERICAL MODEL VS. SDF METHOD RESULTS DESCRIPTION

APPENDIX D:

NUMERICAL MODEL VS. SDF METHOD RESULTS:
INFORMATION PROVIDED BY BILL HAHN (EDO SPECIAL ADVISOR)

The ED Office plans to use an analytical approach (such as AWAS) for the evaluation and scoring of future groundwater projects whenever possible. Numerical models (e.g. COHYST) may be used to generate distributions of aquifer parameters, such as SDF, to expedite and simplify the analysis of scoring of future projects. Where it is impractical to use an analytical approach, or the analytical approach is unable to represent a particular project setting, the Program office may consider using a model such as the COHYST model directly.

In the case of the Phelps Groundwater Recharge Project, testing of alternative means of analysis early on in the project indicated that an SDF approach (use of the numerical model to calculate SDF values throughout the Project area), would provide reasonable estimates of groundwater response to recharge. Comparison of the methods (use of a numerical model directly vs. use of model-calculated SDF values) suggested that the methods would provide comparable results (cumulative returns using the SDF method were approximately 5% higher than the numerical model at the conclusion of the 48-year simulation). Subsequent changes in the location of recharge may have caused the differences between the methods. For example, subsequent to the initial comparisons, the area of canal recharge was extended to the 13.3 check, resulting in recharge occurring much closer to a boundary of the numerical model than had previously been considered.

In the process of scoring the Project using the SDF method, we observed that a portion of the returns from recharge were delayed beyond the initial 48-year scoring period. We believe this is an artifact of the SDF method. In the SDF method, SDF values are calculated with the numerical model and should therefore reflect all of the hydrologic conditions influencing the timing and location of return flows. However, the SDF method employs an analytical solution that does not include boundaries in an explicit way. As a result, the solution approaches, but never actually reaches, a full accounting of the water that was previously recharged. This behavior has been observed by others in similar hydrogeologic settings. In reality, we expect, and the numerical model confirms, that a large fraction of recharge returns occur within the 48-year simulation. These returns occur directly to the river, and through the model's other boundaries, particularly the eastern boundary of the model.

One way to address this limitation is to include boundaries in the analytical solution explicitly, a method frequently referred to as the Glover alluvial aquifer method. This method allows for the specification of boundaries, and also requires that the properties of the aquifer be specified for each location where recharge is being contemplated. The ED Office considered approaching the Phelps Canal scoring in this manner. We anticipated that the values assigned for aquifer properties and boundary conditions would have to be specified for multiple points along the canal, as the return flows are highly dependent on the separation between the canal and the river.

These values would also have to be "calibrated" such that the results of the process agreed with the results of the numerical model. In the interest of efficiency and time, and to advance the scoring process, the ED Office determined that at this time it would rely on the numerical model for use in scoring. In comparing the two scoring predictions, i.e. the SDF method with the numerical model, we found that the SDF method yielded scores that were about 9% lower than scores obtained using the numerical model for the 48-year simulation period.

APPENDIX E:

MEMORANDUM - COMPARISON OF REACH GAINS/LOSSES

TO: SCORING SUBCOMMITTEE
FROM: ED OFFICE
SUBJECT: COMPARISON OF REACH GAINS/LOSSES
DATE: NOVEMBER 13, 2013 (REVISED NOVEMBER 26, 2013)

The Scoring Subcommittee had a conference call on 10/28/2013. During the call, the Subcommittee discussed comparing the WMC Loss Model and OpStudy hydrology for reach gains and losses. The WMC Loss Model always shows a loss, even though there may be times when OpStudy hydrology shows a reach gain, specifically in the Overton to Grand Island reach where recharge accretions occur. The ED Office completed a brief comparison of the reach gains/losses to discuss on the 11/15/13 conference call, which is described further below.

The WMC Loss Model routes water downstream by applying monthly loss factors that include an evaporation factor and a seepage factor to the project yields[1]. Evaporation losses are calculated from estimated river surface evaporation as a function of river channel width and length. A water balance is used to calculate monthly gains and losses within each model reach. Return flows from diversions are included in the gain/loss term. Seepage losses equal the estimated loss calculated in the water balance analysis (seepage losses are zero during months the river is gaining). The evaporation and seepage losses are expressed as a percent loss per mile within a given reach. Percent loss factors are applied to water contributions as they are routed downstream. An underlying assumption is that losses are shared by and prorated among all inflows regardless of where they occur in the reach. Per the model documentation "After the additional water is routed downstream, the additions to the streamflow at Grand Island, Nebraska are compared to historical target flow shortages and excesses to determine reductions to target flow shortages associated with an alternative".

As shown in the tables in **Appendix A**[2] of this memorandum, the seepage factor is typically driving the overall routing loss. Months with a net gain to the river result in a WMC Loss Model seepage factor of zero, meaning the yield is reduced by evaporation only. During net loss periods, both evaporation and seepage are deducted from the yield. In both the Overton-to-Odessa and Odessa-to-Grand Island "% Seep Per Mile" tables, the reaches have gaining periods and losing periods. For example, from Overton to Odessa, the river is typically gaining in the spring and summer months but often losing in the fall and winter months. When the river is gaining, the Program yield is still reduced because of the evaporation component in the WMC Loss Model.

[1] There are also diversion factors in the model, which assumes the project yield is not protected. This was not used for the purpose of scoring. For more information, see, Appendix 2 in the *Water Management Study, Phase 1: Evaluation of Pulse Flows for the Platte River Recovery Implementation Program* by Boyle in 2008.
[2] From Appendix 2 in the *Water Management Study, Phase 1: Evaluation of Pulse Flows for the Platte River Recovery Implementation Program* by Boyle in 2008.

The ED Office compared hydrology data for USGS gages, OpStudy (without pulse) and the monthly WMC Loss Model data to see how the gain/loss periods in the Odessa to Grand Island reach compare. In general, the hydrology seems to follow the same trends during the selected years. When there are gaining periods in the WMC Loss Model, OpStudy hydrology and USGS gage data also show gain periods. However, the WMC Loss Model does not add water to the yield during a gaining period. There is always a loss, either from evaporation during a gain month or a combination of evaporation and seepage during a loss month.

The ED Office selected two years to evaluate the hydrology for demonstration purposes in this memorandum. The years were selected based on the seepage per mile for the Odessa to Grand Island reach in the WMC Loss Model. The years do not represent typical wet, normal or dry years. The year 1993 (normal to dry) was selected due to the high seepages rates in January-February following by periods of reach gain (no seepage applied in the WMC Loss Model). The year 1978 (wet) was selected because the seepage pattern appears to be typical for the period, with losses in the winter and gains in the summer. The graphs in **Figures 1-3** below show 1993 hydrology data and **Figures 4-6** show 1978 hydrology data and the gain/loss periods. In general, the graphs represent the following:

- Red period (loss): red line is higher (Odessa is greater than Grand Island)
- Blue period (gain): blue line is higher (Grand Island is greater than Odessa)

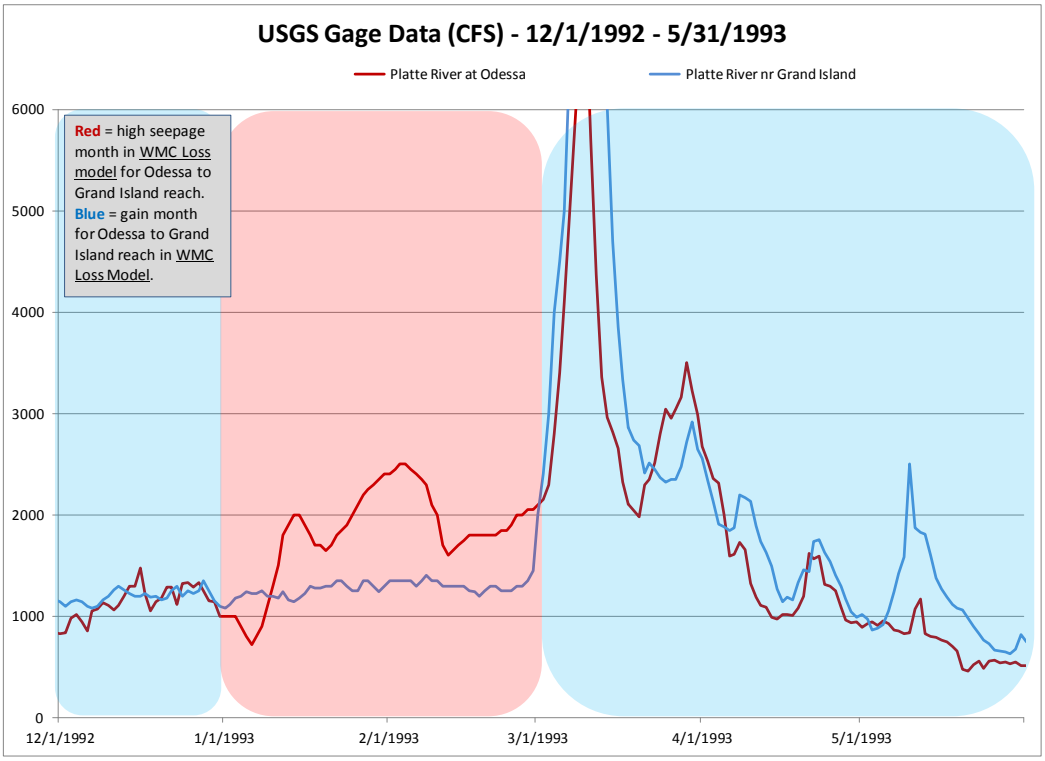

Figure 1. USGS gage data in WY 1993.

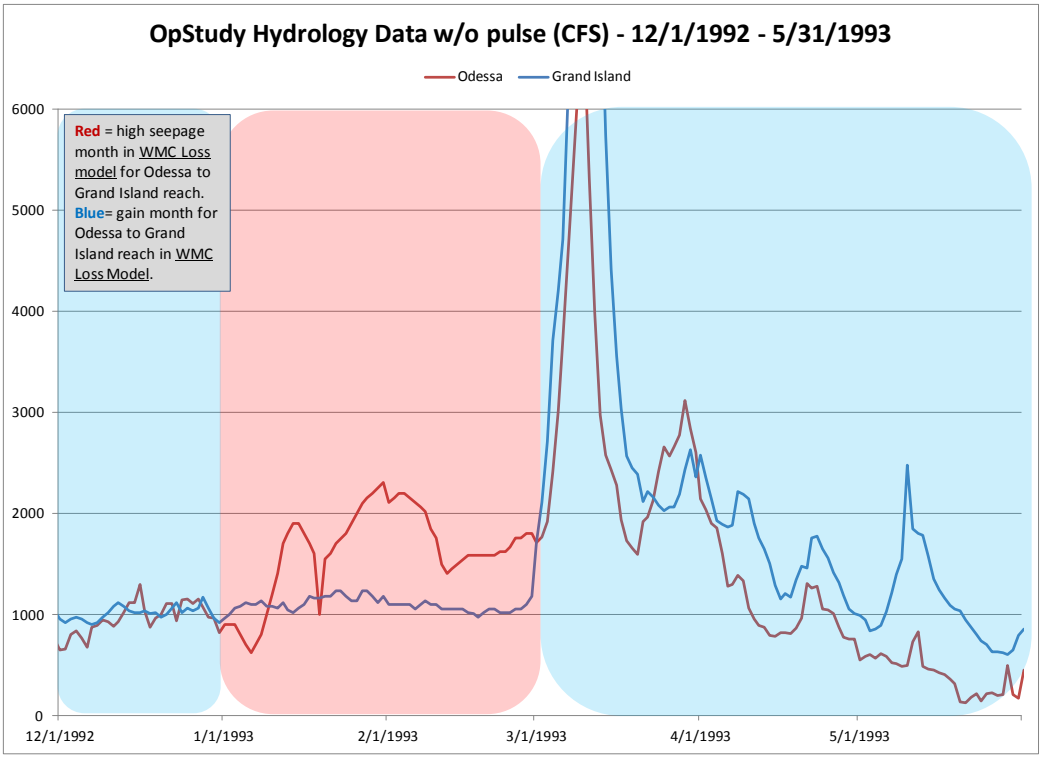

Figure 2. OpStudy data in WY 1993.

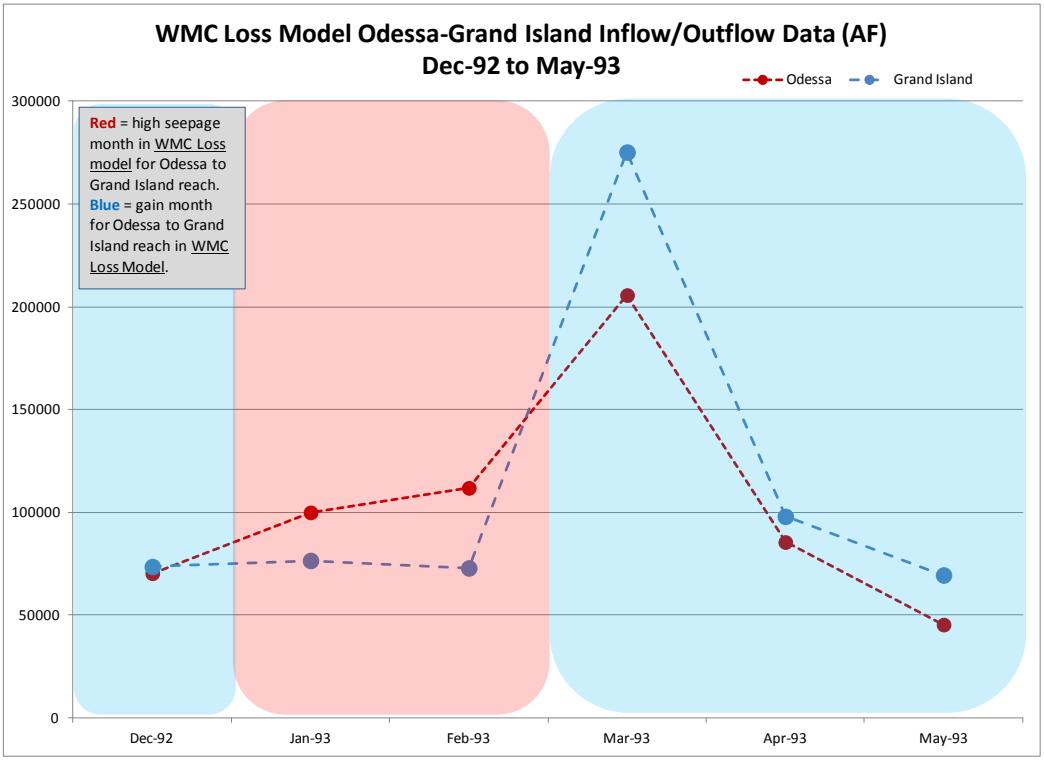

Figure 3. Monthly WMC Loss Model data in WY 1993.

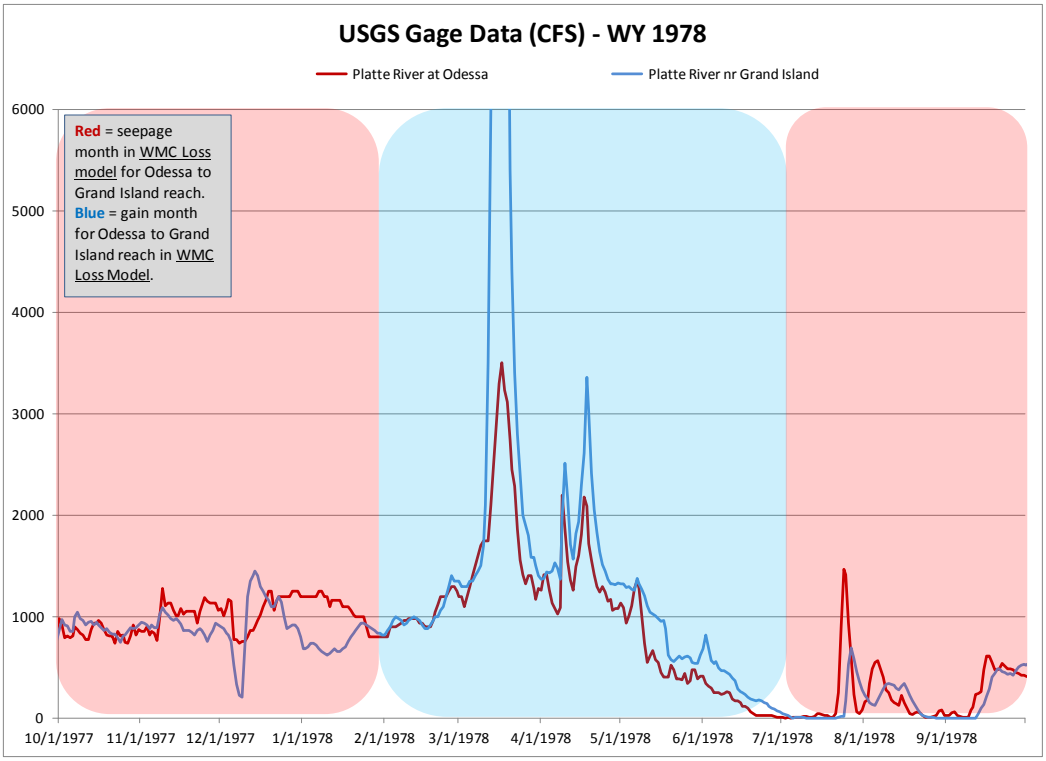

Figure 4. USGS gage data in WY 1978.

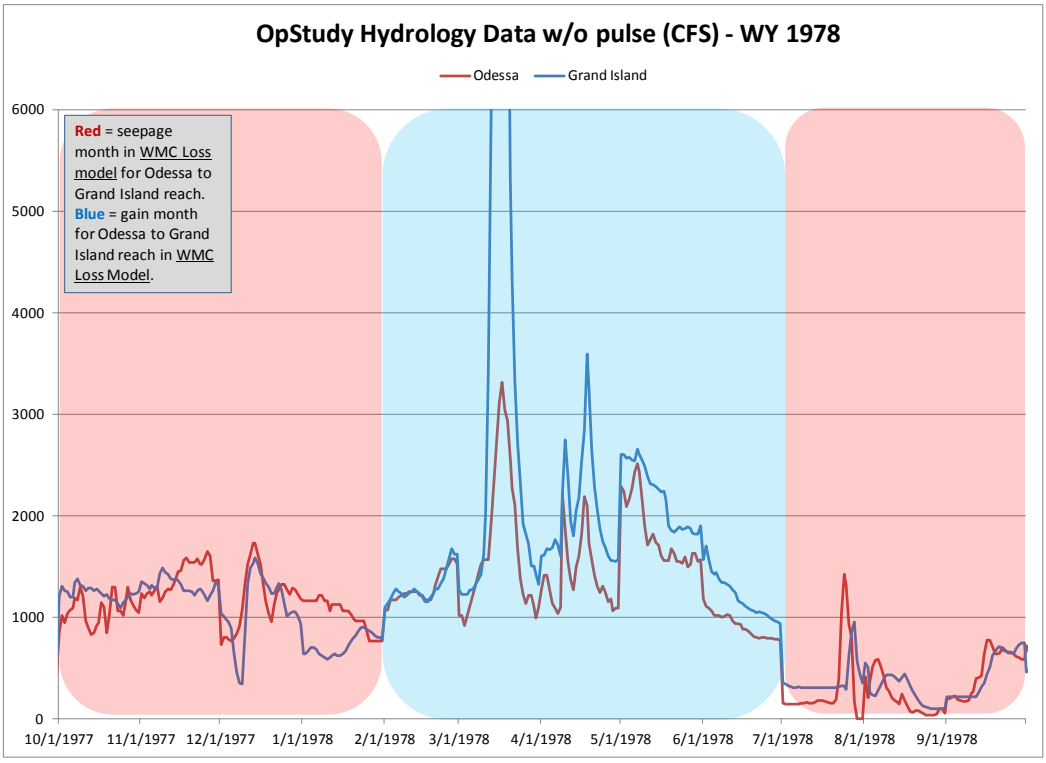

Figure 5. OpStudy data in WY 1978.

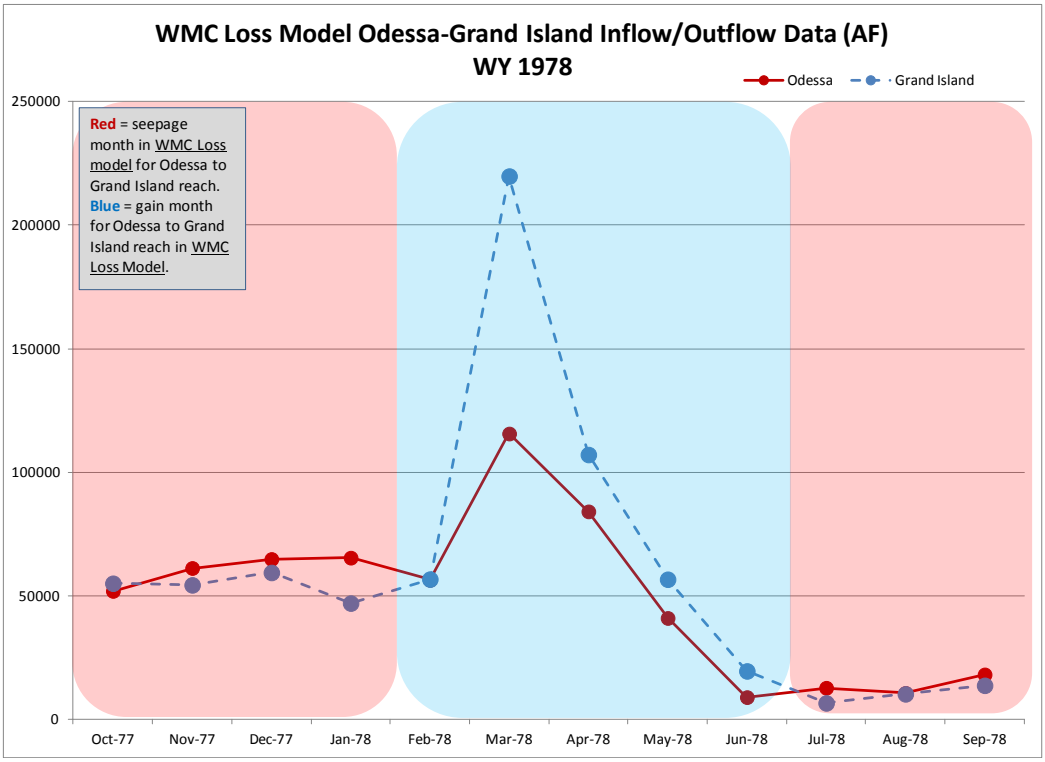

Figure 6. Monthly WMC Loss Model data in WY 1978.

APPENDIX A

TABLES FROM WATER MANAGEMENT STUDY, PHASE I (APPENDIX 2)

% EVAP PER MILE

Reach 18 Overton Gage to Odessa Gage Length 15.7 miles

% Evap = Evap divided by Total Inflow to the Reach multiplied by 100

Wtr Yr	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1975	0.0316	0.0102	0.0058	0.0047	0.0081	0.0115	0.0216	0.0522	0.0309	0.0893	0.0711	0.0348
1976	0.0197	0.0085	0.0051	0.0038	0.0065	0.0105	0.0222	0.0484	0.1061	0.0953	0.1406	0.0454
1977	0.0225	0.0107	0.0058	0.0054	0.0088	0.0114	0.0180	0.0295	0.0583	0.1211	0.0643	0.0363
1978	0.0306	0.0106	0.0061	0.0058	0.0105	0.0095	0.0254	0.0449	0.1127	0.1241	0.0798	0.0683
1979	0.0287	0.0104	0.0065	0.0059	0.0096	0.0092	0.0308	0.0454	0.0201	0.0306	0.0578	0.0570
1980	0.0355	0.0125	0.0041	0.0031	0.0043	0.0062	0.0098	0.0063	0.0120	0.1222	0.0871	0.0420
1981	0.0209	0.0116	0.0061	0.0046	0.0083	0.0130	0.0481	0.0417	0.0937	0.0470	0.0415	0.0421
1982	0.0218	0.0114	0.0059	0.0058	0.0077	0.0109	0.0448	0.0536	0.0611	0.1035	0.0572	0.0300
1983	0.0186	0.0073	0.0042	0.0028	0.0042	0.0062	0.0083	0.0075	0.0032	0.0076	0.0115	0.0079
1984	0.0084	0.0083	0.0027	0.0019	0.0022	0.0031	0.0045	0.0051	0.0080	0.0250	0.0533	0.0117
1985	0.0064	0.0027	0.0019	0.0022	0.0038	0.0049	0.0254	0.0265	0.0428	0.0583	0.0466	0.0213
1986	0.0113	0.0074	0.0040	0.0025	0.0041	0.0072	0.0110	0.0164	0.0210	0.0356	0.0189	0.0092
1987	0.0112	0.0047	0.0031	0.0026	0.0048	0.0063	0.0158	0.0152	0.0217	0.0486	0.0493	0.0237
1988	0.0126	0.0060	0.0037	0.0032	0.0040	0.0072	0.0208	0.0279	0.1127	0.0451	0.0557	0.0389
1989	0.0302	0.0132	0.0063	0.0040	0.0069	0.0084	0.0552	0.0809	0.0499	0.0792	0.0566	0.0345
1990	0.0374	0.0142	0.0079	0.0050	0.0084	0.0103	0.0231	0.0249	0.0884	0.1264	0.0656	0.0807
1991	0.0439	0.0111	0.0068	0.0059	0.0082	0.0141	0.0402	0.0307	0.0504	0.1058	0.1059	0.0818
1992	0.0408	0.0121	0.0070	0.0050	0.0078	0.0080	0.0329	0.0984	0.0691	0.0423	0.0596	0.0773
1993	0.0272	0.0117	0.0058	0.0038	0.0061	0.0059	0.0214	0.0488	0.0519	0.0262	0.0395	0.0278
1994	0.0183	0.0076	0.0045	0.0039	0.0062	0.0095	0.0306	0.0566	0.0858	0.0434	0.0728	0.0513
1995	0.0292	0.0116	0.0060	0.0045	0.0091	0.0140	0.0366	0.0229	0.0071	0.0128	0.0329	0.0265
1996	0.0137	0.0063	0.0047	0.0042	0.0055	0.0087	0.0222	0.0319	0.0317	0.0450	0.0267	0.0150
1997	0.0114	0.0057	0.0039	0.0034	0.0053	0.0086	0.0194	0.0291	0.0135	0.0416	0.0219	0.0192
1998	0.0098	0.0038	0.0025	0.0022	0.0041	0.0067	0.0108	0.0202	0.0303	0.0478	0.0344	0.0256
1999	0.0152	0.0059	0.0043	0.0029	0.0057	0.0090	0.0207	0.0130	0.0131	0.0287	0.0195	0.0141
2000	0.0091	0.0048	0.0031	0.0023	0.0040	0.0066	0.0175	0.0284	0.0428	0.0478	0.0568	0.0479
2001	0.0256	0.0095	0.0069	0.0051	0.0086	0.0108	0.0230	0.0340	0.0754	0.0529	0.0424	0.0339
2002	0.0257	0.0164	0.0063	0.0054	0.0093	0.0135	0.0446	0.0906	0.1180	0.0921	0.1207	0.0505
2003	0.0401	0.0194	0.0097	0.0089	0.0148	0.0221	0.0515	0.0609	0.0963	0.1151	0.1044	0.1214
2004	0.1026	0.0206	0.0123	0.0101	0.0138	0.0236	0.0927	0.1439	0.1783	0.1273	0.1216	0.1296
2005	0.0591	0.0181	0.0105	0.0075	0.0144	0.0214	0.0469	0.0571	0.0385	0.1192	0.0894	0.0907
2006	0.0416	0.0178	0.0108	0.0088	0.0178	0.0189	0.0570	0.1165	0.1354	0.1417	0.0834	0.0993
Avg	0.0269	0.0104	0.0058	0.0046	0.0076	0.0105	0.0298	0.0440	0.0588	0.0703	0.0622	0.0467
Max	0.1026	0.0206	0.0123	0.0101	0.0178	0.0236	0.0927	0.1439	0.1783	0.1417	0.1406	0.1296
Min	0.0064	0.0027	0.0019	0.0019	0.0022	0.0031	0.0045	0.0051	0.0032	0.0076	0.0115	0.0079
Std	0.0184	0.0045	0.0024	0.0020	0.0036	0.0049	0.0180	0.0318	0.0428	0.0394	0.0316	0.0313

% SEEP PER MILE

Reach 18 Overton Gage to Odessa Gage Length 15.7 miles

% Seep = Seep divided by Total Inflow to the Reach multiplied by 100

Wtr Yr	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1975		0.6520	0.2095		0.1043	0.2063	0.0101		0.0727			0.7529
1976	0.9291	1.2195	1.0255	1.0021	0.4467	0.2985	0.3650					0.1641
1977	0.0442	1.0920	0.2384	0.2338	0.4978		0.7329					0.4988
1978		0.0852	0.7870		0.2519				0.0484			0.1233
1979	0.8301	0.7010	0.0945						0.3565			
1980	0.2184		0.0302	0.3549								0.3941
1981	0.4626	0.6857			0.1404	0.4152						0.7824
1982			0.0851			0.4052						
1983		0.8729	0.6962	0.0280					0.2305		0.0520	0.4428
1984	0.0512	0.2084	0.0723	0.0373		0.0964		0.1652	0.0261			0.0664
1985	0.3171	0.4734	0.1676		0.2002	0.1289		0.0126				
1986		0.7581		0.1517					0.4130			
1987		0.3657	0.2644	0.1085								
1988			0.0758		0.2064							
1989	0.9034		0.0976									
1990		0.5384		0.1001	0.1468						0.0933	0.5019
1991	0.6422			0.7588	0.1905	0.1990						
1992	0.3265	0.0040			0.0498	0.2267						
1993	0.3415	0.6201	0.7018	0.4682								
1994	0.1684		0.0179									
1995				0.5383								0.0876
1996		0.5316	0.6363	0.0886	0.2454	0.5839						
1997						0.0178						0.1590
1998			0.2119		0.2216		0.2838					0.4979
1999	0.4043	0.4258										
2000			0.0886									0.1328
2001	0.5901											
2002												0.9425
2003	0.0659	1.6610	0.9319	0.5700								
2004		0.6694	0.5649	0.1843	0.4490	0.1676						
2005	0.3528	0.3272										
2006	1.0871	1.6665	1.7019	0.8770	1.4576	0.0197						

% DIVERSION PER MILE

Reach 18 Overton Gage to Odessa Gage Length 15.7 miles

% Div = Diversions divided by Total Inflow to the Reach multiplied by 100

Wtr Yr	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1975	1.2674	0.9841	0.0731			0.0892	0.6847	1.4358	1.1315	3.3059	2.9789	0.9157
1976	1.5850	0.7045				0.1737	0.9803	0.8138	2.3990	3.1585	4.6572	1.9518
1977	1.5700	0.7032				0.4412	0.7411	0.9215	2.0181	4.0427	3.7402	1.8480
1978	1.2261	0.3029					0.3983	1.4686	3.6300	2.7367	3.7627	2.8313
1979	1.7728	0.9125					0.3934	2.0227	0.6398	1.1498	3.0292	3.1102
1980	3.3932	0.3212					0.1443	0.1904	0.3315	4.2102	3.1347	2.3311
1981	2.3957	1.7283				0.2061	2.2264	2.2170	3.7660	1.4802	2.2482	2.3065
1982	0.7610						0.4728	1.2879	3.1227	4.3368	3.5652	1.9485
1983	0.1269						0.4101	0.2078	0.0984	0.1672	0.3332	0.2459
1984	0.3525	0.0065					0.0001	0.0419	0.1456	0.7626	2.4035	0.5357
1985	0.4204	0.2120					0.3800	0.4999	0.7683	2.4355	1.9968	1.1154
1986	1.0119	0.6720					0.1070	0.5460	0.6161	1.2897	0.7878	0.4329
1987	0.3849	0.1699					0.0806	0.4161	0.4929	1.2763	1.8659	0.7654
1988	0.7830	0.8018	0.3094			0.0621	0.4531	0.7486	2.6651	1.0236	1.4331	1.3857
1989	0.3496						0.6335	3.2836	1.2605	2.1594	2.2670	1.3525
1990	1.2909						0.1375	0.9571	3.3263	4.8582	2.1522	3.2321
1991	1.6186	0.0337					0.3252	0.4887	0.6111	2.3150	2.2409	1.2364
1992							0.1242	2.4719	2.3700	0.9176	1.0576	1.4867
1993	0.1704							0.1395	0.6948	0.2060	0.6141	0.4282
1994								0.0336	1.3136	0.9816	2.2136	0.7555
1995		0.4262						0.5434	0.1614	0.3146	1.1517	0.6122
1996								0.3813	0.6625	0.9540	0.5652	0.3753
1997	0.5674	0.5321					0.4302	0.9418	0.2624	1.3886	0.7966	0.8074
1998	0.2737	0.0017					0.2424	0.5851	0.7237	1.6690	1.3821	0.7138
1999	0.4581					0.2263	0.6394	0.1005	0.1394	0.4795	0.4091	0.3317
2000	0.2380	0.1363			0.0131		0.1623	0.5058	0.7834	0.8502	1.4461	1.3050
2001	0.7702							0.0512	1.5916	1.8806	1.8329	1.7126
2002	2.0328	1.9948					0.3044	2.9033	1.5254	2.2503	4.7793	2.5244
2003	2.4690							1.7854	4.5031	5.6744	6.0816	4.5512
2004								1.0973	5.6378	4.7396	5.5632	4.3365
2005	0.0011					0.2585	2.3655	2.8818	1.1514	5.0985	5.0904	5.4614
2006	3.3099	1.9225				0.6455	3.4599	5.7222	6.0631	6.1520	4.4899	5.8723
Avg	0.9563	0.3927	0.0120		0.0004	0.0657	0.5093	1.1779	1.7064	2.3208	2.5022	1.8381
Max	3.3932	1.9948	0.3094		0.0131	0.6455	3.4599	5.7222	6.0631	6.1520	6.0816	5.8723
Min								0.0336	0.0984	0.1672	0.3332	0.2459
Std	0.9483	0.5692	0.0549		0.0023	0.1453	0.7626	1.2150	1.5954	1.7008	1.5713	1.4776

% EVAP PER MILE

Reach 19 Odessa Gage to Grand Island Gage Length 56.2 miles

% Evap = Evap divided by Total Inflow to the Reach multiplied by 100

Wtr Yr	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1975	0.0280	0.0100	0.0050	0.0039	0.0069	0.0087	0.0177	0.0406	0.0252	0.0727	0.0747	0.0314
1976	0.0205	0.0090	0.0041	0.0037	0.0051	0.0084	0.0192	0.0375	0.1104	0.1076	0.1817	0.0391
1977	0.0204	0.0111	0.0050	0.0047	0.0075	0.0095	0.0140	0.0228	0.0416	0.1527	0.0688	0.0358
1978	0.0270	0.0091	0.0059	0.0049	0.0092	0.0043	0.0179	0.0371	0.1138	0.1469	0.0927	0.0657
1979	0.0295	0.0102	0.0055	0.0050	0.0080	0.0057	0.0196	0.0290	0.0172	0.0248	0.0596	0.0526
1980	0.0340	0.0109	0.0033	0.0026	0.0035	0.0043	0.0077	0.0048	0.0090	0.1112	0.1016	0.0400
1981	0.0202	0.0112	0.0051	0.0038	0.0070	0.0105	0.0415	0.0375	0.1026	0.0422	0.0310	0.0434
1982	0.0190	0.0094	0.0048	0.0047	0.0054	0.0077	0.0358	0.0338	0.0465	0.1002	0.0662	0.0271
1983	0.0161	0.0069	0.0034	0.0022	0.0034	0.0050	0.0066	0.0058	0.0025	0.0058	0.0091	0.0065
1984	0.0066	0.0066	0.0021	0.0013	0.0016	0.0024	0.0034	0.0040	0.0061	0.0172	0.0519	0.0093
1985	0.0052	0.0022	0.0015	0.0018	0.0029	0.0036	0.0170	0.0180	0.0358	0.0585	0.0433	0.0179
1986	0.0082	0.0068	0.0032	0.0021	0.0032	0.0055	0.0087	0.0134	0.0184	0.0317	0.0157	0.0073
1987	0.0090	0.0039	0.0026	0.0021	0.0038	0.0044	0.0116	0.0123	0.0157	0.0447	0.0462	0.0196
1988	0.0105	0.0050	0.0032	0.0026	0.0031	0.0059	0.0183	0.0230	0.0994	0.0412	0.0520	0.0340
1989	0.0269	0.0105	0.0051	0.0034	0.0057	0.0068	0.0491	0.0820	0.0451	0.0438	0.0552	0.0220
1990	0.0275	0.0103	0.0067	0.0028	0.0060	0.0073	0.0192	0.0199	0.0674	0.1602	0.0664	0.0920
1991	0.0448	0.0096	0.0058	0.0057	0.0064	0.0114	0.0365	0.0262	0.0353	0.1173	0.1131	0.0757
1992	0.0379	0.0104	0.0059	0.0041	0.0062	0.0066	0.0258	0.0986	0.0592	0.0385	0.0563	0.0762
1993	0.0246	0.0111	0.0053	0.0034	0.0050	0.0036	0.0158	0.0297	0.0399	0.0172	0.0306	0.0218
1994	0.0142	0.0057	0.0036	0.0032	0.0050	0.0056	0.0216	0.0483	0.0621	0.0354	0.0724	0.0463
1995	0.0257	0.0107	0.0051	0.0036	0.0073	0.0107	0.0225	0.0177	0.0054	0.0089	0.0265	0.0228
1996	0.0111	0.0052	0.0042	0.0035	0.0046	0.0067	0.0171	0.0196	0.0172	0.0310	0.0208	0.0123
1997	0.0091	0.0044	0.0032	0.0028	0.0044	0.0062	0.0145	0.0225	0.0107	0.0345	0.0187	0.0164
1998	0.0080	0.0030	0.0021	0.0017	0.0030	0.0053	0.0084	0.0138	0.0196	0.0394	0.0262	0.0233
1999	0.0122	0.0040	0.0033	0.0023	0.0043	0.0071	0.0146	0.0092	0.0096	0.0209	0.0143	0.0112
2000	0.0073	0.0038	0.0024	0.0019	0.0032	0.0054	0.0145	0.0224	0.0343	0.0434	0.0548	0.0436
2001	0.0233	0.0079	0.0059	0.0036	0.0060	0.0076	0.0182	0.0246	0.0600	0.0485	0.0390	0.0299
2002	0.0214	0.0142	0.0049	0.0041	0.0080	0.0115	0.0372	0.0722	0.1235	0.0933	0.1461	0.0536
2003	0.0382	0.0236	0.0100	0.0066	0.0130	0.0184	0.0412	0.0408	0.0910	0.1695	0.0008	0.0006
2004	0.0004	0.0200	0.0086	0.0092	0.0120	0.0177	0.0830	0.1592	0.2387	0.1761	0.1466	0.0008
2005	0.1014	0.0260	0.0150	0.0106	0.0191	0.0314	0.0615	0.0513	0.0411	0.3598	0.1323	0.1931
2006	0.0461	0.0215	0.0093	0.0078	0.0173	0.0174	0.0439	0.1448	0.2205	0.0936	0.1034	0.1187
Avg	0.0229	0.0098	0.0050	0.0039	0.0065	0.0085	0.0245	0.0382	0.0570	0.0778	0.0631	0.0403
Max	0.1014	0.0260	0.0150	0.0106	0.0191	0.0314	0.0830	0.1592	0.2387	0.3598	0.1817	0.1931
Min	0.0004	0.0022	0.0015	0.0013	0.0016	0.0024	0.0034	0.0040	0.0025	0.0058	0.0008	0.0006
Std	0.0182	0.0057	0.0027	0.0021	0.0039	0.0057	0.0171	0.0362	0.0563	0.0709	0.0437	0.0383

% SEEP PER MILE

Reach 19 Odessa Gage to Grand Island Gage Length 56.2 miles

% Seep = Seep divided by Total Inflow to the Reach multiplied by 100

Wtr Yr	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1975	0.2666	0.2434	0.4072	0.2251	0.1382						0.4637	
1976	0.3405	0.1561		0.2015					0.2759	0.9518	1.3683	0.9573
1977	0.2292	0.1427	0.3839	0.3205						0.4382	0.5168	
1978	0.1870	0.2600	0.1442	0.4968						0.9512	0.7961	0.9156
1979	0.4337	0.2415	0.2297	0.3410	0.4217				0.4159		0.3587	0.7015
1980	0.4552	0.2993		0.3853	0.0936		0.0395	0.2426			0.1920	0.6221
1981	0.3152	0.3176	0.2023	0.3026	0.2667				0.2928	0.6775		0.5441
1982	0.2859										0.0336	0.4714
1983		0.0709		0.2305	0.0916	0.0447	0.1619		0.1185	0.1095	0.1612	0.1976
1984						0.0082	0.0324		0.0649		0.5319	0.2977
1985	0.1862	0.0245	0.0975	0.2854								
1986				0.0411			0.3029	0.0051	0.0337	0.1491	0.3720	0.2638
1987	0.1225		0.0998	0.1676	0.0975			0.0638			0.3941	0.4372
1988	0.3702	0.1445	0.3227	0.2900		0.0814	0.1259	0.1497		0.2006	0.1922	0.2818
1989				0.0945	0.0826	0.1559		0.0912			0.2422	
1990			0.3194				0.0024			0.5663	0.1041	0.4685
1991	0.2442	0.3462	0.5582	0.2007			0.1698	0.1611		1.0087	0.8704	0.8192
1992	0.5798	0.1019	0.1310					0.1482		0.3107	0.5846	0.4392
1993	0.1312			0.4136	0.6159							
1994				0.2924	0.3213							0.4433
1995			0.0716									0.1210
1996				0.2765	0.3808							0.1342
1997			0.2363	0.2142	0.1418				0.1282		0.1305	0.0844
1998	0.0044	0.1742	0.0916									0.0587
1999												0.2318
2000	0.1953			0.0995	0.1229	0.0259	0.0078			0.0123	0.2863	0.5477
2001			0.1187							0.5008	0.3010	0.2038
2002					0.1073	0.0745			0.7163	1.1980	1.5880	0.9414
2003	0.2637	0.1180	0.0774							0.6972	1.7785	1.7787
2004	1.7789	1.0083							1.2403	0.7771	1.6320	1.7786
2005	1.1056	0.3734	0.2468	0.4955		0.0369			0.3815	0.1872	1.0703	0.7566
2006	0.9444					0.1563			0.5671	1.6377	1.1215	0.6409

APPENDIX F:

SCORING SUBCOMMITTEE MEETING MINUTES

PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM
GC Scoring Subcommittee Meeting Minutes
Conference Call
October 28, 2013

Meeting Attendees

Scoring Subcommittee

State of Colorado
Suzanne Sellers – Member

State of Nebraska
Jesse Bradley – Member

State of Wyoming
Mike Besson – Member (Chair)

U.S. Bureau of Reclamation
Brock Merrill – Member

Downstream Water Users
Brian Barels – Member
Cory Steinke – Alternate for Mike Drain
Duane Woodward – Interested Party

Executive Director's Office (ED Office)
Jerry Kenny, Executive Director (ED)
Beorn Courtney
Sira Sartori

Colorado Water Users
Jon Altenhofen – Member
Alan Berryman – Member

U.S. Fish and Wildlife Service (USFWS)
Tom Econopouly – Member

Environmental Groups
Duane Hovorka – Interested Party

Introduction

Besson did a roll call of the meeting attendees and briefly introduced the main discussion points for the conference call.

Habitat Scoring Adjustment

Courtney outlined the habitat scoring adjustment question posed in the 7/22/13 preliminary Phelps County Canal score memo and the responses the ED Office received from Scoring Subcommittee members. The question was whether there should be a habitat scoring adjustment for projects that do not benefit the entire reach. The comments received before the conference call from the Subcommittee members were across the board and included yes, maybe and no.

Besson said he believed that there should be a habitat adjustment for certain projects but not for other projects, such as wet meadow projects, so it should be determined on a case-by-case basis. Altenhofen noted that there are two compliance points (top of the habitat and Grand Island) and that the standard should be to benefit the whole reach. If flow improvements are part way down the reach, the Program is only reducing shortages in a portion of the reach. Besson commented

that the Program should get a full score for Short Duration High Flow (SDFH) events and Altenhofen agreed that certain projects, such as SDHFs and wet meadows do not necessarily need to be adjusted because they have a different purpose than reducing shortages in the reach. Berryman asked if SDHF events were included in the J-2 Regulating Reservoir and Courtney said no, the J-2 Regulating Reservoir was only scored for reduction to shortages.

Econopouly stated that the USFWS still has the position that there should be a habitat adjustment, in addition to routing losses. Sellers commented that it seems somewhat counterintuitive to route losses in the reach since there are two compliance points. Sellers related it to instream flow rights in Colorado. Sellers clarified that she believes a routing loss should occur from the project location to the top of the habitat reach, but not necessarily within the reach since the travel losses are a natural occurrence. The Scoring Subcommittee thought this was a good point and there was some discussion on this topic. The group was open to thinking more about whether routing losses should be applied to scoring in the future, but not going back and revising the J-2 Regulating Reservoir score. It was noted that the Program scoring has always been conservative.

Besson asked about how the Nebraska Department of Natural Resources (NDNR) treats conveyances losses for instream flows. Bradley said they do not deal with routing losses for instream flows but losses are assigned to storage water or transferred surface water. Bradley didn't think that recharge accretions needs to be routed. If water is actively pumped to the river for instream uses, the water would be protected and would be routed under a water right.

Barels noted that when project yields are combined, the routing losses may be different than for individual projects and the Program could be overstating losses. Natural flow in the river will also share a portion of the total reach losses. He asked how the ED Office has been treating losses for projects. Courtney responded that the Program scoring has used proportional loss factors, as opposed to a set loss volume. Econopouly said he thought the Overton to Grand Island reach may be gaining, based on his observations of OpStudy data. There was discussion among the group about various loss modeling components, such as evaporation, seepage and diversions. The group was interested in learning more about how the WMC Loss Model compares to other modeling, such as in OpStudy and an HDR report. Econopouly said he would check in with the ED Office regarding his thoughts on loss modeling.

Besson asked about whether the Phelps County Canal recharge project should have a habitat adjustment, since there is only a 2% difference in the score. Members of the Subcommittee said yes, to be consistent among project scoring. The Subcommittee also agreed to use a linear approach to adjust the score for the proportion of habitat reach impacted. Besson mentioned that the group should keep in mind that it is important to accept scores before moving forward with projects and the group should not necessarily wait until more detailed information and modeling is available.

Main points:

- Subcommittee will think more about whether routing losses should be applied to project scoring since there are two compliance points and travel losses are natural within the reach.
- Subcommittee agreed that a habitat adjustment is justified and a linear approach is appropriate. The Phelps County Canal score should be adjusted for consistency among projects.
-

Preferential Use of Accretions

The discussion moved onto the next question raised in the 7/22/13 preliminary score memo, which was the preferential use of accretions with Program partners. Bradley said that in terms of the Nebraska New Depletions Plan (NNDP), the NDNR has historically reported annual volumes because of the accuracy of the analysis tools available. In the future, the NDNR anticipates mitigating during shortages and modeling on a shorter basis, such as monthly. The Scoring Subcommittee agreed that since the NNDP is intended to replace shortages and will be accounted for this way in the future, the Program cannot preferentially claim credit during shortages.

There was some discussion on leasing water from project partners that may not need a full supply, such as the NDNR's portion of the J-2 Regulating Reservoir. The Program may be able to lease this in the future. Altenhofen reminded the group that scoring is based on historical hydrology, which may be different than the current and future hydrology.

Main points:

- Scoring Subcommittee decided that the Program cannot preferentially use accretions from the Phelps recharge project during shortages with project partner, Tri-Basin Natural Resource District (TBNRD).

Scoring Multiple Projects

The ED Office had asked the group whether combined operations between projects should be included in the score analyses. The Scoring Subcommittee member comments provided to the ED Office before the call included yes and maybe answers. Courtney talked about a follow-up combined operations scoring analysis completed by the ED Office in a memo dated 10/22/13.

The ED Office assumed the J-2 Regulating Reservoir was first priority to divert excesses and then, either the Phelps County Canal or Central Platte Natural Resource District (CPNRD) had the next diversion priority. The analysis was not meant to assume the Phelps County Canal recharge or the CPNRD recharge had a certain priority over each other, as neither of the recharge permit applications have been approved by the NDNR. In general, the ED Office's preliminary analysis of the J-2 Regulating Reservoir and Phelps County Canal showed a 2% overall impact to the combined score or about a 38% reduction in the Phelps recharge score. Assuming the CPNRD has second priority and the Phelps County Canal has third priority has a minimal additional impact on the combined score. The J-2 Regulating Reservoir diversions have a much

greater impact on combined operations. It was asked whether the capacity of the Phelps County Canal is a limiting factor in diverting excesses into recharge. The ED Office thought it may be a combination of both capacity and excesses that may be limiting. Steinke noted that the water coming out of the hydropower plant is about 1,700 cfs so the Phelps County Canal capacity may not be the issue. The ED Office will look at this further.

Steinke also mentioned that when there are big storm events, the stream flow can be forecasted and both projects may be able to fill without an impact. The ED Office has already looked at optimizing the projects by forecasting using a typical wet, normal and dry year but has not evaluated this for the 1947-1994 modeling period. The ED Office will look at this further. In addition, Courtney mentioned that the Program may use COHYST in the future to evaluate the impact of combined projects.

Main points:

- Scoring Subcommittee did not make a decision on whether the score should be reduced for combined operations, as the ED Office will provide additional documentation on optimizing combined operations.

Protection of Flows

The group discussed whether recharge accretions can be protected under the Nebraska State Statue Section 46-252. In general, a point discharge to the river that can be measured can be protected. It was noted that guidance from the NDNR will be important on this topic. Steinke said water for the NNDP is different than Program water. NNDP water is not protected since it is for the downstream water users to prevent injury to water rights. The purpose of the Program water is to reduce shortages, not provide other users with water. Steinke also noted it will be difficult to distinguish the water in the river and returns estimated using modeling. Altenhofen commented that this issue is important to look at for each project. Barels agreed that it will be difficult to "color" the water from recharge. A couple of the Scoring Subcommittee members raised the concern that the water recharged cannot be protected because it could be pumped by irrigation wells. The question was raised whether the Phelps numerical model accounts for irrigation wells and Courtney responded that well pumping is a factor in the model but wells are not modeled individually. In general, the group felt that if water is discharged to the river, the Program can protect the flows. For other projects, such as recharge, the water is assumed to be unprotected. For the Phelps County Canal Groundwater Recharge project, the Kearney Canal is the only downstream diversion before Grand Island.

Main point:

- Scoring Subcommittee does not believe recharge accretions can be protected. Other Water Action Plan projects that discharge directly to the river can be protected from other water users.

Other Comments from Subcommittee

Additional questions raised by the Scoring Subcommittee, submitted to the ED Office before the call, were discussed. These are included in the 9/13/13 memo to the Scoring Subcommittee outlining the group comments. Courtney addressed the comment about using an SDF method or Glover method vs. using the Phelps numerical model. Courtney said that once the score is accepted, it won't be necessary to complete monthly accounting with lagged accretion modeling, unless the project significantly changes. Modeling may be done periodically as a check. Altenhofen agreed that it doesn't make sense to recalibrate SDFs for the 9.7 to 13.3 portion of the canal so it is appropriate to use the numerical model.

A question was raised about whether the recharge season assumed in the modeling (mid-September through mid-April) is appropriate. Steinke said he believes the full season is appropriate. Econopouly expressed concern that canal maintenance may restrict diversions in some years. Typically, maintenance doesn't last very long and Steinke thinks it would have a minimal impact. Sartori noted that the preliminary score analysis for the Phelps County Canal is on the conservative side. The group seemed to agree with using the mid-September through mid-April period since CNPPID seems confident in that time frame.

To wrap up the meeting, Besson told the group that the ED Office will send out a poll for the next conference call, which is expected to be scheduled in about 2 weeks. A final score summary memo will be completed by the ED Office after the Scoring Subcommittee has come to an agreement on the score topics.

Action Items

General Subcommittee

- Send additional scoring comments to Besson.
- Review combined scoring operations memo dated 10/22/13 (emailed to group on 10/25/13).
- Review additional combined operations information the ED Office will send out in the next week.

ED Office

- Discuss various routing methods with Econopouly after combined operations analysis is update is completed.
- Evaluate how often the Phelps County Canal capacity limits the excesses diverted in the combined scoring evaluation.
- Follow up with Woodward to confirm the CPNRD recharge assumptions in the combined scoring memo dated 10/22/13 are appropriate.
- Evaluate optimization of the J-2 Regulating Reservoir and Phelps County Canal Groundwater Recharge score model and send to the Scoring Subcommittee in the next week.
- Send out a doodle poll to schedule the next meeting.

PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM
GC Scoring Subcommittee Meeting Minutes
Conference Call
November 15, 2013

Meeting Attendees

Scoring Subcommittee

State of Colorado
Suzanne Sellers – Member

State of Nebraska
Jesse Bradley – Member

State of Wyoming
Mike Besson – Member (Chair)

U.S. Bureau of Reclamation
Brock Merrill – Member

Downstream Water Users
Jeff Shafer – Alternate for Brian Barels (Member)
Mike Drain – Member
Duane Woodward – Interested Party

Executive Director's Office (ED Office)
Jerry Kenny, Executive Director (ED)
Beorn Courtney
Sira Sartori

Colorado Water Users
Jon Altenhofen – Member
Alan Berryman – Member

U.S. Fish and Wildlife Service (USFWS)
Tom Econopouly – Member

Introduction

Besson did a roll call of the meeting attendees and briefly introduced the main discussion points for the conference call.

Season of Recharge

Courtney went over the memorandum provided to the Scoring Subcommittee dated 11/13/13 regarding the recharge season. The memo was in response to Econopouly's question during the 10/28/13 conference call about whether canal maintenance would impact diversions into recharge. Based on the analysis, it appears there are often days when recharge diversions are not occurring in the shoulder season and it is anticipated that canal maintenance could be scheduled during these times. Courtney noted that Cory Steinke of the Central Nebraska Public Power and Irrigation District (CNPPID) has expressed that maintenance could likely be planned around recharge activities. The Scoring Subcommittee agreed that the recharge season used in the preliminary analysis is appropriate.

Econopouly asked if Environmental Account (EA) releases from Lake McConaughy will impact diversions into recharge. Drain stated the EA water is a protected release, all the way to

Chapman. The scoring analyses do not re-regulate EA water (the flow data used for the scoring analyses does not include EA water) and diversions into the Phelps recharge project occur during excess periods only. Courtney explained that although there isn't a score for Short Duration High Flow events, the EA Manager/USFWS can use the water in the J-2 Regulating Reservoir for this purpose without an impact to the score. The score is based on target flow reductions, but the water can be used for other Program releases.

Main points:

- Scoring Subcommittee agreed to continue using the recharge season of September 15th through April 15th, described in the 7/22/13 preliminary Phelps recharge score analysis memo.

WMC Loss Model

Courtney described the WMC Loss Model and the reach gains/losses memorandum dated 11/13/13 provided to the Scoring Subcommittee. The Scoring Subcommittee had requested information on the application of the WMC Loss Model and how the reach gains/losses compare to OpStudy during the 10/28/13 conference call. The ED Office used the WMC Loss Model in the 2009 Water Action Plan update. The WMC Loss Model was used in the 1999 Water Conservation Study and the 2000 Reconnaissance-Level Water Action Plan, to route specific project yields to Grand Island. As described in the 2000 Water Action Plan, OpStudy modeling was also used in developing the final Program milestone range of 50,000 acre-feet (AF) to 70,000 AF per year.

Courtney explained that although there may be a gain in the river, the WMC Loss Model will still deduct evaporation from the Program yield on a percent per mile basis. During a loss period, the WMC Model will also deduct seepage from the Program yield on a percent per mile basis. Courtney pointed out the evaporation and seepage tables in Appendix A of the 11/13/13 memo. Drain recalled that the WMC Loss Model assumptions are similar to how the NE Department of Natural Resources (NDNR) administers water rights. Gains in the river are credited to the natural streamflow for downstream appropriators. New projects should not get additional flow from the gaining river. All users share in the evaporation losses. Drain thought the WMC Loss Model is appropriate for scoring.

The group discussed using the WMC Loss Model to apply routing losses or not applying any routing losses. Altenhofen said that not applying losses would be inconsistent with the J-2 Regulating Reservoir score model. Drain believes routing the yields to Grand Island is consistent with what was intended for the Program during the Cooperative Agreement. Econopouly agreed with routing and a habitat discount. The group discussed that the target flows are set at Grand Island and scoring at Grand Island was discussed during the Cooperative Agreement.

Altenhofen requested a brief explanation of the years used in the 11/13/13 reach gains/losses memo, as these are not the representative years used in the combined operations analysis memo dated 11/5/13. The ED Office will add a brief explanation in the memo.

Main points:

- Scoring Subcommittee agreed to continue using the WMC Loss Model as described in the 7/22/13 preliminary Phelps recharge score analysis memo.

Score Optimization

Courtney and Sartori went over the two combined scoring memos given to the Scoring Subcommittee. The first combined scoring memo is dated 10/22/13 and includes the J-2 Regulating Reservoir, Phelps recharge and Central Platte Natural Resources District (CPNRD) canal recharge. The second memo is dated 11/5/13 and discusses the "optimization" of the J-2 Regulating Reservoir and Phelps recharge, to minimize the impact of combined operations with forecasting (note that the ED Office has subsequently identified that referencing this analysis as an "optimization" may be misleading and therefore it will be referenced as an "event-based operations" analysis herein and moving forward).

In the combined scoring analysis of the J-2 Regulating Reservoir and Phelps recharge (10/22/13), the J-2 Regulating Reservoir diversions impact the Phelps recharge diversions by 38%. The ED Office evaluated two scenarios to maximize the operation of the projects. A 3-day event-based analysis was completed, in which the Phelps recharge became the diversion priority if the J-2 Regulating Reservoir was going to fill in the following 3 days. This reduced the impact to the Phelps recharge to 32%-34%. The ED Office also looked at manually adjusting the diversions into the Phelps recharge by forecasting excesses during a representative wet, normal and dry year. The impact to the Phelps recharge project ranged from 0% to 31%. Drain stated that CNPPID will likely be able to forecast the excesses available in advance and that the representative year analysis is more reflective of future operations then the 3-day event-based operations. He also noted that previous scoring estimates have also forecasted flows. Econopouly agreed with this, as long as forecasting is operationally feasible.

Courtney also discussed that the ED Office believes a higher canal capacity may be appropriate to use in future scoring, based on the estimate to Mile Post 13.3 from Steinke at CNPPID. The score analysis includes recharge in the beginning of the canal, before the flume. Drain asked whether the first couple miles of canal are included in the storage estimate and reminded the group that water in CNPPID's system will now be routed through the reservoir and returned to the river. The ED Office will check in with Steinke regarding the canal capacity question. Besson believes that the Program can still take credit for recharge in the early section of the canal, even if other water is diverted through this section. Altenhofen agreed that taking credit during excess periods made sense. The Scoring Subcommittee agreed with continuing to include recharge in the beginning of the canal section in the scoring analyses. Drain was uncertain about the permitting of such operations and therefore abstained from the decision.

Sartori noted that there are several factors that impact the combined operations, such as times when the J-2 Regulating Reservoir diverts all of the available excesses and quickly releases for a

score. Drain said that the reservoir will be better able to capitalize on these periods because water is already flowing in the canal and into the reservoir.

Drain proposed an approximate score of about 1,700 AF per year, based on representative year event-based analyses and a weighted average of the scores (shown in Table 2 Column L of the 11/5/13 memo) and Besson agreed with using this score. The Scoring Subcommittee decided it may be beneficial to agree upon the assumptions for the methodology and then the ED Office could update the score analysis with a higher canal capacity, if appropriate. Besson suggested that the recommended score be brought to the Governance Committee at the December 3-4, 2013 meeting. He requested the ED Office look at an additional set of representative wet, normal and dry years to see if the results are about the same, and to make the analysis more credible. Sartori pointed out that the impact to the Phelps recharge project won't be more than the impact with combined operations, so there is a general score range presented. Besson said that as long as the results of the second set of representative year analyses are about the same as the first set, the score methodology is appropriate.

The group came to a consensus to use the methodology presented in Table 2 of the 11/5/13 memo and update the analysis with the appropriate canal capacity, if needed. The methodology is to calculate the estimated score for a representative wet, normal and dry year and then calculate a weighted average based on the proportion of dry, normal and wet years during the modeling period. Besson asked if anyone had an issue with this consensus and there was no response from the group. Bradley said he agreed with the approach. The Scoring Subcommittee agreed that unless the results are significantly different, the group agrees to this methodology and resulting score.

Altenhofen requested the ED Office update the 7/22/13 preliminary score analysis memo with the final recommended score and put the additional sensitivity analyses discussed by the Scoring Subcommittee in an appendix to the memorandum. The ED Office will update the preliminary score analysis memo; however, due to time constraints with the GC meeting, the ED Office will provide a brief memo to the Scoring Subcommittee on the final recommended score beforehand. If any of the members in the group have an issue or question about the recommended score, they should contact Besson; otherwise, the Scoring Subcommittee agrees to recommend this score to the GC, based on the methodology outlined previously.

Main points:

- The Scoring Subcommittee agreed to the methodology and the resulting score (to be provided to the Scoring Subcommittee by the ED Office) to recommend to the GC at the December meeting.

Other Comments from Subcommittee

Besson asked the group about whether this detailed scoring process should be completed for every future project. Besson noted that detailed scoring can become expensive and questioned whether similar requirements would be made of every sponsor bringing forward projects. Drain

said he believes scoring should be completed by the Program. Project sponsors can provide input but it is the Program's decision on how to score each project. Altenhofen noted that each project using excesses should be evaluated in comparison to the J-2 Regulating Reservoir, since there may be competition for excess flows. In future projects, Altenhofen and Drain agreed that projects using excess flows should be modeled and scored based on combined operations. The Scoring Subcommittee agreed.

Action Items

General Subcommittee

- Review memo on final score to propose to GC and provide any comments to Besson. The ED Office will provide this to the Subcommittee in the next week.

ED Office

- Additional analyses:
  - Discuss the canal capacity with Steinke and determine if 1,160 AF is appropriate.
  - If the canal capacity changes, update the representative year event-based analyses.
  - Evaluate an additional dry, normal and wet year with event-based combined operations of both projects.
- Write up a brief memo and provide to the Scoring Subcommittee next week with the proposed score to recommend to the GC.
- Revise the following memos:
  - 7/22/15 preliminary score memo: update memo with final score recommendations for the GC, add sensitivity analyses as appendix.
  - 11/5/13 combined score memo: describe that Scenario A and Scenario B are different and the impacts are not cumulative.
  - 11/13/13 reach gains/losses: explain why the graphed years were evaluated, as they are not the same representative years as used in the combined operations memo.

APPENDIX G:

MEMORANDUM – COMBINED SCORING ANALYSIS FOR J-2 RESERVOIR, CPNRD RECHARGE AND PHELPS RECHARGE

TO: SCORING SUBCOMMITEE

FROM: ED OFFICE

SUBJECT: COMBINED SCORING ANALYSIS FOR J-2 RESERVOIR, CPNRD RECHARGE AND PHELPS RECHARGE

DATE: OCTOBER 22, 2013

I. INTRODUCTION

To date, the J-2 Regulating Reservoir is the only Water Action Plan project that has received a Governance Committee-approved score[1]. The Governance Committee (GC) approved a score for the J-2 Regulating Reservoir of 40,800 acre-feet per year (AFY). The Program will receive credit for 75% of this project or a score of 30,600 AFY. The ED Office completed a preliminary scoring analysis for the Phelps Groundwater Recharge project and presented findings to the Scoring Subcommittee in a memo dated 7/22/2013, however this analysis considered the Phelps County Canal Groundwater Recharge project independently from other projects. In review of the Phelps County Canal Groundwater Recharge analysis, Scoring Subcommittee members raised questions regarding the potential competition for excess flows[2] between various Water Action Plan projects. The J-2 Regulating Reservoir, Phelps County Canal Groundwater Recharge and the Central Platte Natural Resource District (CPNRD) Groundwater Recharge are three Water Action Plan Projects that will use excess flows from the Platte River as a water supply.

Unlike the J-2 Regulating Reservoir project, where the reservoirs can be operated to make releases at times of shortage, the recharge projects result in lagged accretions that may or may not accrue to the river at times of shortage. The lagging process has a dramatic effect on the project score. At this time, the ED Office has completed significantly more modeling of the J-2 Regulating Reservoir and the Phelps County Canal Groundwater Recharge projects versus the CPNRD Groundwater Recharge project. Specifically, more information about lagged groundwater recharge effects is available for the Phelps County Canal project. Therefore, it is not possible to estimate a CPNRD Groundwater Recharge score with the same degree of certainty as for the Phelps County Canal Groundwater Recharge project. However, it is possible to analyze the impacts of combined projects on excess flows available to be diverted by each project, and then to estimate the subsequent impact on the project score.

The ED Office completed a preliminary analysis to evaluate combined effects of the three projects on the potential Phelps County Canal Groundwater Recharge project score. In this preliminary analysis, the ED Office assumed the J-2 Regulating Reservoir had the first diversion priority when excess flows were available and then either the Phelps County Canal Groundwater recharge project could divert, or CPNRD Recharge projects could divert next followed by the

[1] A project score is in reference to the Program's First Increment Objective of reducing shortages to USFWS target flows by an average of 130,000 to 150,000 AFY (Water Action Plan projects are 50,000 to 70,000 AFY of that total).

[2] Excesses are considered excess to USFWS target flows and instream flows.

Phelps County Canal Groundwater Recharge project. The combined diversion and score analyses are included in Sections II and III in this memorandum. The analyses only consider the potential impact on the Phelps County Canal Groundwater Recharge project and do not attempt to include the CPNRD Groundwater Recharge project score.

The ED Office also compared the excess flows at Grand Island in the OpStudy hydrology versus the Nebraska Department of Natural Resources (NDNR) Excess Flow Report[3] hydrology, which is described in Section IV. The score analyses and excess flow evaluation presented in this memorandum are preliminary and may be refined in the future.

II. ANALYSIS A: COMBINED SCORING OF PROGRAM PROJECTS

The J-2 Regulating Reservoir and the Phelps County Canal Groundwater Recharge are both in Central Nebraska Public Power and Irrigation District's (CNPPID) system and use the Phelps County Canal to divert excess flows. The J-2 Regulating Reservoir will be located adjacent to the Phelps County Canal and will use the canal from its headgate to approximately 3 miles downstream of the J-2 Return. The Groundwater Recharge project will use the Phelps County Canal from the headgate to Mile Post 13.3 for recharge within the canal. The ED Office completed a preliminary scoring analysis to evaluate whether there could be an impact to the Program scores for the J-2 Regulating Reservoir and the Phelps County Canal Groundwater Recharge projects due to implementation of both projects on the same system. The J-2 Regulating Reservoir was considered the first priority to divert water and the Phelps County Canal Groundwater Recharge project was considered the second priority. ***The CPNRD canal recharge project was not included in this combined scoring analysis.***

A. J-2 REGULATING RESERVOIR

As first priority, the J-2 Regulating Reservoir is the first project to be able to divert excess flows (minimum of Grand Island excesses or excesses available in CNPPID's system at the Phelps Canal). The J-2 Regulating Reservoir score model was not changed. The total project score remains 40,800 AFY in Analysis B and the Program portion is 75%, as previously accepted by the GC.

- **J-2 Regulating Reservoir Score = 30,600 AFY for Program**

B. PHELPS COUNTY CANAL RECHARGE

The scoring analysis presented in the 7/22/2013 memo evaluated the Phelps County Canal Groundwater Recharge as an independent project and did not incorporate combined operations with the J-2 Regulating Reservoir. Based on this analysis, the total project score was estimated at 3,729 AFY when a habitat discount was considered. The Program would receive 50% of this credit or 1,865 AFY.

[3] *Evaluation of Historic Platte River Streamflow in Excess of State Protected and Target Flows* dated December 2010 and the report supplement dated March 2013 by HDR and The Flatwater Group, Inc. for the Nebraska Department of Natural Resources.

To determine the impact from combined operations on the score, the ED Office revised the Phelps Groundwater Recharge diversion analysis by deducting the J-2 Regulating Reservoir diversions[4] from the excess flows available in the Phelps County Canal. Due to the lagged effect of groundwater recharge, not all diversions into recharge result in a reduction to shortages. Therefore the remaining part of the scoring analysis needs to be considered to evaluate the potential impact of reduced diversions on the project score. The diversions into recharge were reduced by approximately 38%, based on this analysis. The volume of water recharged in the canal was lagged to the river using the numerical model; however, the ED Office did not re-run the score model. Instead, the ED Office assumed a "score efficiency" of 40%, based on the results of the 7/22/13 Phelps Groundwater Recharge scoring memo to the Scoring Subcommittee. The "score efficiency" is considered the score divided by the diversions into recharge (or the volume recharged).

- **Phelps Groundwater Recharge Score: 1,159 AFY for Program**
  - This is a 38% decrease than when scored independently (1,865 AFY score).

C. TOTAL PROGRAM SCORE

The total estimated Program score for the J-2 Regulating Reservoir and the Phelps County Canal, when scored as individual projects is **32,464 AFY** (30,600 AFY + 1,865 AFY, including habitat adjustment). When the projects are scored together, the total Program score reduces to **31,759 AFY** (30,600 AFY + 1,159 AFY). This is approximately a **2% decrease in the total Program score** towards the First Increment water objective. Note that the J-2 Regulating Reservoir water released to reduce shortages was not accounted for in this score estimate so it is unknown whether this would impact the combined score. **Table 1** is a summary of the results.

Table 1. Analysis Summary of Combined Scoring with J-2 Res and Phelps Recharge.

Analysis Item	Volume (AFY)
J-2 Regulating Reservoir Score (A)	30,600
Independent Analyses	
Phelps Recharge Diversions (B)	*4,631*
Phelps Recharge Score (C)	1,865
Total Score from Independent Analyses (D)	32,465
Combined Analysis (J-2 Res as Priority)	
Phelps Recharge Limited Diversions (E)	*2,896*
Phelps Recharge Score (F)	1,159
Total Score from Combined Analysis (G)	31,759
Impact of Combined Analysis	
Reduction in Phelps Recharge Score (H)	706
Estimated Reduction in Score for Combined Operations (I)	**2%**
Estimated Reduction in Score for Phelps Recharge Only (J)	**38%**

(A) Score for the Program (75% of project is credited to the Program, 40,800 AF × 75%).

[4] Both the J-2 Regulating Reservoir diversions and the Phelps Groundwater Recharge diversions were calculated on a daily basis (the lagging and subsequent portions of the scoring analysis for the recharge project were conducted on a monthly basis).

(B) Diversions into recharge associated with the Program (50% of project is credited to the Program, 9,261 AF × 50%).
(C) Score for the Program, with a habitat adjustment (50% of project is credited to the Program, 3,729 AF × 50%).
(D) Total score for the Program (as independent projects). Calculation = (A) + (C)
(E) Diversions into recharge for Program (50% of project) after accounting for diversions into the J-2 Reservoir.
(F) Score based on efficiency of 40%. Calculation = (E) × 40%.
(G) Total project score for the Program (as combined projects). Calculation = (A) + (F).
(H) Calculation = (C) - (F).
(I) Total reduction in Program score for Phelps Recharge and the J-2 Reservoir. Calculation = (H) ÷ (D).
(J) Total reduction in Program score for Phelps Recharge only. Calculation = (H) ÷ (C).

III. ANALYSIS B: COMBINED SCORING WITH CPNRD RECHARGE

The ED Office evaluated combined operations for the J-2 Regulating Reservoir, the CPNRD Canal Recharge project and the Phelps County Canal Recharge. In this analysis, it was assumed the J-2 Regulating Reservoir was able to divert excess flows first (first priority) and then CPNRD for recharge in the 30-Mile, Cozad and Orchard-Alfalfa Canals (second priority) and then the Phelps County Canal for recharge (third priority). The main analysis components are described below.

A. J-2 REGULATING RESERVOIR

As first priority, the J-2 Regulating Reservoir is the first project to be able to divert excess flows (minimum of Grand Island excesses or excesses available in CNPPID's system at the Phelps Canal). The J-2 Regulating Reservoir score model was not changed. The total project score remains 40,800 AFY in Analysis B and the Program portion is 75%, as previously accepted by the GC.

- **J-2 Regulating Reservoir Score = 30,600 AFY for Program**

B. CPNRD CANAL RECHARGE

The CPNRD Canal Recharge was modeled as the second priority to divert excess flows after the J-2 Regulating Reservoir. It was assumed CPNRD could divert up to 275 cfs, which is based on the permit application filings for 100 cfs for each of the 30-Mile and Cozad Canals and 75 cfs for the Orchard-Alfalfa Canal. The permit applications were submitted to the NDNR in August 2011 and are currently pending. CPNRD intends to recharge in the shoulder season so there aren't issues with icing in the canals. For the purpose of this analysis, it was assumed the "shoulder season" was March/April and October/November. The following score analysis components were evaluated to estimate the CPNRD canal diversions.

Grand Island Excesses

The excesses at Grand Island were updated from the J-2 Regulating Reservoir score model to account for diversions of excesses into the J-2 Regulating Reservoir. The excesses at Grand Island were reduced by the J-2 Regulating Reservoir diversions.

Brady Excesses
Since the CPNRD canals are in the Brady to Cozad reach upstream of the J-2 Return, the ED Office used the Brady OpStudy data to determine if excesses were available in this reach. The OpStudy hydrology without pulse flow data was used and the ED Office manually determined the water available at Brady using the following equation:

Brady = Brady w/o pulse flows + Jeffrey Return flows – Brady to Cozad diversions – EA flows at Cozad

A run was also completed using the Cozad without pulse and without EA (daily EA removed by ED Office) instead of the Brady data. The diversions for CPNRD were approximately 201 AF higher when using the Cozad data.

CPNRD Diversions
It was assumed CPNRD could divert 275 cfs in March/April and October/November when there are excesses at Grand Island (and available at Brady). The amount CPNRD could divert was the minimum of Grand Island excesses or Brady excesses. The 3 canals were modeled as one canal that could divert up to 275 cfs (since they were modeled the same, the canals' actual location in the reach and excesses at that location were not evaluated). The CPNRD analysis was not modeled with a "storage pool", and therefore, was not limited by canal storage capacity. While this could be added at a later date, it is not anticipated to have much impact on the results. The CPNRD diversions in this analysis are the maximum potential diversions, based on the 275 cfs diversion rate.

According to the permit application, the maximum limit that CPNRD can recharge in the canals is 36,000 AFY; therefore, excesses were not diverted once this limit had been reached in any given calendar year. The 36,000 AFY rate is based on CPNRD's permit application for a maximum annual diversion of 12,000 AF, 15,000 AF and 9,000 AF in the 30-Mile, Cozad and Orchard-Alfalfa Canals, respectively. Based on this preliminary analysis, approximately 11,410 AFY on average is diverted during the 1947-1994 OpStudy period. Note that the estimated recharge per CPNRD's presentation to the WAC in August 2013 was approximately 10,250 AFY (50% or 5,125 AFY will be made available for the Program).

C. PHELPS COUNTY CANAL RECHARGE

The Phelps County Canal recharge was modeled as the third priority for the purpose of the combined scoring analysis in Analysis B. This means the excesses available first went to the J-2 Reservoir and then the CPNRD canal recharge project. The remaining excesses were available for diversion into the Phelps County Canal for recharge. The score assumed the Program will recharge to Mile Post 13.3. The Phelps County Canal Groundwater Recharge score is minimally impacted by the CPNRD diversions since water can be stored in the canal storage pool. In general, the J-2 Regulating Reservoir takes all the excesses in the river until it fills and then there are typically enough excesses to satisfy both the CPNRD and Phelps County Canal recharge projects.

The Phelps County Canal daily diversion model (used in the 7/22/13 preliminary score analysis model) was updated to reflect the J-2 Regulating Reservoir and CPNRD recharge diversions. The ED Office did not re-run the Phelps numerical model to determine the accretions to the river. The 40% score efficiency estimated in the preliminary 7/22/13 score analysis was used. The major components of the score analysis are described below.

Grand Island Excesses

The excesses were calculated as the excesses less the J-2 Reservoir diversions and the CPNRD canal recharge diversions. This is the amount of excesses available to divert into the Phelps County Canal for recharge.

Water Available in CNPPID's System

In the model analysis, it was assumed the Phelps County Canal diverted the minimum of the excesses at Grand Island or the excesses available in CNPPID's system (calculated as the excesses in CNPPID's system in the J-2 Reservoir score model less the diversions into the J-2 Reservoir). The CPNRD recharge diversions were not deducted from the excesses available in CNPPID's system because it was assumed CNPPID would continue to divert the same amount at the Tri-County Canal, per their hydropower and irrigation permits.

Phelps Diversions

Excesses diverted into the Phelps County Canal result from direct recharge and diversions into canal storage which are then recharged at a later time. The direct recharge is calculated as the minimum of excesses at Grand Island (after J-2 Reservoir/CPNRD diversions), excesses in CNPPID's system (after J-2 Reservoir diversions) or the 32 cfs average canal recharge rate to Mile Post 13.3. The diversions into storage were considered the minimum of the Grand Island excesses or CNPPID's system excesses (after J-2/CPNRD/direct recharge diversions), up to a total of 115 cfs, the average canal filling rate during the first two years of operations. Diversions into the storage pool can occur any time there are excesses in the system and there is capacity in the Phelps County Canal. The total revised diversions of excess flows into the Phelps County Canal for recharge on an annual basis are 5,674 AF (in comparison to the 9,261 AFY of diversions when evaluated as an independent project). The Program will purchase 50% of this value or 2,837 AFY.

Phelps Recharge Score

As discussed previously, the numerical model was not re-run to determine the score; the estimated 40% score efficiency was used. The model could be re-run, if requested by the Scoring Subcommittee. Note that the J-2 Regulating Reservoir diversions are the main restriction to the Phelps County Canal Groundwater Recharge diversions and the CPNRD canal diversions have a relatively minor effect. Assuming J-2 Regulating Reservoir is the first priority for the use of excess flows, prioritizing CPNRD recharge before Phelps County Canal recharge results in a score reduction of approximately 24 AF (1,159 AF - 1,135 AF). Note that the reduction in shortages from the J-2 Regulating Reservoir (and potentially the CPNRD Recharge reduction to shortages) were not accounted for in this analysis.

- **Phelps Recharge Score: 1,135 AFY for Program**
    - This is a 39% decrease from when scored independently (1,865 AFY score).

D. TOTAL PROGRAM SCORE

The total estimated Program score for the J-2 Regulating Reservoir and the Phelps County Canal, when scored as individual projects is **32,464 AFY** (30,600 AFY + 1,865 AFY, including habitat adjustment). The CPNRD canal recharge score was not included in the total Program score as additional refinements in the assumption should be made before determining a score. When the projects are scored together (including the CPNRD recharge diversions, but without the CPNRD recharge score included), the total Program score reduces to **31,735 AFY** (30,600 AFY + 1,135 AFY). This is approximately a **2% decrease in the total Program score** of the J-2 Regulating Reservoir and the Phelps County Canal recharge. **Table 2** is a summary of the scores. **Appendix A** provides supplemental information on the analyses.

Table 2. Analysis Summary of Combined Scoring with J2 Res, CPNRD & Phelps Recharge.

Analysis Item	Volume (AFY)
J-2 Regulating Reservoir Score (A)	30,600
Independent Analyses	
Phelps Recharge Diversions (B)	*4,631*
Phelps Recharge Score (C)	1,865
Total Score from Independent Analyses (D)	32,465
Combined Analysis (J-2 Res as Priority)	
Phelps Recharge Limited Diversions (E)	*2,837*
Phelps Recharge Score (F)	1,135
Total Score from Combined Analysis (G)	31,735
Impact of Combined Analysis	
Reduction in Phelps Recharge Score (H)	730
Estimated Reduction in Score for Combined Operations (I)	**2%**
Estimated Reduction in Score for Phelps Recharge Only (J)	**39%**

(A) Score for the Program (75% of project is credited to the Program, 40,800 AF × 75%).

(B) Diversions into recharge associated with the Program (50% of project is credited to the Program, 9,261 AF × 50%).

(C) Score for the Program, with a habitat adjustment (50% of project is credited to the Program, 3,729 AF × 50%).

(D) Total score for the Program (as independent projects). Calculation = (A) + (C)

(E) Diversions into recharge for Program (50% of project) after accounting for diversions into the J-2 Reservoir and CPNRD Recharge.

(F) Score based on efficiency of 40%. Calculation = (E) × 40%.

(G) Total project score for the Program (as combined projects). Calculation = (A) + (F).

(H) Calculation = (C) - (F).

(I) Total reduction in Program score for Phelps Recharge and the J-2 Reservoir. Calculation = (H) ÷ (D).

(J) Total reduction in Program score for Phelps Recharge only. Calculation = (H) ÷ (C).

IV. COMBINED ANALYSIS SUMMARY

The J-2 Regulating Reservoir significantly impacts the potential diversions into the Phelps County Canal recharge project; however, the impact on the total Program score from both projects combined is much less significant. In summary, the estimated combined score of the J-2

Regulating Reservoir and the Phelps Recharge project is reduced from 32,465 AFY (30,600 AFY + 1,865 AFY) to 31,759 AFY (30,600 AFY + 1,159 AFY), or 2 % during combined operations of these two projects. The impact to the Phelps County Canal score is about 706 AF, or a 38% reduction (706 AFY ÷ 1,865 AFY).

Including the CPNRD Canal Recharge diversions into the combined analysis creates a minimal additional impact on the Phelps County Canal Groundwater Recharge score. The CPNRD diversions reduce the project score by an additional 24 AFY (1,159 AFY – 1,135 AFY) or about 1% of the total Phelps score (24 AFY ÷ 1,865 AFY) and the 2% reduction in the J-2 Regulating Reservoir and Phelps Recharge combined score remains the same.

V. EXCESS FLOW COMPARISON

The ED Office evaluated the daily NDNR Excess Flow Tool's excesses (or "unappropriated" flows) at Grand Island in comparison to the OpStudy hydrology excesses, used in the J-2 Regulating Reservoir score model and the Phelps Recharge score model. There are several notable differences between the two models. The NDNR Tool uses the permitted diversion capacities for each canal to model canal diversions whereas the OpStudy model uses historical diversions. The NDNR Tool limits upstream excesses by the quantity and timing of excesses available downstream. For example, the NDNR Tool uses a lag time between Grand Island and Duncan of 1 day. If on January 1 an excess of 1,000 cfs is available at Grand Island but the excess at Duncan on January 2 is 500 cfs, the excess at Grand Island on January 1 would be limited to 500 cfs.

The ED Office used the OpStudy modeling period of 1947 through 1994, which is also available in the NDNR Excess Flow Tool. In general, the NDNR Excess Flow Tool shows greater excesses at Grand Island than the OpStudy model on a daily basis[5]. It should be noted the ED Office only compared excesses at Grand Island, and did not do a similar comparison at Overton and Brady. Based on this initial analysis, using the OpStudy data appears to be conservative and is consistent with previous Program scoring analyses; therefore, the ED Office believes this initial investigation of combined operations is appropriate until further direction is provided by the Scoring Subcommittee. The comparison is included as **Appendix B**.

The ED Office did not complete a scoring analysis using the NDNR Tool data as the tool does not calculate shortages, which are used to determine when releases occur from the J-2 Regulating Reservoir and when lagged groundwater recharge return flows reduce shortages for the score.

VI. POTENTIAL FOLLOW-UP

The preliminary combined scoring analyses described above used very basic assumptions that may need to be revised with further investigation. The following items may be follow-up analyses for review:

[5] In the monthly summaries, the NDNR Excess Flow Tool limits the available excesses to 30,000 AFY so that monthly averages are not biased by large daily excess flow events. There is no limitation on the daily excesses, which were compared to the OpStudy daily hydrology in this analysis.

1. Continue more detailed analyses using the existing spreadsheet score models, potentially including:
    - Refining assumptions
    - Completing an independent CPNRD canal recharge scoring analysis and lagged accretion modeling
    - Re-run the Phelps County Canal numerical model to determine the revised lagged accretions
    - Evaluate the combined score of the projects based on the reduction to shortages to target flows from each project

2. Add Program projects into COHYST model to complete combined scoring analysis and evaluate the priority of each project. Note that some budget has been included in the draft 2014 Water Plan budget; however, it may not be sufficient to fully evaluate these topics in 2014.

APPENDIX A

The average reduction in the Phelps Recharge diversions is about 119 AFY when the CPNRD diversions are considered the priority. A monthly summary of the difference in the Phelps County Canal diversions with and without the CPNRD diversions are shown in **Table 1**. In most months, the Phelps County Canal Recharge project is not impacted by CPNRD Recharge diversions.

Table 1. Difference in Phelps Recharge diversions by adding CPNRD diversions as priority (AF). Red=reduction in diversions.

Mo	1	2	3	4	5	6	7	8	9	10	11	12	Total
1947	0	0	0	63	0	0	0	0	0	0	0	0	63
1948	0	0	192	19	0	0	0	0	0	0	0	0	211
1949	0	0	228	52	0	0	0	0	0	0	63	0	344
1950	0	0	508	198	0	0	0	0	0	63	0	0	770
1951	0	0	0	0	0	0	0	0	0	0	0	0	0
1952	0	0	0	0	0	0	0	0	0	0	0	0	0
1953	0	0	77	63	0	0	0	0	0	0	0	0	141
1954	0	0	0	0	0	0	0	0	0	0	0	0	0
1955	0	0	0	0	0	0	0	0	0	0	0	0	0
1956	0	0	0	0	0	0	0	0	0	0	0	0	0
1957	0	0	0	0	0	0	0	0	0	5	0	0	5
1958	0	0	0	0	0	0	0	0	0	0	0	0	0
1959	0	0	0	0	0	0	0	0	0	0	0	0	0
1960	0	0	0	0	0	0	0	0	0	0	0	0	0
1961	0	0	0	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	111	0	0	0	0	0	0	0	0	111
1964	0	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	30	127	0	157
1966	0	0	63	689	0	0	0	0	0	0	0	0	753
1967	0	0	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	55	252	0	0	0	0	0	0	0	0	306
1970	0	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	317	0	0	0	0	0	0	0	63	0	381
1973	0	0	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	63	165	228
1975	0	0	0	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	127	0	0	0	0	0	0	0	0	127
1977	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	139	0	0	0	0	0	0	0	0	139
1979	0	0	0	0	0	0	0	0	0	0	15	0	15
1980	0	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	127	0	0	0	0	0	0	0	0	127
1984	0	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	42	0	42
1986	0	0	190	256	0	0	0	0	0	36	549	0	1,031
1987	0	0	0	0	0	0	0	0	0	432	131	0	563
1988	0	0	127	0	0	0	0	0	0	0	63	0	190
1989	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	0
Avera	0	0	37	44	0	0	0	0	0	12	23	3	119

Figure 1 shows an example month (March 1950) when the CPNRD diversions reduce the Phelps County Canal diversions. **Figure 2** shows example months (Mar/Apr 1959) when the CPRND diversions do not impact the Phelps County Canal diversions and both projects can operated in combination without an impact to each other (note that J-2 Reservoir diversions impact both projects' diversions).

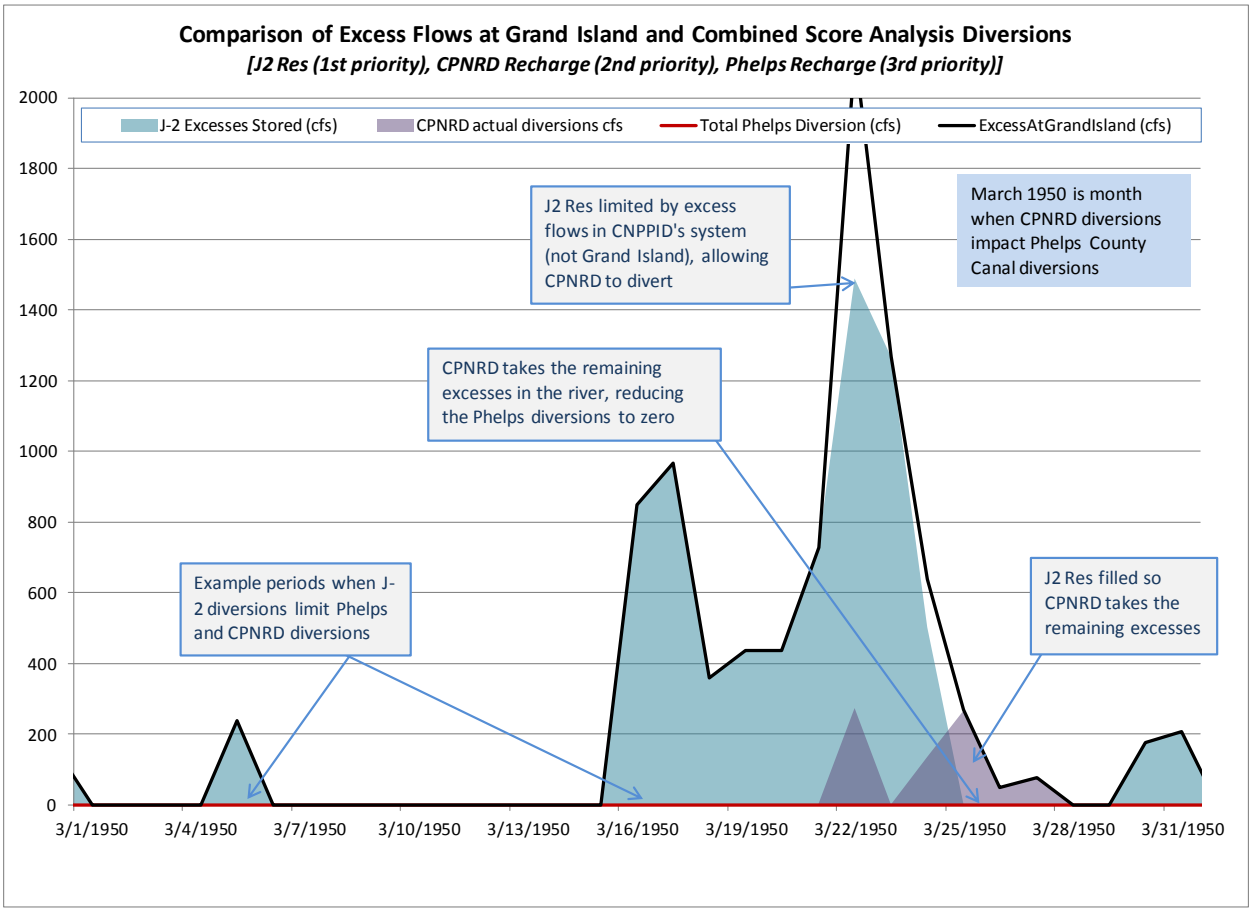

Figure 1. Example period when CPRND diversions reduce Phelps County Canal diversions.

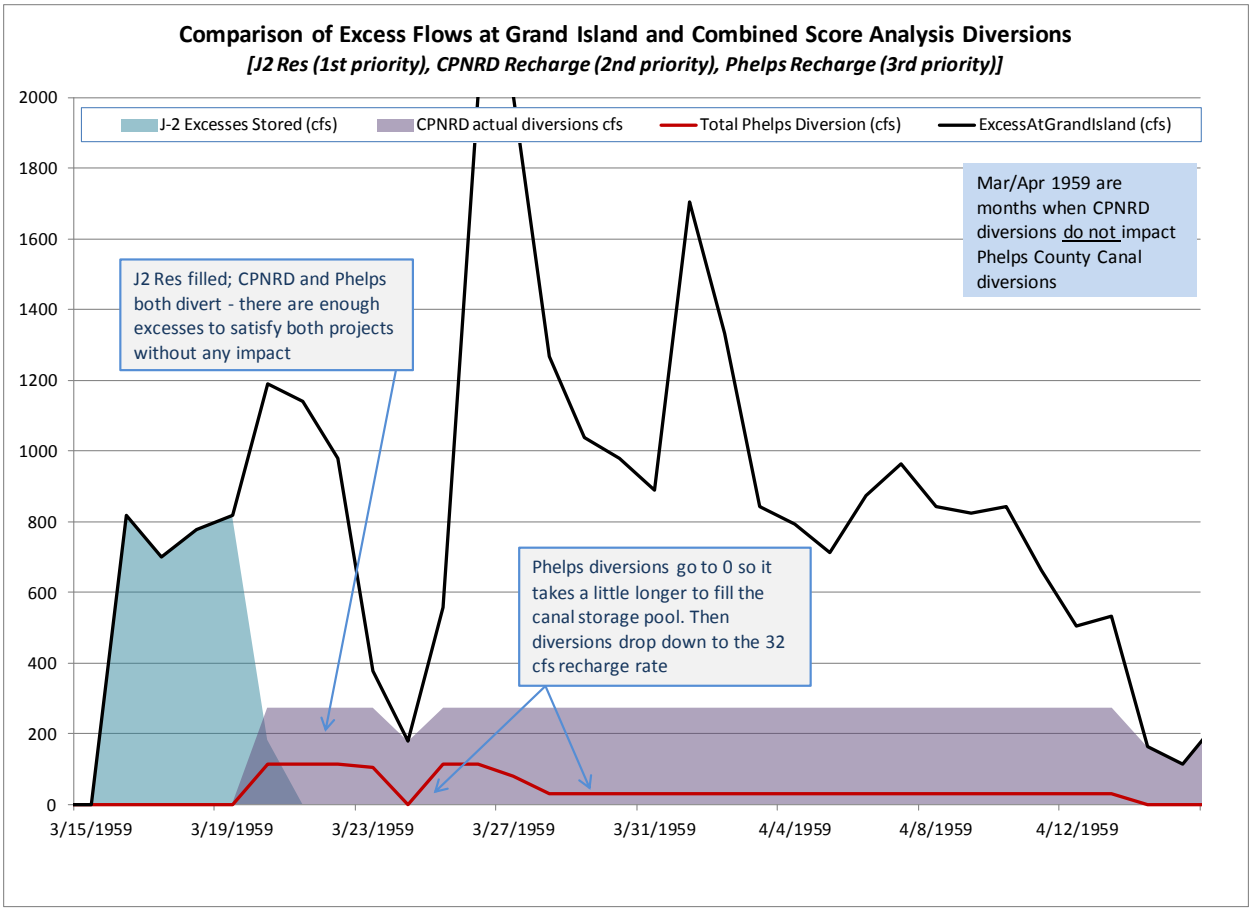

Figure 2. Example period when CPRND diversions do not impact Phelps County Canal diversions.

APPENDIX B

Difference between OpStudy and NDNR Excess Flow Tool - Grand Island Flows

Calculation = (OpStudy - NDNR Excess Flow Tool)

+ = OpStudy is higher, - = NDNR is higher = NDNR Excess Flow Tool flows are greater (- value)

Values in cfs

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1947	2304	7348	-2145	7251	11398	-73425	12770	1659	1146	2796	12004	9448	-7444
1948	7058	2177	-27333	3054	12254	-3206	1576	-7564	0	0	-6175	-7318	-25476
1949	8170	-2003	-48083	-2112	-10817	-120962	-17740	0	-484	6974	5478	1878	-179699
1950	13426	10832	4268	256	2867	0	2852	88	516	18942	-4282	-15231	34534
1951	-17385	851	-3203	186	-7442	-14229	-3146	65	39051	12537	-5605	3007	4686
1952	-23889	-62491	-49916	-14157	-2177	0	-510	0	0	0	1928	12042	-139170
1953	-1579	-9843	-6552	17531	23227	6962	0	0	0	0	-1974	-5189	22583
1954	14658	-7552	-461	408	24736	676	0	275	0	0	2101	2773	37613
1955	7148	284	-9037	0	1454	-1283	0	0	0	0	-507	2918	978
1956	1172	0	-595	0	481	0	0	0	0	0	426	2755	4239
1957	164	1333	0	260	-45150	6787	10894	0	6004	5342	-3678	-4142	-22187
1958	6345	0	-5199	-17537	-1099	4350	5023	758	0	0	3478	6718	2837
1959	8211	433	-14415	-3269	17991	6286	1881	0	188	0	1618	4512	23437
1960	5918	759	-32607	-7589	6010	-221	302	0	0	0	3905	6918	-16604
1961	6783	4684	875	1248	-8262	1958	321	1097	0	0	-19879	11942	767
1962	282	-7696	-27908	315	0	6182	-1649	2256	0	0	-8937	-5569	-42723
1963	-1107	-268	-5208	5297	31621	6150	0	0	-3879	0	2049	4008	38665
1964	2092	2619	2185	6553	17244	0	0	524	0	0	814	3120	35150
1965	-984	0	-243	0	-3409	-18786	-20942	147	-19632	-13091	-16019	-37677	-130635
1966	-3397	861	-3985	257	5651	0	0	0	0	0	1352	960	1700
1967	-746	300	0	0	0	-86379	-57841	877	152	0	-4119	-5332	-153087
1968	-6223	319	0	0	723	-346	540	956	-615	-1954	-1869	642	-7826
1969	-4463	14	-23485	472	9961	-192	-17089	183	-3631	-1520	-6319	1132	-44937
1970	351	121	-7774	-18450	4164	-11326	19060	0	1052	0	-5145	-9320	-27270
1971	-25350	-2237	-13362	-2814	-290998	-241742	-20262	0	1846	65	-5543	-18893	-619289
1972	-1839	-4546	-20403	-3368	-27044	0	16	1095	64	-912	-17905	-14742	-89585
1973	-25863	-29878	-21235	-12129	-168488	-192400	-16498	-299	-171127	-184571	-59586	-42087	-924160
1974	-93108	-65181	-150728	-156027	-16413	762	0	0	123	0	7225	1590	-471758
1975	132	133	-38	0	14809	-19978	345	499	582	0	4985	22578	24047
1976	1225	-2511	-3789	3835	32249	1998	0	0	1065	0	1015	4440	39526
1977	-992	0	-238	-8663	845	411	0	0	-1031	0	3874	5078	-715
1978	0	0	-52299	-568	11020	0	0	0	0	0	1189	0	-40658
1979	15	0	-13491	28	7236	-17941	-11130	2863	0	0	7966	-17115	-41569
1980	-17043	-13897	-37568	-145116	-222479	-65795	1330	85	909	0	3919	-3523	-499179
1981	-14277	-1242	0	0	1778	4635	-3326	-11918	425	0	-10785	-33316	-68026
1982	-7250	-99	-4902	0	283	200	830	0	-1617	1755	-18647	-29358	-58806
1983	-46978	-22054	-25406	-51129	-175882	-360727	-261696	-280603	-320583	28101	15876	-81946	-1583028
1984	-144354	-178221	-214470	-282555	-167614	-95455	-50425	0	-108078	-41027	-140309	-145560	-1568069
1985	-71229	-32504	-92564	30537	-15635	1946	-806	-3709	-16301	-1826	4715	-23193	-220568
1986	-59448	-30850	-17087	-57781	-42949	6552	-16352	-49399	-133296	-77501	-47117	-51891	-577120
1987	-56273	-13035	-37218	-13558	-40051	-24719	876	-1010	-22738	3060	-11281	-22236	-238184
1988	-25037	-17422	-3524	91	-5582	0	-1501	2888	-4046	0	6105	-3516	-51545
1989	-20635	0	-4777	0	3961	-15847	-4524	-51	-9861	0	275	-2770	-54228
1990	-31395	-747	-952	0	-3364	0	0	-1026	0	0	0	-575	-38059
1991	-8564	-3694	-127	0	-18737	-12896	0	816	0	0	-5305	-14795	-63302
1992	-15808	0	-10334	0	0	0	-2698	-3590	-635	-60	-1071	-9167	-43362
1993	-10570	0	-62728	-143	-2812	-8127	-52716	-2752	-20161	-99	-13014	-44173	-217296
1994	-24114	-893	-16307	0	6804	0	-7384	0	0	0	3527	-9719	-48086
Average	**-14051**	**-9912**	**-22174**	**-14987**	**-21409**	**-27711**	**-10617**	**-7183**	**-16346**	**-5062**	**-6651**	**-11456**	**-167560**

APPENDIX H:

MEMORANDUM – EVALUATION OF J-2 RESERVOIR AND PHELPS COUNTY CANAL RECHARGE EVENT-BASED SCORING

TO: SCORING SUBCOMMITTEE

FROM: ED OFFICE

SUBJECT: PRELIMINARY EVALUATION OF J-2 RESERVOIR AND PHELPS COUNTY CANAL RECHARGE EVENT-BASED SCORING

DATE: NOVEMBER 5, 2013 (REVISED NOVEMBER 26, 2013)

I. INTRODUCTION

The Scoring Subcommittee had a conference call on 10/28/2013 to discuss the preliminary Phelps County Canal Groundwater Recharge (Phelps recharge) score analysis (memo dated 7/22/13). During the call, the ED Office also presented information regarding a preliminary combined scoring analysis for the J-2 Regulating Reservoir, Phelps recharge and the Central Platte Natural Resource District (CPNRD) canal recharge projects (memo dated 10/22/13). The preliminary combined project analysis showed that always prioritizing diversions into the J-2 Regulating Reservoir reduced the Phelps recharge score by approximately 38%. However, this analysis did not take into account times when both projects could be operated together to maximize the score, such as during runoff periods when there is sufficient flow to fill both projects. Prioritizing CPNRD diversions after the J-2 Regulating Reservoir but before the Phelps recharge diversions reduced the score by a minimal additional amount. The larger potential impact on the Phelps recharge score appears to be operations with the J-2 Regulating Reservoir.

Since the combined scoring analysis showed that the J-2 Regulating Reservoir could potentially have a significant impact on the Phelps recharge project, the Scoring Subcommittee was interested in evaluating whether the projects could be operated in a way to maximize the diversions into both projects and the resulting scores. Both projects utilize excess flows available in the Central Nebraska Public Power and Irrigation District's (CNPPID) system. The ED Office completed a preliminary evaluation of event-based combined operations[1] for the J-2 Regulating Reservoir and Phelps recharge. The event-based analysis allows both projects to divert during periods with sufficient excesses to fill both projects, such as during runoff periods. Due to time constraints, the ED Office modeled two sets of representative wet, normal and dry years. Similar to the J-2 Regulating Reservoir scoring, it was assumed the Phelps County Canal diversion capacity would be upgraded to 1,675 cfs, which is the rate the hydropower plant returns water to the system. All of the analyses in this memo take into account the impact of combined operations through shared infrastructure. For example, if 115 cfs is being allocated toward recharge, then the J-2 Regulating Reservoir can only divert 1,560 cfs (1675 cfs - 115 cfs) into the reservoir.

The canal capacity below the J-2 Regulating Reservoir inlet will remain 1,000 cfs; however, the potential recharge diversions were limited to less than the maximum capacity in the analyses completed by the ED Office. In general, there are times when the J-2 Regulating Reservoir is diverting all the excesses in the river and there are also times when the J-2 Regulating Reservoir

[1] Note that this analysis was previously referred to as "optimization"; however, the ED Office identified that this terminology may be misleading and therefore, revised the evaluation terminology to "event-based".

is diverting all the excesses available in the Phelps County Canal, but there are additional excesses at Grand Island. Both of these situations create a reduction in the Phelps recharge score during combined operations. Two different event-based scenarios were evaluated and described in further detail below. Note that the impacts identified in the two different event-based scenarios are separate and are not cumulative.

II. SCENARIO A – 3 DAY EVENT-BASED SCENARIO

In this scenario, the ED Office created a new operating rule in the J-2 Regulating Reservoir score model[2] to maximize combined operations with the Phelps recharge project during the full OpStudy period from 1947-1994. The ED Office entered a rule that assumed diversions into recharge were the priority if the J-2 Regulating Reservoir was estimated to fill within the following 3 days. The 3-day estimate was based on a general assumption that reservoir operators may practically be able to foresee the amount of excesses in the system by about 3 days. It was anticipated that the J-2 Regulating Reservoir would likely be able to fill a day or two later without any, or minimal, impact to the score (dependent on whether sufficient excesses are available a day or two later).

Two variations of this scenario were considered. The first variation of Scenario A used the same assumptions as the 7/22/13 preliminary Phelps recharge score analysis memo. The 7/22/13 analysis is referred to as the "independent analysis" because it does not include the impact of J-2 Regulating Reservoir diversions or any other Water Action Plan projects. The maximum diversion rate[3] into the canal for recharge is 115 cfs, which was based on the average rate during the fill period for the first 2 years of recharge. The canal storage to Mile Post 13.3 was assumed to be 1,000 AF, which was based on the Feasibility Study[4] estimate to Mile Post 9.7. In the second analysis, the ED Office utilized a maximum diversion rate into recharge of about 300 cfs, which was the approximate max 2-day average fill rate for the canal in September 2013. The canal storage volume was based on CNPPID's estimate of 1,160 AF to Mile Post 13.3. The first analysis resulted in an approximate reduction to the Phelps recharge score of approximately 34% and the second analysis resulted in a reduction of 32%, versus the 38% assuming the J-2 Reservoir has the priority, without any combined operation adjustments. The ED Office did not re-run the numerical model, so a 40% "score efficiency" was used, based on the 7/22/13 memo results. There is a slight decrease in the J-2 Regulating Reservoir score; however, it rounds to 0% impact. **Table 1** is a summary of the 3-day event-based evaluation.

[2] Score model used to determine the 40,800 AFY score accepted by the Governance Committee.
[3] The infiltration rate from canal storage (the volume recharged) is different than the canal diversion rate.
[4] "Pilot-Scale Recharge Report for Nebraska Groundwater Recharge Feasibility Study: Platte River Recovery Implementation Program" by EA Engineering, Science, and Technology, Inc. and Daniel B. Stephens & Associates, Inc. in 2012.

Table 1. Summary of 3-day recharge event-based analysis.

Analysis	Max Diversion Rate into Canal for Recharge (cfs)	Canal Storage Volume (AF)	Recharge Diversions (AFY)	Recharge Score (AFY)	Reduction in Recharge Score	J-2 Reservoir Score (AFY)	Impact to J-2 Reservoir Score (AFY)	Total Score (AFY)	Reduction in Combined Score
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)
Independent	*115*	*1,000*	*4,631*	*1,865*		*30,600*		*32,465*	
Combined #1	115	1,000	3,079	1,240	34%	30,573	0%	31,813	2%
Combined #2	300	1,160	3,171	1,277	32%	30,567	0%	31,844	2%

(A) Maximum diversion into the canal for recharge purposes.
(B) Maximum canal storage volume used in analysis (headgate to Mile Post 13.3).
(C) Diversions into recharge (or the volume recharged).
(D) Score based on a 40% efficiency per the results of the independent analysis. Column (C) × 40%.
(E) Reduction in score in comparison to the independent analysis. Difference in Column (D) results.
(F) J-2 Regulating Reservoir score from each analysis.
(G) Reduction in score in comparison to the independent analysis. Difference in Column (F) results.
(H) Column (D) + Column (F).
(I) Reduction in score in comparison to the independent analysis. Difference in Column (H) results.

III. SCENARIO B – WET, NORMAL, DRY YEAR EVENT-BASED SCENARIO

Whereas Scenario A is intended to represent a conservative practical operating scenario, Scenario B is used to represent perfect foresight and is intended to provide a lower bound of potential impacts (i.e. minimum score impact) from combined operations. To meet the deadline between Scoring Subcommittee meetings, the ED Office evaluated the 3 specific representative years rather than the full OpStudy modeling period. The ED Office analyzed representative wet, normal and dry hydrologic condition years by manually adjusting the diversions into each project to maximize the diversions and associated score, based on the knowledge of future operations. The ED Office looked at how the projects could operate together to provide a best-case scenario; although, it is anticipated CNPPID could operate the projects similar to the Scenario B analysis[5]. The diversion rate into recharge and the canal storage volume were the same as the 7/22/13 preliminary score memo (115 cfs and 1,000 AF, respectively). To estimate the Phelps recharge score, a 40% score efficiency was used. The J-2 Regulating Reservoir score is preserved in the Scenario B analyses.

The representative years were based on Olsson Associates' evaluation in the J-2 Regulating Reservoir Pre-Feasibility Study[6]. The representative years were based on water year (WY) in the Pre-Feasibility Study (as opposed to calendar year, which is used for scoring purposes); therefore, the ED Office used WYs. Using the WY also allows the Scoring Subcommittee to see a specific season of recharge. In the representative dry year, 1964, both projects could be operated in a way that preserved the scores of both projects; therefore the impact to the Phelps Groundwater Recharge score was 0% during combined operations with the J-2 Regulating Reservoir. In the representative normal year, 1975, the impact was approximately 31% and in the representative wet year, 1986, the impact was about 14% during combined operations with

[5] See Scoring Subcommittee meeting minutes from 11/15/13 conference call.
[6] "CNPPID Reregulating Reservoir: Elwood and J-2 Alternatives Analysis Project Report" by Olsson Associates and Black & Veatch in 2010.

manual adjustments by the ED Office. Based on the proportion of each hydrologic condition in the 1947 – 1994 OpStudy modeling period, the ED Office estimated an approximate weighted score using the representative year data. The reduction in the Phelps recharge score using the weighted representative year scores is about 9%. **Table 2** is a summary of the results.

Table 2. Summary of representative year score for event-based scenario.

Analysis for Specific Year										
Analysis	Max Diversion Rate into Canal for Recharge (cfs)	Canal Storage Volume (AF)	Independent Analysis Recharge Diversion (AFY)	Indpendent Analysis Recharge Score (AFY)	Optimized Recharge Diversions (AFY)	Optimized Recharge Score (AFY)	Reduction in Optimized Recharge Score	J-2 Reservoir Score (AFY)	Total Optimized Score (AFY)	Reduction in Combined Score
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)
Dry	115	1,000	4,372	1,749	4,372	1,749	0%	30,600	32,349	0%
Normal	115	1,000	4,254	1,702	2,944	1,177	31%	30,600	31,777	2%
Wet	115	1,000	6,649	2,660	5,737	2,295	14%	30,600	32,895	1%

(A) Maximum diversion into the canal for recharge purposes.

(B) Maximum canal storage volume used in analysis (headgate to Mile Post 13.3).

(C) Diversions into recharge (or the volume recharged) in independent analysis, where recharge is always the priority to divert excess flows.

(D) Score based on a 40% efficiency per the results of the independent analysis. Column (C) × 40%.

(E) Diversions into recharge (or the volume recharged) in event-based analysis, where recharge is prioritized over J-2 Res diversions during reservoir-fill periods.

(F) Score based on a 40% efficiency per the results of the independent analysis. Column (E) × 40%.

(G) Reduction in score in the event-based analysis in comparison to the independent analysis. Columns (D - F) ÷ (D).

(H) J-2 Regulating Reservoir score, as approved by the Governance Committee.

(I) Column (F) + Column (H).

(J) Reduction in score in comparison to the independent analysis. Columns (H + D - I) ÷ (H + D).

Analysis for Modeling Period				
Years in Modeling Period	Weighted Recharge Score (AFY)	Reduction in Weighted Recharge Score (AFY)	Total Optimized Score 1947-1994 (AFY)	Reduction in Combined Score 1947-1994 (AFY)
(K)	(L)	(M)	(N)	(O)
12				
20				
16	1,693	9%	32,293	1%

(K) Number of year of dry, normal and wet hydrologic conditions during 1947-1994 modeling period.

(L) Weighted score based on the proportion of hydrologic condition years in Column (K) and the optimized recharge scores in Column (F).

(M) Reduction in score in comparison to 7/22/13 preliminary recharge score of 1,865 AFY, with habitat adjustment. 1,865 AFY - Column (L) ÷ 1,865 AFY.

(N) Column (H) + Column (L).

(O) Reduction in score (Column N) in comparison to the 30,600 AFY J-2 Reg Reservoir score and the 1,865 AFY recharge score, with habitat adjustment, from the 7/22/13 preliminary analysis.

Figure 1 is a graph depicting the J-2 Regulating Reservoir end-of-day storage volume during the dry year when both projects can operate without an impact to the Phelps recharge project. The red line is the J-2 Regulating Reservoir storage volume when the reservoir is always the priority and the black line is the reservoir storage volume during periods when recharge is selectively prioritized during reservoir fill periods. The time periods that were manually adjusted to maximize combined operations by the ED Office are shown in blue. As shown in the graph, prioritizing recharge during the reservoir fill periods allows the reservoir to still fill and maintain the score, while allowing diversions into canal recharge to take priority (when J-2 Reservoir would have otherwise diverted the excesses). Once the J-2 Regulating Reservoir is full, the excesses available in CNPPID's system can be diverted into the canal for recharge. In this scenario, both projects can operate in a way that does not impact the total Program score. **Appendix A** includes graphs of the normal and wet year J-2 Reservoir storage volumes.

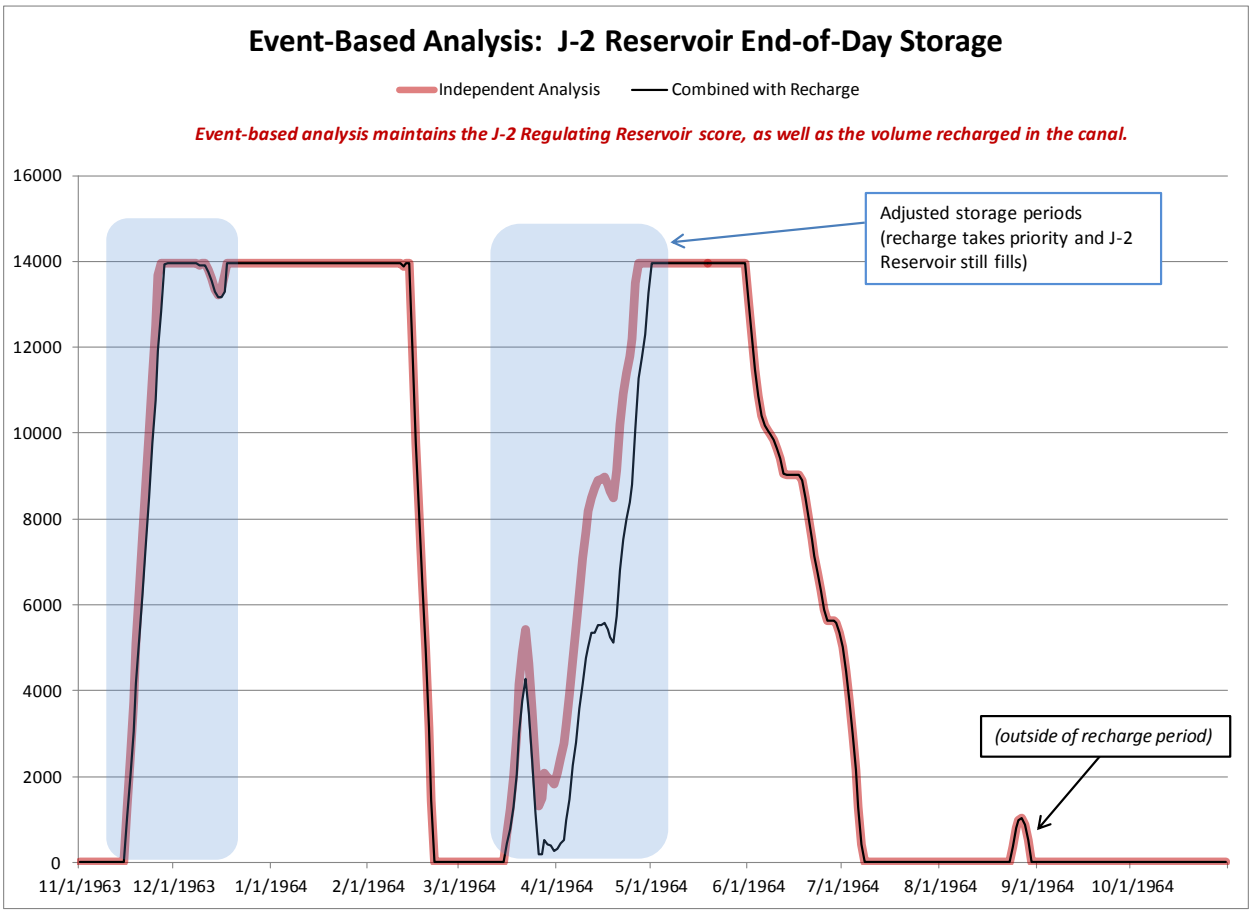

Figure 1. J-2 Reservoir storage during a representative dry water year in 1964.

IV. SUMMARY

Based on the initial investigations described in this memorandum, impacts to the Phelps County Canal Groundwater Recharge score from combined operations with the J-2 Regulating Reservoir may be mitigated, in part, during actual operations. Based on the analysis, maximizing the combined operations by assuming reservoir operators will be able to predict excesses 3 days in

advance resulted is an impact to the groundwater recharge score of about 33%. On a year-by-year basis, the representative year event-based evaluations showed a range of a 0% impact up to a 31% impact, with a weighted average reduction of about 9%. Without the combined operations adjustment, the estimated impact to the Phelps recharge project score is approximately 38% due to J-2 diversions, based on the 10/22/2013 memo on combined operations to the Scoring Subcommittee.

The analyses completed by the ED Office do not include recharge past Mile Post 13.3, which is an option for the Program to purchase in 2013. This would increase the diversion amount into the canal and therefore, increase the corresponding Phelps recharge score. The ED Office will further investigate this with Bill Hahn (ED Office Special Advisor) in the coming months. Also, it should be noted that the Program could evaluate additional recharge configurations, such as adding groundwater management through direct pumping to the river during times of shortage, to increase the score. Other configurations would likely be future phases of the project and would require additional management of project tracking and accounting.

The ED Office can further refine the assumptions and analyses presented in this memo if requested by the Scoring Subcommittee. This memo is intended to provide a general estimate of how the impact from combined operations may be mitigated when the projects are both operational. If the Scoring Subcommittee would like to propose additional analyses, the ED Office can also perform additional work.

APPENDIX A

NORMAL & WET YEAR GRAPHS

Figure A-1 is a graph depicting the J-2 Reservoir end-of-day storage for Water Year 1975, which is characterized as a representative normal year. During the green "no adjustments" periods, the J-2 Regulating Reservoir diverts all the available excesses and potential diversions into the canal for recharge are reduced to zero. The J-2 Regulating Reservoir diversions are not adjusted to allow recharge diversions because the reservoir must divert all excesses to release for a score. During the blue "adjusted storage period", both the J-2 Regulating Reservoir and the Phelps recharge project can operate together, without a negative impact to the Program score. This is because there are enough excesses to provide sufficient water supply for both projects.

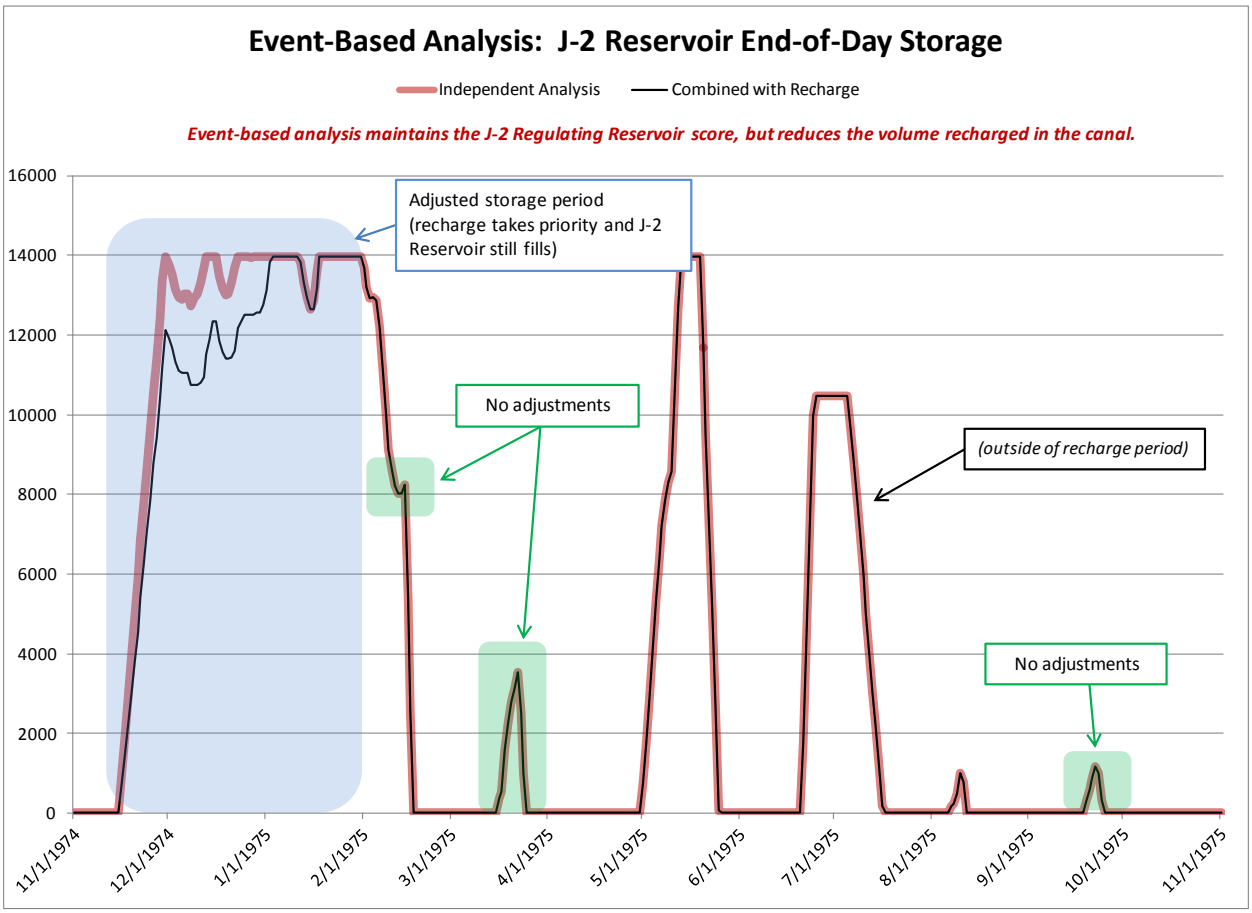

Figure A-1. J-2 Reservoir storage during a representative normal water year in 1975.

Figure 2-A is a graph of the representative wet year, Water Year 1986. During the "adjusted storage periods" in blue, both the J-2 Regulating Reservoir and groundwater recharge can operate together without an impact. During the green "no adjustments" period, groundwater recharge diversions are reduced to zero by the J-2 Regulating Reservoir diversions; however, the previous diversions into canal storage for recharge purposes can continue to infiltrate from the canal, reducing the impact to the volume recharged during this period.

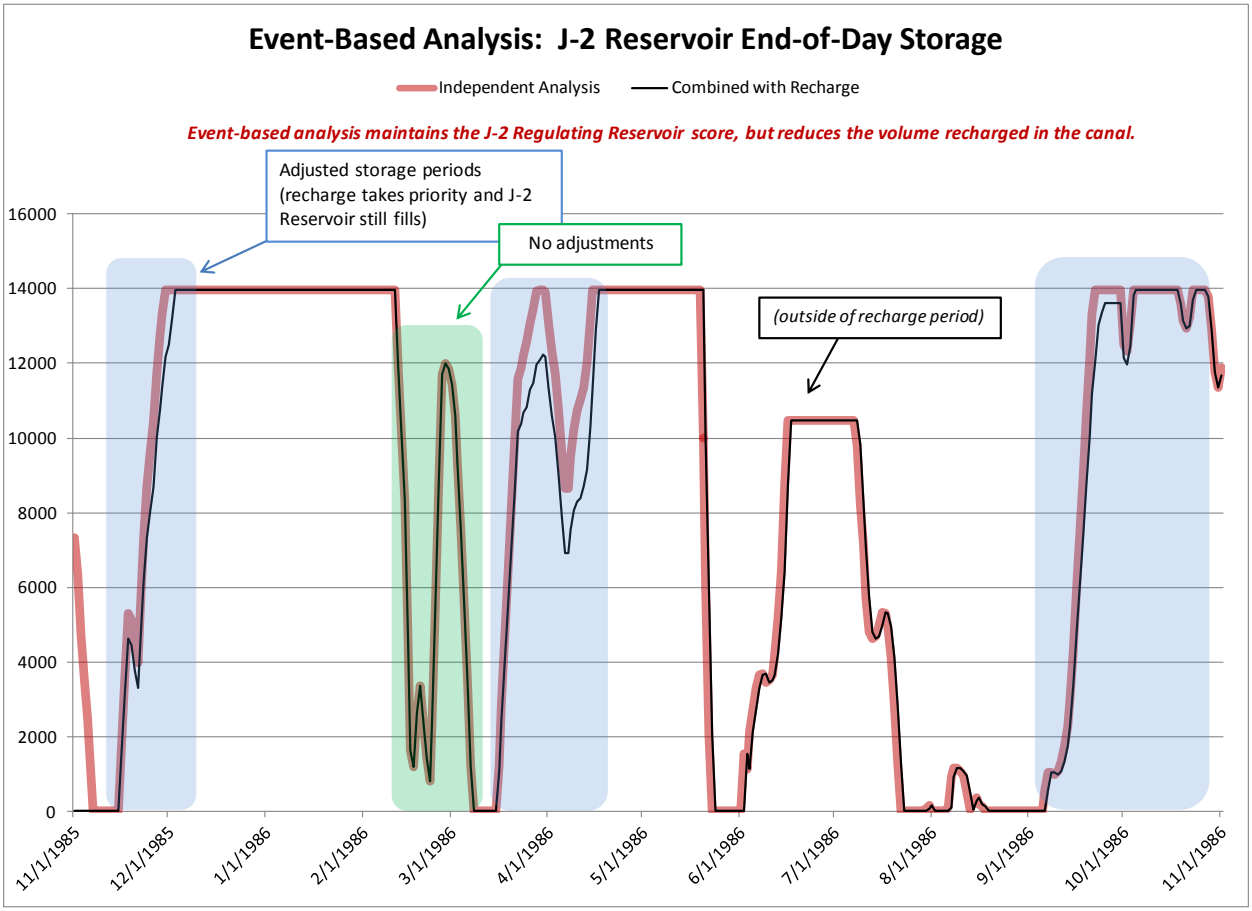

Figure A-2. J-2 Reservoir storage during a representative wet water year in 1986.

APPENDIX I:

TABLES (1 THROUGH 4) – INITIAL SCORE ANALYSIS SUMMARY

Table 1

Phelps Groundwater Recharge - Mile Post 13.3 using Average Infiltration Rate

Max canal diversion rate:	115 cfs
Max canal storage volume:	1,000 AF

Diversions into Recharge/Infiltration (Numerical Model Input)

Values in acre-feet

Year	Yr Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1947	Normal	1,718	1,777	1,381	952	0	0	0	0	317	1,968	1,904	1,968	11,985
1948	Normal	1,968	1,841	1,968	952	0	0	0	0	0	0	508	1,968	9,203
1949	Wet	1,968	1,190	1,968	952	0	0	0	0	1,016	1,619	1,904	1,968	12,584
1950	Normal	1,968	1,777	1,968	952	0	0	0	0	190	1,968	1,904	1,968	12,694
1951	Wet	1,968	1,777	1,026	228	0	0	0	0	1,016	1,968	1,904	1,968	11,854
1952	Wet	1,968	1,841	1,635	952	0	0	0	0	0	0	952	1,968	9,315
1953	Dry	1,968	1,777	1,889	952	0	0	0	0	0	0	1,396	1,968	9,950
1954	Dry	1,968	1,777	1,278	549	0	0	0	0	0	0	952	1,968	8,492
1955	Dry	1,968	1,190	966	254	0	0	0	0	0	0	635	861	5,873
1956	Dry	1,968	1,000	0	0	0	0	0	0	0	0	444	1,617	5,028
1957	Dry	1,325	1,202	0	228	0	0	0	0	1,016	1,968	1,904	1,968	9,610
1958	Normal	1,968	1,000	825	952	0	0	0	0	0	0	952	1,968	7,665
1959	Dry	1,968	1,777	1,968	952	0	0	0	0	127	244	1,460	1,968	10,463
1960	Normal	1,968	1,841	937	952	0	0	0	0	0	0	952	1,968	8,617
1961	Dry	1,968	1,777	1,583	873	0	0	0	0	0	0	1,650	1,968	9,819
1962	Normal	1,968	1,777	1,190	952	0	0	0	0	0	0	952	1,968	8,807
1963	Dry	1,968	1,777	1,968	952	0	0	0	0	635	1,000	952	1,968	11,219
1964	Dry	1,968	1,841	1,063	952	0	0	0	0	0	0	952	1,968	8,744
1965	Wet	1,016	0	228	0	0	0	0	0	954	1,968	1,904	1,968	8,037
1966	Normal	1,968	1,777	1,825	952	0	0	0	0	0	0	952	1,968	9,442
1967	Normal	1,968	1,381	0	0	0	0	0	0	127	175	952	1,968	6,570
1968	Normal	1,968	1,571	0	0	0	0	0	0	0	684	952	1,762	6,937
1969	Normal	1,851	1,028	1,016	952	0	0	0	0	762	1,652	1,904	1,968	11,132
1970	Wet	1,968	1,777	1,762	952	0	0	0	0	889	1,000	952	1,968	11,267
1971	Wet	1,409	1,774	1,016	952	0	0	0	0	444	1,063	1,904	1,968	10,529
1972	Wet	1,968	1,841	1,968	952	0	0	0	0	63	63	952	1,956	9,763
1973	Wet	1,968	1,777	1,968	952	0	0	0	0	1,016	1,968	1,904	1,968	13,520
1974	Wet	1,968	1,777	1,968	952	0	0	0	0	127	117	952	1,968	9,828
1975	Normal	1,968	1,264	1,016	429	0	0	0	0	762	151	952	1,968	8,508
1976	Dry	1,968	1,841	1,841	952	0	0	0	0	571	851	952	1,968	10,943
1977	Normal	873	0	0	234	0	0	0	0	0	0	952	1,968	4,027
1978	Normal	897	0	1,269	720	0	0	0	0	0	0	317	823	4,027
1979	Normal	30	0	1,396	810	0	0	0	0	0	0	952	1,968	5,155
1980	Wet	1,968	1,841	1,968	952	0	0	0	0	635	910	825	1,968	11,066
1981	Dry	1,968	1,228	0	0	0	0	0	0	292	496	952	1,968	6,903
1982	Normal	1,381	855	456	0	0	0	0	0	63	1,345	952	1,968	7,020
1983	Wet	1,968	1,777	1,508	952	0	0	0	0	952	1,968	1,904	1,968	12,996
1984	Wet	1,968	1,841	1,968	952	0	0	0	0	1,016	1,968	1,904	1,968	13,583
1985	Wet	1,968	1,777	1,968	952	0	0	0	0	1,016	1,968	1,698	1,968	13,314
1986	Wet	1,968	1,777	1,952	952	0	0	0	0	1,016	1,968	1,904	1,968	13,504
1987	Wet	1,968	1,777	1,127	952	0	0	0	0	1,016	1,968	1,904	1,968	12,679
1988	Normal	1,968	1,841	1,968	609	0	0	0	0	809	1,000	952	1,968	11,114
1989	Normal	1,968	1,000	988	0	0	0	0	0	1,016	1,000	825	1,127	7,923
1990	Normal	1,968	1,091	0	0	0	0	0	0	0	0	0	0	3,059
1991	Dry	1,515	1,777	1,190	97	0	0	0	0	0	0	1,269	1,968	7,817
1992	Normal	1,968	1,000	0	0	0	0	0	0	0	0	79	1,365	4,412
1993	Wet	1,968	1,000	1,777	942	0	0	0	0	952	1,000	952	1,968	10,559
1994	Normal	1,819	1,000	1,369	0	0	0	0	0	0	0	952	1,825	6,965
Avg	-	1,805	1,424	1,232	640	0	0	0	0	392	750	1,183	1,835	9,261

Values based on daily OpStudy data and summed monthly.

Table 2

Phelps Groundwater Recharge - Mile Post 13.3 using Average Infiltration Rate

Max canal diversion rate:	115 cfs
Max canal storage volume:	1,000 AF

Lagged Accretions to the River (Numerical Model Output)

Values in acre-feet

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1947	151	242	329	345	306	275	260	238	239	400	483	594	3,861
1948	680	684	827	769	699	622	588	539	480	454	437	574	7,353
1949	667	624	787	745	685	617	590	545	589	695	756	856	8,156
1950	924	886	1,038	958	880	787	749	691	639	798	843	942	10,136
1951	1,006	957	1,014	889	828	744	714	665	704	848	890	986	10,246
1952	1,047	997	1,115	1,033	952	855	817	756	681	654	658	782	10,346
1953	865	846	999	938	869	783	751	698	631	608	659	775	9,422
1954	859	840	933	851	792	716	689	643	582	564	579	707	8,755
1955	796	735	810	720	678	616	597	559	509	495	491	526	7,531
1956	646	593	583	520	498	455	444	421	387	381	374	487	5,788
1957	537	529	513	477	452	414	403	380	441	594	660	766	6,165
1958	843	748	803	772	708	640	614	571	516	498	519	648	7,879
1959	738	737	893	841	777	700	670	621	572	570	625	740	8,483
1960	824	813	870	836	770	695	668	621	561	542	559	687	8,446
1961	775	769	891	838	776	700	672	625	564	545	625	738	8,519
1962	823	808	891	851	785	708	680	633	572	552	568	695	8,565
1963	784	776	935	879	813	733	702	652	650	706	688	808	9,123
1964	885	864	933	889	820	739	710	661	597	577	590	717	8,980
1965	714	578	605	535	513	470	461	438	491	646	709	816	6,975
1966	891	861	999	931	857	768	734	679	611	588	598	724	9,241
1967	809	763	742	653	618	563	548	517	483	485	508	640	7,328
1968	732	714	689	608	576	524	510	480	438	491	504	616	6,883
1969	701	641	720	702	649	590	569	531	553	674	737	840	7,908
1970	912	878	1,010	940	866	776	741	686	706	752	728	845	9,840
1971	864	848	913	873	806	729	701	653	634	703	774	877	9,374
1972	950	919	1,075	995	919	825	789	731	664	644	647	770	9,930
1973	854	836	996	934	865	779	747	694	729	871	910	1,004	10,219
1974	1,063	1,004	1,160	1,065	984	882	843	780	715	694	692	814	10,698
1975	894	825	904	819	767	696	673	631	647	624	632	757	8,869
1976	841	830	976	917	849	765	734	682	672	715	699	820	9,499
1977	792	642	644	591	560	514	504	479	440	433	466	600	6,664
1978	596	484	605	578	542	497	484	455	415	405	383	426	5,872
1979	380	321	447	444	418	386	378	357	327	322	365	500	4,644
1980	600	625	775	735	677	610	584	540	546	596	577	703	7,569
1981	786	725	702	615	580	527	512	481	465	493	508	638	7,032
1982	673	610	639	556	530	482	469	442	409	523	520	651	6,503
1983	738	735	845	803	739	666	638	591	625	770	816	914	8,881
1984	978	938	1,089	1,003	924	827	789	729	758	898	932	1,024	10,889
1985	1,080	1,018	1,173	1,076	993	890	850	786	813	952	959	1,056	11,646
1986	1,111	1,045	1,200	1,101	1,018	914	873	809	835	974	1,002	1,093	11,974
1987	1,145	1,073	1,140	1,065	984	886	850	790	819	961	991	1,084	11,789
1988	1,138	1,074	1,231	1,093	1,016	913	874	811	816	859	824	940	11,589
1989	1,011	894	973	839	792	719	697	655	697	748	718	762	9,504
1990	857	776	761	672	637	582	569	538	493	482	425	403	7,197
1991	503	546	633	556	533	488	476	449	410	401	464	591	6,052
1992	687	625	611	539	513	467	454	428	392	384	343	441	5,884
1993	557	518	669	645	598	544	524	488	531	585	579	703	6,941
1994	771	695	804	681	643	582	562	525	476	462	488	606	7,296
Avg	802	760	852	786	730	660	634	591	573	617	635	743	8,384

Table 3

Phelps Groundwater Recharge - Mile Post 13.3 using Average Infiltration Rate (Overton Return Flow Scenario, No Habitat Adjustment)

Score (Yield at River Routing to Grand Island during Shortages)

Max canal diversion rate:	115 cfs
Max canal storage volume:	1,000 AF

Values in acre-feet

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1947	0	0	319	0	290	0	0	183	178	337	0	0	1,308
1948	0	0	0	742	664	578	467	416	357	383	379	0	3,987
1949	0	576	0	0	667	0	0	483	494	0	0	0	2,219
1950	0	0	1,007	924	835	732	0	534	476	0	732	0	5,241
1951	0	883	996	857	806	718	0	589	0	0	0	0	4,848
1952	0	0	0	0	926	824	785	669	571	596	603	0	4,975
1953	0	0	0	0	0	0	309	192	228	328	0	0	1,056
1954	0	0	885	806	0	486	283	176	211	304	430	0	3,581
1955	0	672	768	683	635	418	245	153	184	267	364	0	4,390
1956	0	542	553	493	467	309	183	115	140	205	277	0	3,283
1957	455	483	486	452	0	0	0	104	0	0	0	0	1,981
1958	0	694	779	0	0	0	0	441	384	419	451	0	3,168
1959	0	673	0	0	0	0	275	170	207	307	0	0	1,633
1960	0	755	0	807	731	647	531	479	418	457	485	0	5,309
1961	0	0	844	794	0	0	0	171	204	294	0	0	2,308
1962	0	0	0	821	745	0	0	488	425	465	493	0	3,438
1963	0	0	0	0	0	0	288	179	235	380	0	0	1,083
1964	0	790	884	0	0	502	292	181	216	311	438	0	3,614
1965	634	534	595	515	499	0	0	387	0	0	0	0	3,164
1966	0	0	970	898	813	715	583	524	455	495	520	637	6,611
1967	0	708	720	630	586	0	0	399	360	409	441	0	4,253
1968	0	663	669	587	547	488	405	371	326	414	0	543	5,012
1969	0	595	0	678	616	549	0	410	412	568	0	0	3,828
1970	0	0	992	0	842	748	0	607	592	685	667	774	5,907
1971	0	783	897	841	784	0	0	578	532	641	0	0	5,055
1972	0	0	1,056	959	894	796	759	647	557	587	593	0	6,848
1973	0	0	979	0	0	0	400	614	0	0	0	0	1,993
1974	0	0	0	0	957	851	811	690	600	633	634	0	5,176
1975	0	766	877	790	728	647	535	487	482	526	200	0	6,038
1976	0	0	0	0	0	0	301	187	243	385	519	0	1,636
1977	703	596	625	570	532	479	401	370	328	364	404	0	5,371
1978	529	450	0	558	514	462	385	351	309	342	333	375	4,609
1979	337	298	434	428	397	0	0	275	243	272	0	0	2,684
1980	0	0	0	708	0	0	561	478	458	543	529	0	3,276
1981	0	662	666	583	0	0	210	0	168	266	377	0	2,932
1982	598	566	620	536	503	449	373	341	305	441	452	0	5,182
1983	0	0	830	0	0	0	0	523	0	0	0	0	1,353
1984	0	0	0	0	0	0	0	645	0	0	0	0	645
1985	0	0	0	0	966	858	817	696	0	867	879	0	5,084
1986	0	0	1,179	0	0	0	840	716	0	0	0	0	2,735
1987	0	0	0	0	0	0	0	699	0	0	0	0	699
1988	0	0	1,195	1,055	965	849	0	626	607	724	0	0	6,021
1989	0	830	945	810	752	669	0	505	0	630	623	671	6,435
1990	0	720	739	648	605	542	453	415	367	406	369	355	5,620
1991	0	499	601	527	0	0	195	123	148	216	345	0	2,655
1992	0	581	593	520	487	434	361	331	292	323	298	0	4,219
1993	0	478	0	621	582	524	0	0	0	533	531	0	3,269
1994	685	645	781	657	611	542	0	405	355	389	424	533	6,027
Avg	82	343	510	448	436	329	251	398	272	348	287	81	3,787

Values based on monthly OpStudy hydrology scoring analysis.

Table 4

Phelps Groundwater Recharge - Mile Post 13.3 using Average Infiltration Rate (Split Return Flows Scenario, with Habitat Adjustment)

Score with Habitat Adjustment (Yield at River Routing to Grand Island during Shortages with Habitat Adjustment)

Values in acre-feet

									Max canal diversion rate:			115 cfs	
									Max canal storage volume:			1,000 AF	
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1947	0	0	314	0	286	0	0	181	175	333	0	0	1,288
1948	0	0	0	731	653	569	460	409	352	378	375	0	3,926
1949	0	567	0	0	656	0	0	475	486	0	0	0	2,184
1950	0	0	991	910	822	721	0	525	469	0	723	0	5,161
1951	0	869	980	843	792	706	0	579	0	0	0	0	4,770
1952	0	0	0	0	911	811	773	658	562	587	595	0	4,897
1953	0	0	0	0	0	0	304	188	225	323	0	0	1,041
1954	0	0	871	794	0	478	279	174	208	300	427	0	3,530
1955	0	663	756	672	625	412	241	151	182	263	361	0	4,327
1956	0	534	544	485	459	304	180	114	138	202	275	0	3,236
1957	450	477	479	445	0	0	0	103	0	0	0	0	1,953
1958	0	684	767	0	0	0	0	434	378	414	445	0	3,121
1959	0	665	0	0	0	0	271	168	204	303	0	0	1,610
1960	0	743	0	794	719	637	522	472	412	451	479	0	5,229
1961	0	0	832	782	0	0	0	169	202	290	0	0	2,274
1962	0	0	0	808	733	0	0	480	419	459	487	0	3,387
1963	0	0	0	0	0	0	284	176	232	375	0	0	1,067
1964	0	780	871	0	0	494	287	178	213	307	434	0	3,564
1965	624	525	585	507	491	0	0	381	0	0	0	0	3,113
1966	0	0	955	884	800	704	574	516	449	489	513	629	6,512
1967	0	697	709	620	577	0	0	392	355	404	436	0	4,189
1968	0	653	659	578	538	480	399	365	322	409	0	535	4,936
1969	0	586	0	667	606	540	0	403	406	560	0	0	3,769
1970	0	0	976	0	828	737	0	597	583	675	657	762	5,816
1971	0	770	883	827	771	0	0	568	524	631	0	0	4,975
1972	0	0	1,040	943	879	783	746	636	549	578	585	0	6,740
1973	0	0	963	0	0	0	400	604	0	0	0	0	1,968
1974	0	0	0	0	942	837	798	679	591	623	625	0	5,095
1975	0	754	863	778	716	637	527	479	475	519	200	0	5,948
1976	0	0	0	0	0	0	297	184	240	380	515	0	1,615
1977	691	587	615	561	523	471	394	364	323	360	399	0	5,289
1978	521	443	0	549	506	455	379	346	305	337	328	370	4,539
1979	331	293	427	422	390	0	0	271	240	268	0	0	2,642
1980	0	0	0	696	0	0	552	470	451	535	521	0	3,225
1981	0	654	656	574	0	0	207	0	166	262	374	0	2,892
1982	588	557	610	528	495	442	367	335	300	435	446	0	5,103
1983	0	0	817	0	0	0	0	515	0	0	0	0	1,331
1984	0	0	0	0	0	0	0	635	0	0	0	0	635
1985	0	0	0	0	950	845	804	685	0	854	867	0	5,005
1986	0	0	1,161	0	0	0	826	704	0	0	0	0	2,691
1987	0	0	0	0	0	0	0	688	0	0	0	0	688
1988	0	0	1,176	1,039	949	836	0	616	599	714	0	0	5,928
1989	0	817	930	797	740	658	0	497	0	622	615	662	6,339
1990	0	709	727	638	595	533	445	409	362	401	365	350	5,535
1991	0	493	592	518	0	0	192	121	147	213	342	0	2,618
1992	0	572	583	512	479	427	355	325	288	319	295	0	4,155
1993	0	470	0	611	572	516	0	0	0	525	523	0	3,218
1994	674	635	768	647	601	533	0	399	349	384	419	526	5,935
Avg	81	337	502	441	429	324	247	392	268	343	284	80	3,729

Values based on monthly OpStudy hydrology scoring analysis.

APPENDIX J:

REPRESENTATIVE YEARS DESCRIPTION

APPENDIX J:

REPRESENTATIVE YEAR DESCRIPTIONS

The second set of representative wet and dry years were selected by the ED Office, based on the data presented in **Figures 1 and 2.** The figures were completed by the ED Office and Olsson Associates during the J-2 Regulating Reservoir Pre-Feasibility Study[1] and were used to select the representative hydrologic condition years used in that report. The figures are based on hydrology at Overton and show the selected years that best match the overall 1947-2006 averages for each hydrologic condition.

The ED Office selected 1954 as a representative dry year because it is within the OpStudy modeling period (1947-1994) and the average annual total is closest to the average for all the dry years in the period. Note that 1964 was the selected representative dry year for the first set of years used by Olsson Associates in the Pre-Feasibility Study.

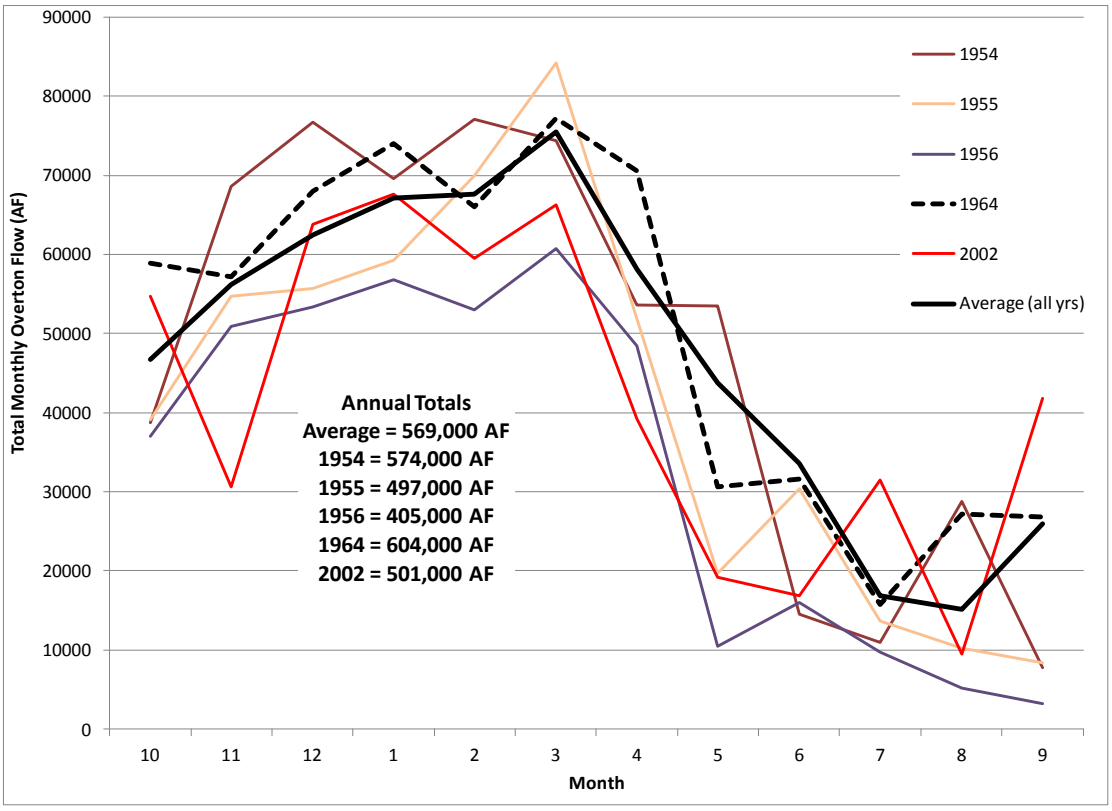

Figure 1. Representative dry year flows at Overton.

[1] "CNPPID Reregulating Reservoir: Elwood and J-2 Alternatives Analysis Project Report" by Olsson Associates and Black & Veatch in 2010.

The ED Office selected 1987 as the second representative wet year in the combined operations analyses, as it is the only other year within the modeling period that best represents a typical wet year. The year 1986 was selected as the representative year in the J-2 Regulating Reservoir Pre-Feasibility Study and used by the ED Office in the first set of representative year analyses.

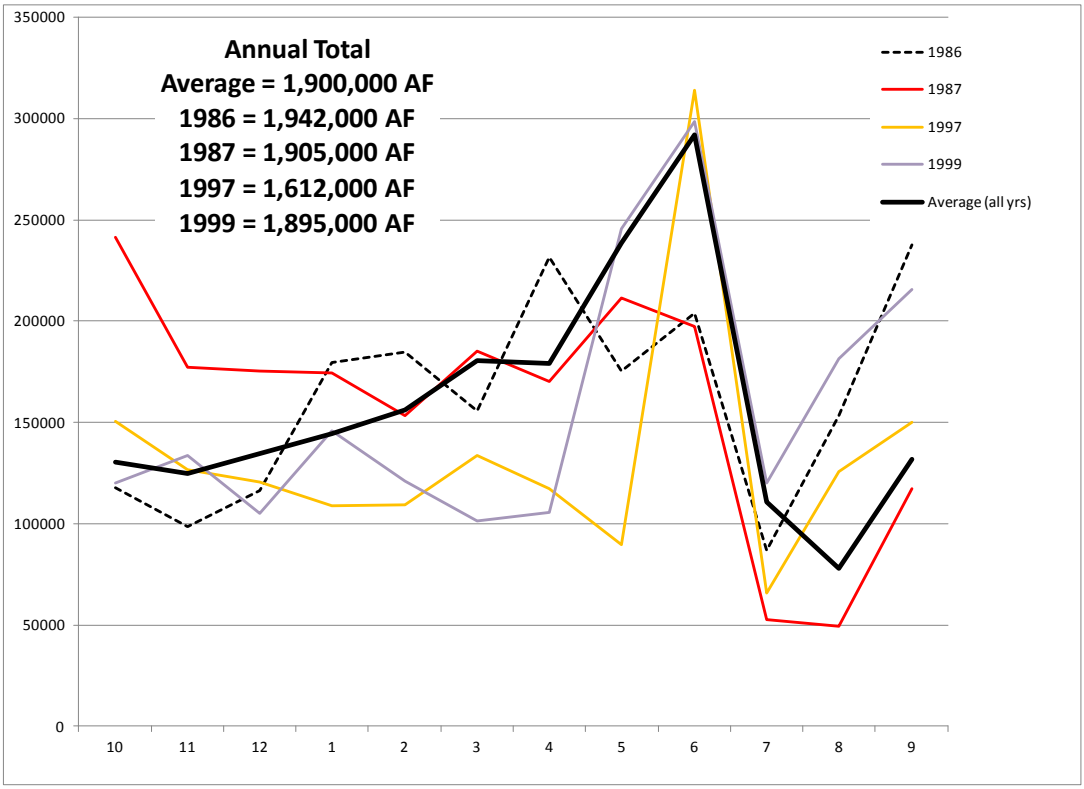

Figure 2. Representative wet year flows at Overton.

APPENDIX K:

MEMORANDUM – SCORE RECOMMENDATION FOR PHELPS COUNTY CANAL GROUNDWATER RECHARGE PROJECT

Note: memo attachments not included
(Scoring Subcommittee minutes are available in Appendix F)

TO: GOVERNANCE COMMITTEE

FROM: SCORING SUBCOMMITTEE

SUBJECT: SCORE RECOMMENDATION FOR PHELPS COUNTY CANAL GROUNDWATER RECHARGE PROJECT

DATE: NOVEMBER 26, 2013 (REVISED NOVEMBER 27, 2013)

The Governance Committee (GC) formed an ad-hoc Scoring Subcommittee to advance discussion related to scoring of proposed Water Action Plan Projects (WAP) for the Platte River Recovery Implementation Program (Program) in 2009. The Scoring Subcommittee previously recommended a score for the J-2 Regulating Reservoir and a proposed methodology for scoring in 2010, which were accepted by the GC. The Scoring Subcommittee has been working with the Executive Director's Office (ED Office) of the Program to determine a score for the Phelps County Canal Groundwater Recharge (Phelps recharge) WAP project. The ED Office completed the technical analyses to support the Scoring Subcommittee's evaluation of scores. This memorandum provides a summary of the score analysis results and the Scoring Subcommittee's recommendations regarding a Phelps recharge score.

Background

The Phelps recharge project utilizes excess flows available in the Central Nebraska Public Power and Irrigation District's (CNPPID) system during the non-irrigation season as a water supply. Excesses are diverted into the canal, infiltrate into the underlying aquifer and accrete to the Platte River to reduce shortages to target flows. Recharge operations in the Phelps County Canal commenced in 2011 and a Feasibility Study[1] was completed during the first year of operations. Recharge operations occurred successfully during the past two seasons (2011-2012 and 2012-2013) and commenced for a third season in September of 2013.

The Scoring Subcommittee based the Phelps recharge score recommendation presented in this memorandum on several score analyses and sensitivity analyses performed by the ED Office. The basic score model assumptions were based on similar methodology as the J-2 Regulating Reservoir, including:

- OpStudy 1947-1994 adjusted Three State hydrology
- Target flows from the Water Plan Reference Materials Appendix A-5
- Excesses and shortages calculated at Grand Island, utilizing the WMC Loss model to route project yields to Grand Island

Additional assumptions were made in the Phelps recharge score analysis to reflect operations specific to the project. The Phelps County Canal numerical model was utilized to determine the lagged accretions at the river. A portion of the Phelps recharge project accretions occur below

[1] "Pilot-Scale Recharge Report for Nebraska Groundwater Recharge Feasibility Study, Platte River Recovery Implementation Program" dated July 2012 by EA Engineering, Science, and Technology, Inc. and Daniel B. Stephens & Associates, Inc.

Overton and the Scoring Subcommittee agreed to apply a linear habitat adjustment for project yields that enter the river below Overton (linear reduction in score from Overton to Grand Island). For the recharge project, a habitat adjustment of approximately 4% was applied to the recharge accretions below Overton (approximately 40% of the yield accrues below Overton). There was no habitat adjustment applied to the recharge accretions that occurred above Overton. The Scoring Subcommittee agreed that a habitat adjustment is appropriate for projects that reduce target flow shortages, such as the Phelps recharge project.

The Scoring Subcommittee evaluated additional sensitivity analyses during the scoring process. Analyses were completed to evaluate the combined operations with and without the J-2 Regulating Reservoir and the Central Platte Natural Resources District's (CPNRD) canal recharge operations. These projects also utilize excess flows as a water supply. Based on the score analyses, there are generally enough excesses to provide a supply to each of the projects without significant impacts to the Program score. The Scoring Subcommittee selected a score that represents a reduction in excess flow diversions in the Phelps recharge project due to combined operations with the J-2 Regulating Reservoir. The Phelps recharge score was not sensitive to a reduction in excesses from CPNRD diversions. Sensitivity analysis score runs were also completed for various Phelps County Canal diversion rates and canal storage capacities. It was assumed recharge occurs from excess flows stored in the canal.

Results

Based on the various analyses completed, the Phelps recharge project score ranged from **1,861 acre-feet per year (AFY) to 1,936 AFY** as an independent project, without impacts from other WAP projects. This score range represents the best-case scenario and assumes the Phelps recharge project is the diversion priority. Analyses were completed to combine the operations of the Phelps recharge project and the J-2 Regulating Reservoir, as both projects utilize excesses available in the Phelps County Canal. When combining the anticipated operations of the Phelps recharge project and the J-2 Regulating Reservoir, the Phelps recharge scores ranged from approximately **1,684 AFY to 1,878 AFY,** based on analyses using representative wet, normal and dry years[2]. The range of scores also incorporates different canal diversion rates and canal storage volumes. The maximum diversion rates in the canal ranged from 115 cfs to 300 cfs, based on actual delivery data during the three seasons of operations. The canal storage volume ranged from 890 AF to 1,160 AF, based on the canal geometry and the location of storage available within the canal[3].

Recommendations

The Scoring Subcommittee recommends the GC assign a score for the Phelps recharge project of 1,800 AFY for the Program, based on the rounded[4] average of scores in the representative year analyses. The recommended score of 1,800 AFY includes an impact from

[2] The full OpStudy simulation period was not modeled for these analyses due to time constraints. Two sets of representative years were modeled for the purpose of sensitivity evaluation with the J-2 Reservoir operations.
[3] The 1,160 AF capacity represents the storage capacity of the canal for the full 13.3 miles of canal with recharge operations. The 890 AF capacity represents the storage volume from the proposed J-2 Reservoir inlet to Mile Post 13.3, assuming there are times when the first section of the canal will not be available for excess flow storage.
[4] Rounded to nearest hundred.

combined operations with the J-2 Regulating Reservoir, since both projects utilize excess flows available in CNPPID's system. The J-2 Regulating Reservoir score was not compromised in the combined operations analysis and is intended to be the Program's first diversion priority for available excesses, although it is anticipated that both projects will be able to operate successfully together. The recharge score was reduced to account for times when the J-2 Regulating Reservoir does not allow the recharge project to maximize excess flow diversions. The score is based on several score model analyses and does not represent a single model run.

Enclosures:
Scoring Subcommittee Conference Call Minutes – October 28, 2013
Scoring Subcommittee Conference Call Minutes – November 15, 2013
[not included]