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Kansas v. Nebraska & Colorado
No. 126, Orig., U.S. Supreme Court

Kansas's Expert Response to Nebraska's Expert Report, "Estimating Computed Beneficial Use for Groundwater and Imported Water Supply under the Republican River Compact"

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I. Executive Summary

The FSS requires that the RRCA Groundwater Model be used to determine the values for GW CBCU and Imported Water Supply (IWS) credit for inclusion in the Accounting Procedures. Procedures in the FSS identify the specific model runs to be used to make these calculations. The specifications described in the FSS were established by the Modeling Committee, which was responsible for developing the Model and the methods for its application. Nebraska is recommending that the Accounting Procedures be changed to add new model runs not currently specified by the FSS.

The reason stated for Nebraska's proposed change is that the impacts computed pursuant to the specifications in the FSS do not sum to the impacts derived using a new model run. However, the new model run is not necessary to implement the Republican River Compact. The individual impacts are necessary elements of the Compact accounting, and the Modeling Committee reasonably developed the specifications to compute those impacts using the historical baseline to which the Model was calibrated. As documented in the FSS and subsequent reports of the Special Master, the Model and Accounting Procedures provide reasonable and appropriate results.

Nebraska's proposal especially affects the amount of the IWS credit calculated for Nebraska. For the years 2001 to 2006 , the credit would be increased by 60% above values computed using the approved method and would be larger than the values computed for years prior to 2000 by either the approved or proposed methods. Accretions from Platte River recharge create the IWS credits and must be determined with the Model. The accretions are highly dependent on the amount of water diverted from the Platte and water level conditions in the mound area of the basin. Both of these conditions must be properly accounted for with the Model to provide reasonable results. The approved methods compute the IWS credit from comparison with a historical baseline condition that considers actual water level conditions, with Nebraska pumping occurring. Nebraska's proposal creates an artificial baseline condition with Nebraska pumping not occurring, which has the effect of increasing the amount of IWS credit. , which causes the increases described above.

The currently approved methods produce reasonable and appropriate results required for the Compact accounting by using the historical baseline conditions. Nebraska's assertion that there is an assumption of additivity implied in the current accounting procedures is not borne out by the documentation of the Model and Accounting Procedures. The method proposed by Nebraska includes a baseline for computing IWS that has water levels generally above actual levels and increases the computed IWS. For these reasons, the Nebraska proposal should not be adopted.

II. Introduction

This report responds to Nebraska's expert report entitled "Estimating Computed Beneficial Consumptive Use for Groundwater and Imported Water Supply under the Republican River Compact," by Ahlfeld, McDonald and Schneider, January 20, 2009 ("Ahlfeld Report").

The Ahlfeld Report proposes a change to the Republican River Compact Administration ("RRCA") Accounting Procedures. Specifically, it recommends a change in the methods by which the Computed Beneficial Consumptive Use ("CBCU") and the Imported Water Supply Credit ("IWS") are computed using the RRCA Groundwater Model ("Model"). The Ahlfeld Report proposes that CBCU and IWS be computed by using additional model runs not currently part of the accounting procedures and a weighted average of differences between numerous base conditions and impact runs. The premise for this change is that the current methodology is based on an incorrect assumption made by the States and Special Master. ("The current Accounting Procedures assume that this additivity will apply to all model results." Ahlfeld Report, p. 43). However, this assumption was not made and is not necessary for the Accounting Procedures.

The selection of the model runs to use to compute depletions due to groundwater pumping and accretions due to Platte River recharge in the approved methods was made with full consideration of how the Model was constructed, what its tendencies were and what results it produced. This report explains why the Nebraska assertion of error in the Accounting Procedures is incorrect and the methods used are reasonable.

The RRCA Accounting Procedures and Reporting Requirements prescribe the methods for using the Model to compute the Beneficial Consumptive Use of Groundwater (GW CBCU) and the Imported Water Supply (IWS) Credit. Those methods have two principal requirements. First, a base Run of historical conditions is made. Second, a set of alternative runs is required, with the specific input data to be removed from the model datasets for each alternative run identified. For example, the specific method for computing the IWS Credit from Section III.A of the Procedures is as follows:

> *The amount of Imported Water Supply Credit shall be determined by the RRCA Groundwater Model. The Imported Water Supply Credit of a State shall not be included in the Virgin Water Supply and shall be counted as a credit/offset against the Computed Beneficial Consumptive Use of water allocated to that State. Currently, the Imported Water Supply Credits shall be determined using two runs of the RRCA Groundwater Model:*
>
> *a. The "base" run shall be the run with all groundwater pumping, groundwater pumping recharge, and surface water recharge within the model study boundary for the current accounting year turned "on." This will be the same "base" run used to determine groundwater Computed Beneficial Consumptive Uses.*
>
> *b. The "no NE import" run shall be the run with the same model inputs as the base run with the exception that surface water recharge associated with Nebraska's Imported Water Supply shall be turned "off."*
>
> *The Imported Water Supply Credit shall be the difference in stream flows between these two model runs. Differences in stream flows shall be determined at the same locations as identified in Subsection III.D.1.for the "no pumping" runs. Should another State import water into the Basin in the future, the RRCA will develop a similar procedure to*

determine Imported Water Supply Credits (Kansas v. Nebraska & Colorado, No. 126 Orig., FINAL SETTLEMENT STIPULATION, VOL. 1 OF 5, (FSS), December 15, 2002, p. C17).

A similar procedure is used to compute each State's GW CBCU.

III. RRCA Groundwater Model and Accounting Procedures

When the States and the United States agreed to the Final Settlement Stipulation (FSS), on December 15, 2002, they had completed and agreed to much of the Model; since such agreement was necessary to consent to the FSS. The RRCA Groundwater model was adopted on July 1, 2003. The status and agreements were documented in the FSS and Appendices, published December 15, 2002. Appendix J to the FSS (Volume 5) described the status of the model at that time, including agreements reached as of that time. Appendix C to the FSS consists of the Accounting Procedures, which describe the specific steps to be followed with the Groundwater Model to obtain the IWS Credit and GW CBCU (as referenced above). The FSS also provided procedures for resolving disagreements which might arise between November 15, 2002 and the final adoption of the Model by the RRCA. Because all three states agreed to the Model, it was not necessary to invoke these procedures.

The Modeling Committee, which developed the Model and the procedures for using it, was comprised of members designated by each State and the United States. Each State had three members and the Untied States two. The members of the Modeling Committee participated in all aspects of the Model development, including the structure, sources of data, calibration and use of the Model. The development of the Model and Accounting Procedures through the collaborative efforts of the Committee was described as providing a better tool than would have been possible through litigation, due to the constructive process and joint efforts (Second Report, pp. 48-49). They considered and used a wide range of parameters, analytical processes and calibration techniques. Many aspects of the modeling process, such as base flow separation, precipitation recharge (including changes due to irrigation), phreatophyte coverage and ET function, and irrigation efficiency to determine net pumping were determined to have direct and significant effects on the computed impacts being derived for use in the Compact Accounting

The calibration of the Model to historical base flow and water levels was a very important aspect of the Model development. The agreed upon baseflow targets were included in the Model progress report in the FSS. The Committee had computed the impacts of groundwater pumping over an extended historical period, from the pre-development conditions of 1918 through the post-development conditions of 2000. As the Special Master noted in the Second Report, the States agreed to "the architecture, parameters, procedures and calibration targets" at the time of the FSS and that "the Model matches as closely as possible the actual effects of both alluvial and table-land pumping on stream flow in the Basin." (Kansas v. Nebraska & Colorado, No. 126 Orig., SECOND REPORT OF THE SPECIAL MASTER (SUBJECT: FINAL SETTLEMENT STIPULATION) (Second Report), April 15, 2003, p. 38). The Special Master further noted the importance of the calibration to historical conditions to the States:

> *In the words of David Pope, Chief Engineer and Director of the Kansas Department of Agriculture, Division of Water Resources, the goal of the Modeling Committee's calibration of the Groundwater Model is to ensure that it "is replicating the actual known historical stream flow as compared to what the model predicts."*

Id., n. 63, pp. 37-38. All three states agreed that the Model must be calibrated to correspond with actual historical conditions. The requirement for correspondence with observed conditions is generally accepted procedure in the application of models.

When the Modeling Committee had completed its work, its members agreed that the Model was sufficient for its intended purposes, including the specific method for using the Model's results in the Accounting Procedures. Because the Model was not finalized at the time the FSS was completed, the FSS contained a provision that allowed for binding arbitration if disagreement arose among the states concerning the Model. However, none of the states, including Nebraska, invoked this provision to take an issue to binding arbitration. Instead, the states agreed that the Model and the methods proposed were sufficient for its purpose. It is well documented that each of the States and their respective members on the Modeling Committee were aware of the purpose of the Model, its assumptions and limitations (Kansas v. Nebraska & Colorado, No. 126 Orig., FINAL REPORT OF THE SPECIAL MASTER WITH CERTIFICATE OF ADOPTION OF RRCA GROUNDWATER MODEL (Final Report), September 17, 2003, p. 9).

At the first annual Compact meeting following the completion of the FSS in 2003, the RRCA adopted the FSS Accounting Procedures and the Model as rules and regulations of the RRCA. Since then the RRCA has completed a careful review of the Accounting Procedures, amending them to correct minor problems and omissions, and to allow for improved data. The RRCA has also revised the Model to correct minor problems and to make the Model operate more efficiently.

Nebraska's experts now state that "current accounting procedures assume that this additivity will apply to all Model results (Ahlfeld Report, p. 43)." However, there are no statements or other indications in the documentation of the Model that the Committee assumed additivity would always apply, or considered it a necessary condition for use of the Model results. But the states agreed that, taken as a whole, the Model does what is necessary for the Compact accounting.

Nebraska notes that the Special Master's statement about the role of the Groundwater Model in the Accounting Procedures is misleading (Ahlfeld Report, p. 5) because the Model does not calculate depletions. However, the Special Master's statement accurately describes the direct use of the Model to derive the amounts necessary for the Accounting Procedures. Nebraska's statement should not be accepted as a valid criticism of either the description of the Model or the methods used in the Accounting Procedures. The Accounting Procedures state that the difference in Model results from two runs "is assumed to be the depletions to streamflow", for use in the accounting. This is a common use of models. The Modeling Committee made explicit that the Model was to be used to directly compute depletions and accretions as the differences of Model results from the historical baseline condition. To introduce other baselines would not have been acceptable, given the emphasis placed on the calibration results.

IV. Nebraska's Recent Efforts to Change the Accounting Procedures

In June, 2007, Nebraska gave notice to the other States that it wanted to change the Accounting Procedures, using a different baseline model run and then comparing the "no NE import run" to this new baseline, to determine the GW CBCU. The proposal to remove the historical baseline condition from the computation of GW CBCU was not accepted by Kansas and Colorado for a number of reasons. The condition proposed for computing pumping impacts on streamflows did not consider the actual water levels, by assuming that Platte River recharge was not occurring. This assumption resulted in an understatement of pumping impacts on streamflows. Ultimately, Nebraska agreed that it was inappropriate to compute the pumping impacts exclusively from this new baseline.

Nebraska subsequently withdrew this specific proposal and stated that a number of alternative scenarios could be used to calculate the effects used in the accounting, noting that different methods would yield significantly different results (January, 2008). This was followed by a Nebraska statement in March, 2008 that if two equally reasonable pairs of scenarios give different answers, then the Accounting Procedures must be changed to account for the differences. Neither the January nor March, 2008 statements asserted that there were any technical flaws in the Accounting Procedures specified in the FSS.

In August, 2008, before the RRCA Engineering Committee, Nebraska proposed a variation for computing the IWS credit and GW CBCU. This variation proposed adding a number of new model runs which would provide a range of possible results from the Model, and then averaging those results for input to the Compact Accounting. The Engineering Committee took no action on this proposal.

The methodology described in that report was modified for the proposal currently under consideration (Ahlfeld Report). The current proposal would result in substantial changes to the computed IWS credit and impacts of pumping on certain tributaries and IWS. These changes are caused by introducing new baselines for derivation of impacts that are different from actual historical conditions.

The Ahlfeld Report's proposal to re-compute GW CBCU and the IWS would significantly increase the amount of the IWS credit to Nebraska beyond the values determined using changes from the calibrated historical condition. It is important to evaluate proposed changes by comparing the new results with those considered and adopted as part of the Model documentation by the Modeling Committee (Final Report, p. 51 and Appendix U).

V. Nebraska's Proposed Changes to the Accounting Procedures

The Ahlfeld Report proposes a new method for computing GW CBCU and IWS. That method is premised on the conclusion that the difference in results from two of the model runs should be accepted as the "true" amount of net CBCU associated with groundwater pumping and imported water. First, it must be clearly recognized that the "true" or actual value of net CBCU associated with groundwater pumping and imported water is unknown. It must also be understood that many different factors and parameters affect the location and amount of stream depletions or accretions calculated by the RRCA Groundwater Model and that uncertainty in all of these factors and parameters contributes to uncertainty in Model results.

The Ahlfeld Report describes the issue as follows:

> *The problem arises from the assumption that the correct impact of a given stress in a sub-basin can be determined from the difference of a run of the RRCA Groundwater Model in which all stresses are active and one in which the target stress is inactive* (Ahlfeld Report, p. 1).

This description does not accurately reflect what is assumed by the FSS. The FSS recognizes that the Model provides estimates of depletions or accretions. The "true" or "correct" values are unknown. For purposes of the FSS, it was agreed that specific model runs would be used to make determinations of depletions as departures from the historical baseline for use in the compact accounting. These determinations were understood to be specific calculations using the Model and were not assumed to be the "true" or "correct" values. It was also clear that the Model structure contained non-linear components which could affect the additive properties of the depletion calculations. Some non-linear components, such as aquifer transmissivity, were idealized as linear (that is, constant) for specific reasons with the knowledge that such an idealization could affect the Model results to some degree (Final Report, p. 31).

The states together accepted the approximations and idealizations of the Model as adequate to calculate depletions and accretions as input to Compact Accounting. Three examples from the Model reveal how the Modeling Committee worked out compromises on these procedures. First, the relationship between precipitation and groundwater recharge is considered to be different on irrigated land than on non-irrigated land. The actual degree of that difference was the subject of extensive discussion within the Modeling Committee, which adopted a compromise for use in the compact accounting (Final Report, p. 20).

Another uncertain model parameter that is especially important in determining the amount and distribution of depletions and accretions is evapotranspiration. Losses due to evapotranspiration are a significant component of the RRCA Groundwater Model water budget (Final Report, page 16). The impact of evapotranspiration on the amount and distribution of depletions and accretions is even more significant in that it can often produce a "salvage" effect that reduces the amount of impact that declining groundwater levels might have on streamflow depletion. The actual degree of "salvage" that occurs is uncertain but it has been included in the Model for purposes of providing a tool for compact accounting. At times the inclusion of evapotranspiration changes produces counter-intuitive results such as stream flow accretions caused by groundwater pumping. These counter-intuitive results have nevertheless been included in the compact accounting because they represent the results from the calculation process that was agreed to in the FSS.

Results from the RRCA Groundwater Model should not be characterized as "true". Calculations of the difference in base flows between the historical base run and a "no State pumping" run are *considered* to be the depletions for purposes of compact accounting (Final Report, page 50). This characterization plainly shows that these calculated depletions may not be the *actual* depletions. Furthermore, the Model documentation report is careful to not characterize the Model as perfect, but rather uses such terms as "reasonable" and "sufficient" (Final Report, pp 10, 49 and 51) for purposes of providing a tool for compact accounting. The report is also careful to acknowledge that the Model does not assess certain practices such as land use and conservation practices or reservoir operations that could also have an impact on stream flow conditions (Final Report, p. 8). Ultimately, the RRCA Groundwater Model was developed through a collaborative process by technical experts from all three States to provide a tool for use in compact accounting (Final Report, p. 9).

There is no disagreement by any of the states that there are non-linear effects produced by the Model due to the relationship between groundwater pumping, evapotranspiration and stream effects. Groundwater pumping induces changes to storage, ET, and streamflows in complex manners both spatially and temporarily. These effects are especially noticeable in tributaries with intermittent baseflows, where in dry years aquifer storage is used, to be replenished in wet years. Nonetheless, the Ahlfeld Report claims to identify supposed "large errors" in Beaver Creek in 2003 and to a lesser extent in the Frenchman Creek and elsewhere. Beaver Creek is a small intermittent tributary, a minor part of the total supply. The intermittent nature of Beaver Creek, as well as certain other sub-basins, makes it subject to non-linear responses more so than other areas. Storage effects and evapotranspiration effects represent a larger portion of the entire water budget in Beaver Creek than elsewhere, especially during dry periods. That fact was recognized and accepted during the development and negotiation of the Model, the Accounting Procedures, and the FSS. It is not a question of whether these non-linear effects exist but whether they should be attenuated or eliminated, as suggested by Nebraska.

VI. Imported Water Supply Credit

One of the most significant effects of the Nebraska proposal is the increase in IWS credit that would result. This credit is only available to Nebraska. The IWS credit is the accretion to streams in the Republican River Basin in Nebraska, computed for each compact tributary and the main stem resulting from incidental recharge from Platte River diversions. The components of recharge include canal seepage, reservoir seepage and irrigation return flows from Platte River diversions. The Platte River facilities considered in the Model are shown on Figure 1. The diversions occur over a reach of 20 miles on the Platte River amounting to more than two million ac-ft/yr. The lands irrigated with this supply total 120,000 acres near the topographic divide between the Republican and Platte River Basins.

The total recharge to groundwater from Platte River supplies is estimated to be approximately 610,000 ac-ft/yr. The diversions and recharge amounts are shown of Figure 2. Actual Platte River recharge peaked during the 1970's and has been on a steady decline since then. Peak recharge amounts reached 680,000 ac-ft/yr during the decade of the 1970's, and declined to 600,000 in the decade of the 1990's. Since 2000, the Platte River recharge has declined to 475,000 ac-ft/yr, or to 70% of the peak rate during the decade of the 1970's. Reductions in recharge have been caused by reduced diversions from the Platte, system improvements and changes in irrigation efficiency over time.

Historical IWS credits are plotted on Figure 3. The average for the period of 1981 to 2000 was 16,300 ac-ft/yr, or approximately 2.7% of the total Platte River recharge input to the Model. Most of the Platte River recharge returns to the Platte River. Estimated accretions to the Republican River and tributaries increased from the early 1940's, to approximately 15,000 ac-ft/yr during the late 1980's.

The Groundwater Model is necessary to compute the IWS credit in Nebraska (Second Report, p. 64). As noted above, much of the Platte River recharge returns to the Platte River. Accretions reaching the Republican streams are highly dependent on water level conditions at the groundwater divide. Pumping along the Platte River affects the gradient of the aquifer and direction of groundwater flow. It is necessary to compute the Republican River accretions with the Model using a baseline condition that includes pumping so that the modeled water levels reflect actual conditions.

Nebraska's methodology would modify the IWS credit substantially. Figure 4 shows the changes for the years 2001 to 2006 proposed by Nebraska. The IWS Credit would be increased from 12,800 to 20,400 ac-ft/yr, a significant 60% increase. This increase is recommended by Nebraska even though Platte River recharge actually continued to decrease for this period and water levels were low due to higher pumping and reduced recharge in the Nebraska mound area.

The amount of accretion derived from the Model for the approved method and Nebraska's proposed method was compared to the amount of Platte River recharge documented above. Figure 5 plots the ratio for the period 1981 to 2006. The ratio for the currently approved method increased from 2% in 1981 to approximately 3% in the mid-1990's. This level was maintained until the recent drought years. The methodology proposed by Nebraska results in increasing ratios of accretions to recharge in recent years, exceeding 4% by 2006.

VII. The Method Specified in the FSS and Accounting Procedures is not Flawed

The Nebraska report (Ahlfeld report, p. 5 & 6) refers to "errors" in CBCU and IWS and refers to the accounting as comparing allocations to "actual water use". These descriptions mischaracterize the real situation. An "error" could describe one of two things; either the difference between a calculated value and a true or actual value; or a mistake such as adding two values that should have been subtracted.

The "error" that the Ahlfeld Report refers to is not an "error" in the sense of comparing an estimate to a measured or known value and it is not a mistake in the sense that the RRCA calculations are not what they were intended to be. It refers to a difference between calculations of CBCU and IWS using one method versus an alternative method and comparisons of those calculations to a third calculation. Nebraska assumes that this third calculation is the "true" value and then characterizes differences from this calculation as error.

The Ahlfeld Report's reference to "actual water use" is also a mischaracterization. The "actual water use" is not a known or measured quantity. Instead, it is a value developed through a calculation process as described in the compact and the FSS. These calculations represent methods of accounting that have been agreed to by the States for purposes of determining a value for water use that will be used to determine compliance with the compact. The calculations are based in part on various idealizations and assumptions that have been accepted for these purposes. Reference to these calculations as "actual" gives the misleading impression that they are more precise than they actually are.

Nebraska relies on the difference between the sum of the individual effects and the total impact of all stresses applied simultaneously (simultaneous impact) to conclude that changes are necessary to eliminate such differences. The necessity to eliminate such differences is not stated in the Compact, FSS or Accounting Procedures. Nebraska states that the lack of summation is caused by stream drying in recent years, an actual condition in the field as well as predicted by the Model. The Model is necessary to consider these conditions. The Modeling Committee did not state any limitation on the magnitude of the differences cited by Nebraska.

To check this conclusion, the differences between the sum of the individual effects required by the FSS and the simultaneous impacts were compared on a statewide basis for the entire period of 1940 to 2006. This allows the assertion by Nebraska to be checked against the results obtained over the entire model period considered by the Model Committee when the procedure was specified. Figure 6 shows the annual and five-year running average of this difference starting in 1971, as a percentage of the sum of the impacts. Prior to 2000, differences ranged from 3% to -4%. (The difference for 2003 is 3%.) Impacts are pumping depletions, with imported water supply netted out. As indicated by Figure 6, the differences have been positive for the years 2003 to 2006. Nebraska experts state a concern that any difference at all exists and the objective of their proposal is to eliminate the differences. As shown by the Model results, this was not a criteria for acceptance of the Model in 2003. Differences since 2002 are not substantially different than for prior years.

The Accounting Procedures set out a methodology to directly use the Groundwater Model to compute the GW CBCU for each state and the IWS credit to Nebraska. One requirement for the calculation of IWS credit is that actual water level conditions be considered. This requirement is met by using the approved and calibrated historical baseline condition. Nebraska's procedure introduces a series of baselines and effectively averages the results in a post-processing calculation not previously considered and apparently not unique. However, they fail to discuss the fact that these multiple "base conditions" are not equally reliable. The Model run representing the historical condition is different from all of the other model runs in that these conditions were subjected to a calibration process whereby the Model results were compared to measured groundwater levels and stream base flows. These comparisons provided a direct measure of the Model's reliability that could be assessed and understood by each of the States. None of the proposed Nebraska "base conditions" can be evaluated in this manner and thus the degree to which these conditions accurately reflect a "true" condition is unknown. Yet, in the proposed scheme, the condition assuming no pumping or imported water is given the same weight as the historical condition that was subjected to the calibration process. Since the historical condition can be compared and evaluated against actual measurements, it made sense to use the historical conditions as the "base condition" as was done in the agreed upon RRCA method rather than other alternatives whose conditions could not be compared and evaluated against actual measurements.

IWS credits should be evaluated with Nebraska pumping on in order to insure that credits appropriately reflect water level conditions consistent with Nebraska pumping. Nebraska states ".. the impact of mound recharge is masked by the presence of Nebraska pumping" (Ahlfeld Report, p. 43) which is exactly the point here. Nebraska pumping reduces the mound credit.

VIII. Conclusions

Nebraska has requested that the method used to compute CBCU and IWS credit be changed to include additional model runs that deviate from the historical water level conditions. The change would have a significant effect on the results of the Groundwater Model used in the RRCA Accounting Procedures. Nebraska proposes a method that would increase Nebraska's IWS credit by 15% for the period prior to 2000, and by 50% for the drought period of 2002 to 2006.

Nebraska's proposal is based on a presumption that individual impacts must sum to a specific value and that this presumption was adopted or should now control how model results are processed for use in the accounting. However, this presumption was not stated in any of the decree documents describing the Model or accounting procedures. The necessity for impacts to sum to a specific value was not adopted by the States.

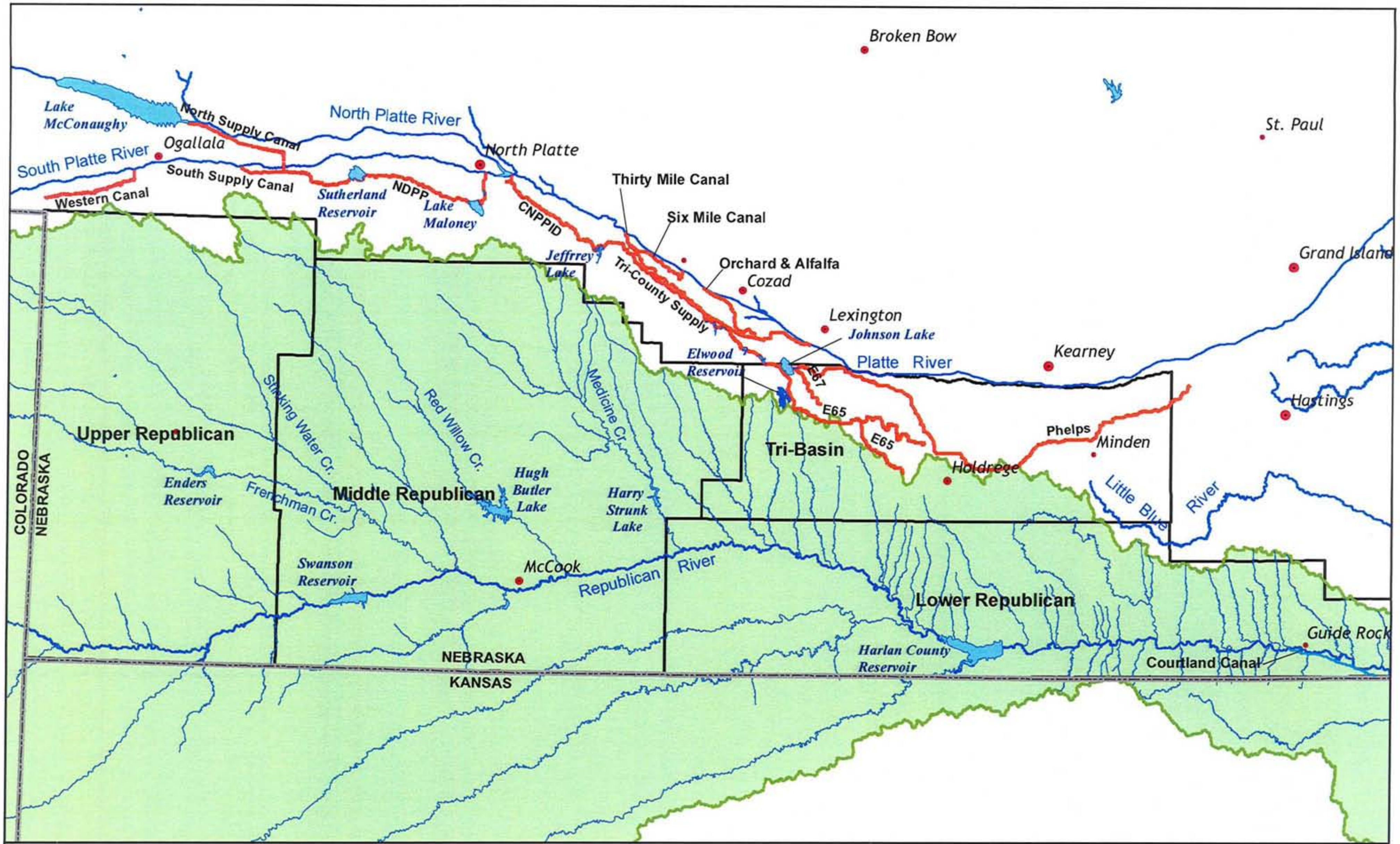
There is no "error" in the agreed upon method of accounting. The special master's reports and FSS clearly state that the Groundwater Model will be used to calculate the GW CBCU and IWS. This application of a model to determine impacts is common practice.

The Nebraska proposal requires a post-processing approach to translate model results to accounting elements, by weighting the results of new model runs. Thus, the IWS credit is no longer directly calculated by the Model with actual water level conditions.

IWS credit is not a term in the compact, but was added during the development of the FSS because the Groundwater Model was going to be available to quantify it. Nebraska does not measure the water reaching the Republican streams, but rather must depend on calculations and modeling for determination of the small percentage of imported water that reaches the Republican River.

The current procedures were established by the Modeling Committee in their role of developing the Groundwater Model for the States and are reasonable and sufficient to estimate the impacts of the pumping and Platte River recharge. Nebraska concerns arose from conditions occurring subsequent to the end of the period considered by the Modeling Committee. However, a review of the model results since 2000 does not indicate any "errors" or need to implement accounting changes proposed by Nebraska, which would result in significant changes to the computed States' impacts.

Figures



Source: Republican River Basin - HUC12 (USDA)
Platte River Canals - NE DNR COHYST

Figure 1
Location Map
Platte River Recharge Area

Platte River canals
Republican River Basin
Nebraska NRD

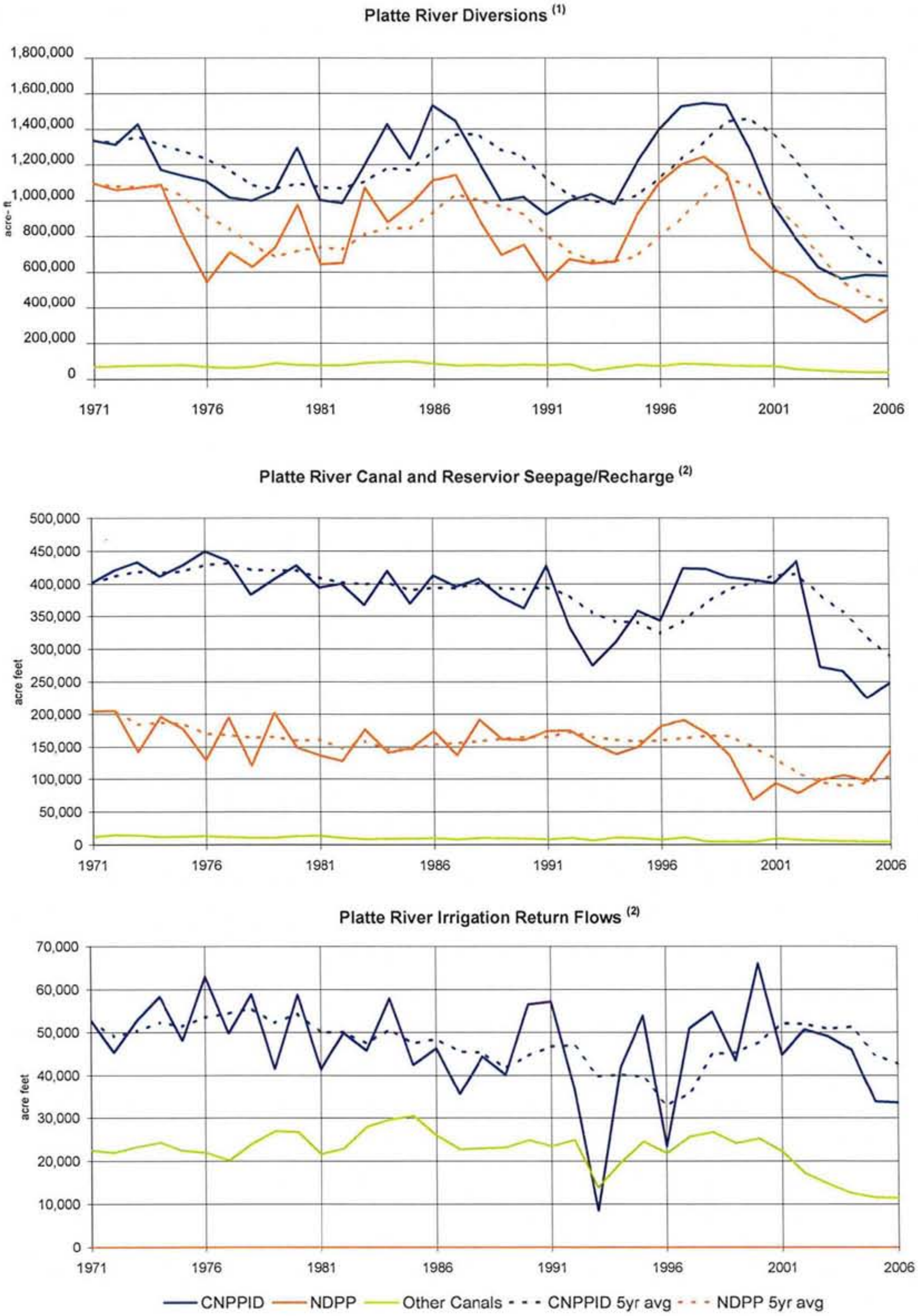
10 5 0 10 20 30 Miles
Approximate Scale = 1:1,300,000

Spronk Water Engineers, Inc.
1000 Logan Street Denver, CO 80203

02.16.09

Figure 2

Platte River Diversions and Calculated Mound Recharge
1971 - 2006
acre-ft

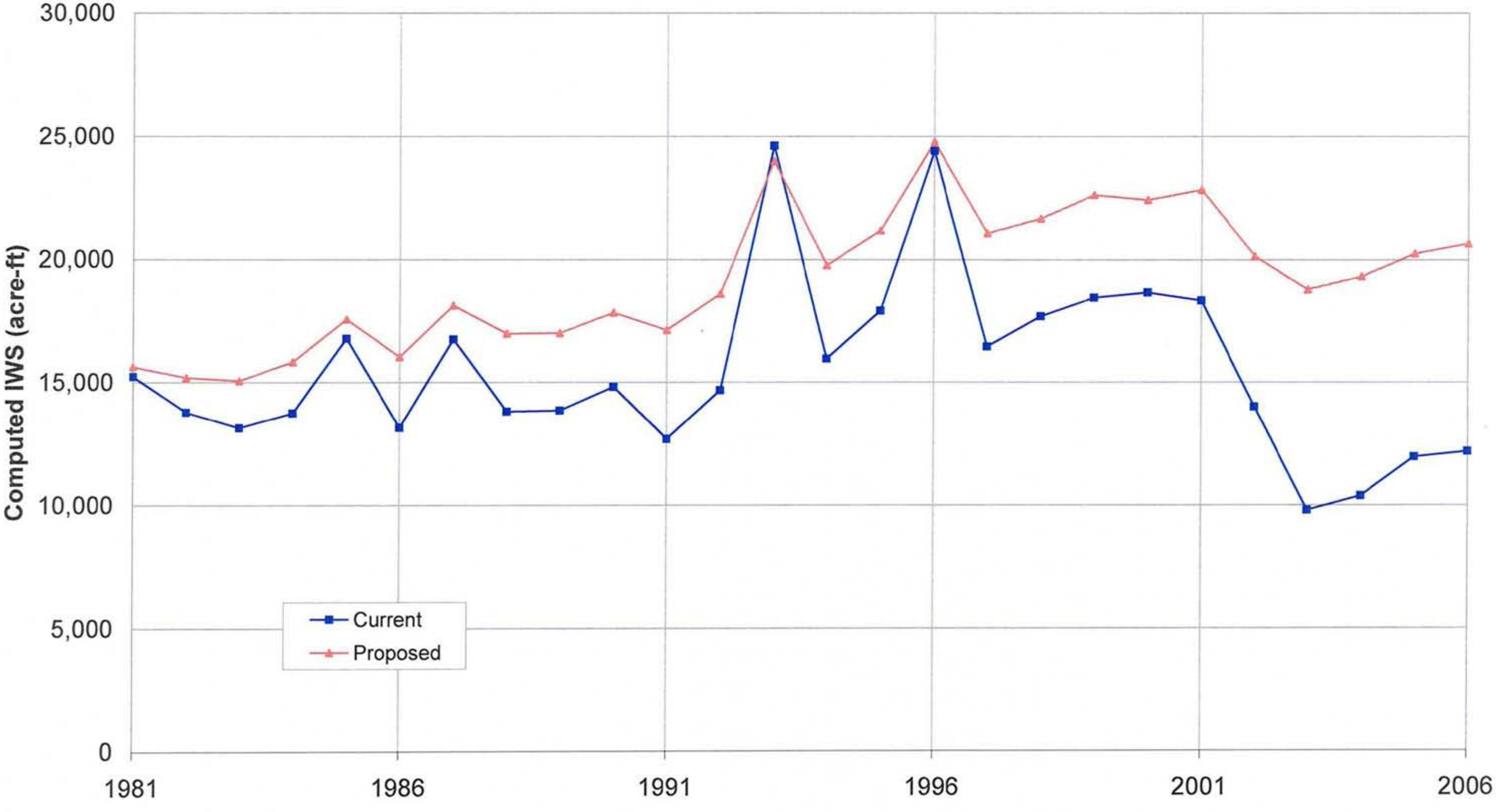


Notes:

(1) 2005 and 2006 Other Canals diversions estimated using relationship between CNPPID diversions from 1971 - 2004.

(2) 2001 - 2006 Other Canals recharge and irrigation return flows estimated using relationship between Other Canal diversions from 1971 - 2000.

Figure 3
Nebraska's Computed Imported Water Supply (IWS) Using the Current and Proposed Accounting Methodology
1981 - 2006
(acre-ft)

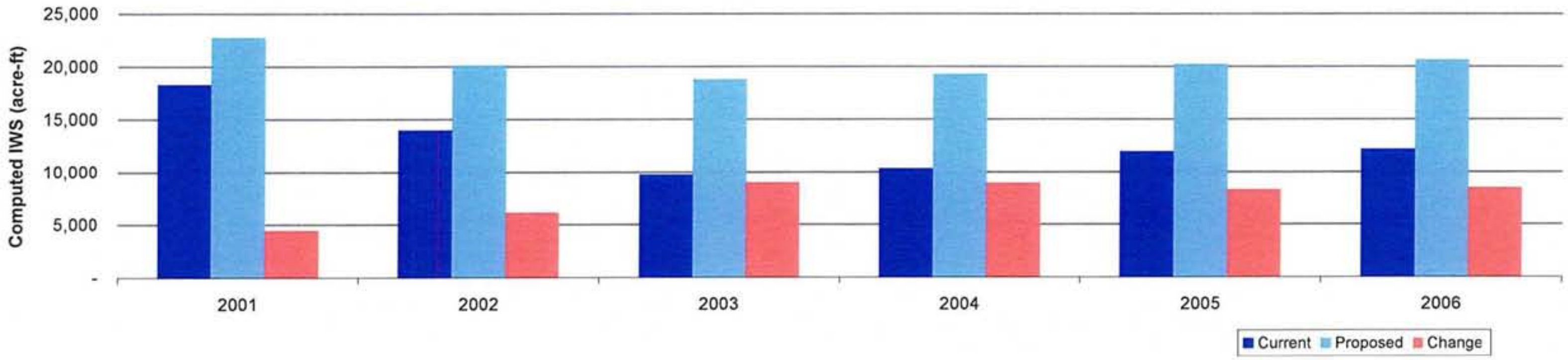


Note: Current IWS from areed upon RRCA accounting. Proposed IWS from Nebraska's proposed accounting (2001 - 2006) (Ahlfeld, et al., 2009) and generated by KDWR (1981 - 2000).

Figure 4

Comparison of Nebraska's Computed Imported Water Supply (IWS) Using the Current and Proposed Accounting Methodology
2001 - 2006
acre-ft

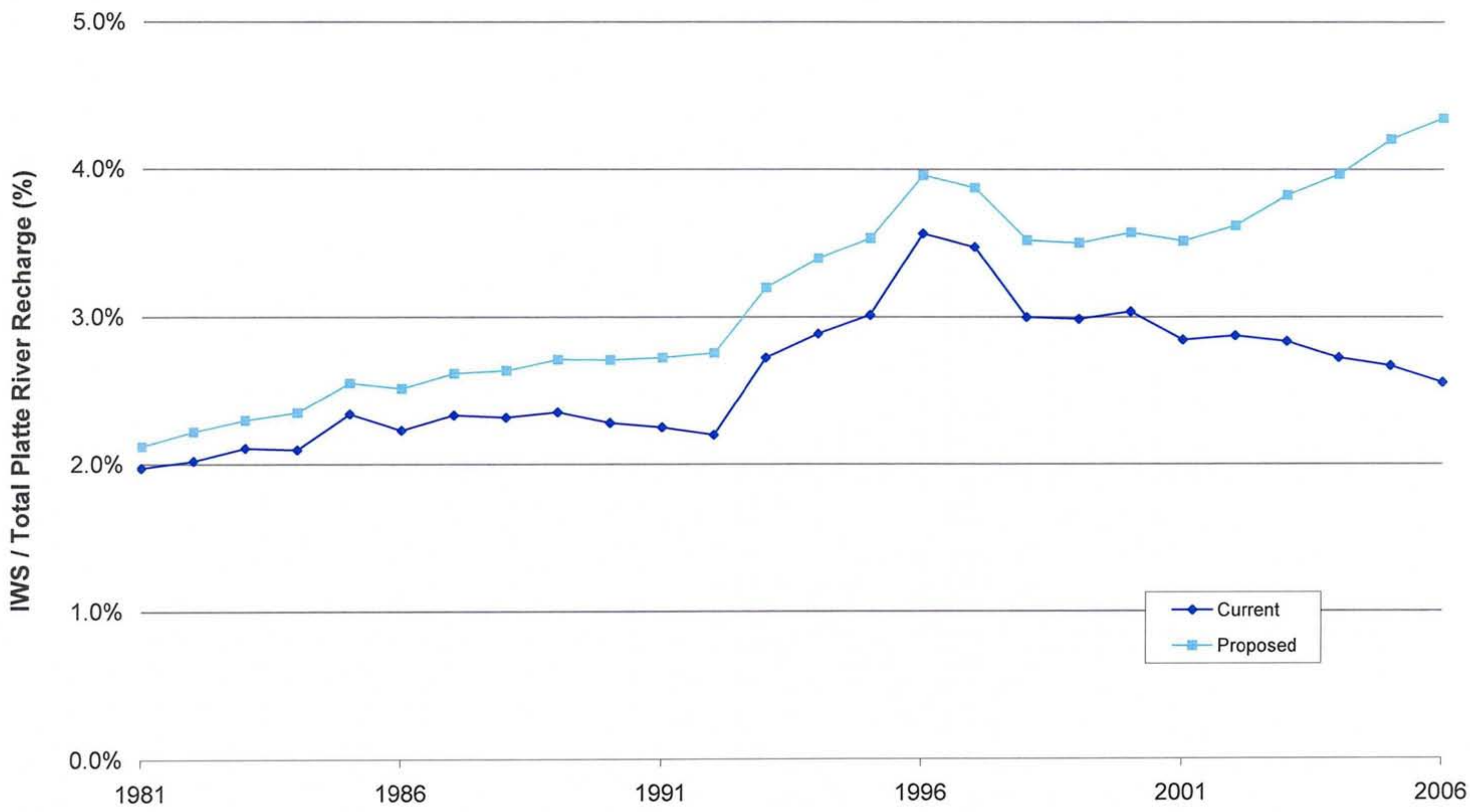
	2001		2002		2003		2004		2005		2006	
Sub-Basin	Current	Proposed	Current	Proposed	Current	Proposed	Current	Proposed	Current	Proposed	Current	Proposed
Maintstem	9,009	13,266	5,608	11,162	334	9,044	826	9,453	2,288	10,258	2,752	10,794
Medicine	9,303	9,500	8,373	8,925	9,439	9,680	9,533	9,795	9,644	9,908	9,405	9,759
Other	29	71	24	64	20	65	25	70	34	82	25	102
Total	18,341	22,837	14,005	20,151	9,793	18,789	10,384	19,318	11,966	20,248	12,182	20,655



Note: Current IWS from areed upon RRCA accounting. Proposed IWS from Nebraska's proposed accounting (2001 - 2006) (Ahlfeld, et al., 2009) and generated by KDWR (1981 - 2000).

Figure 5

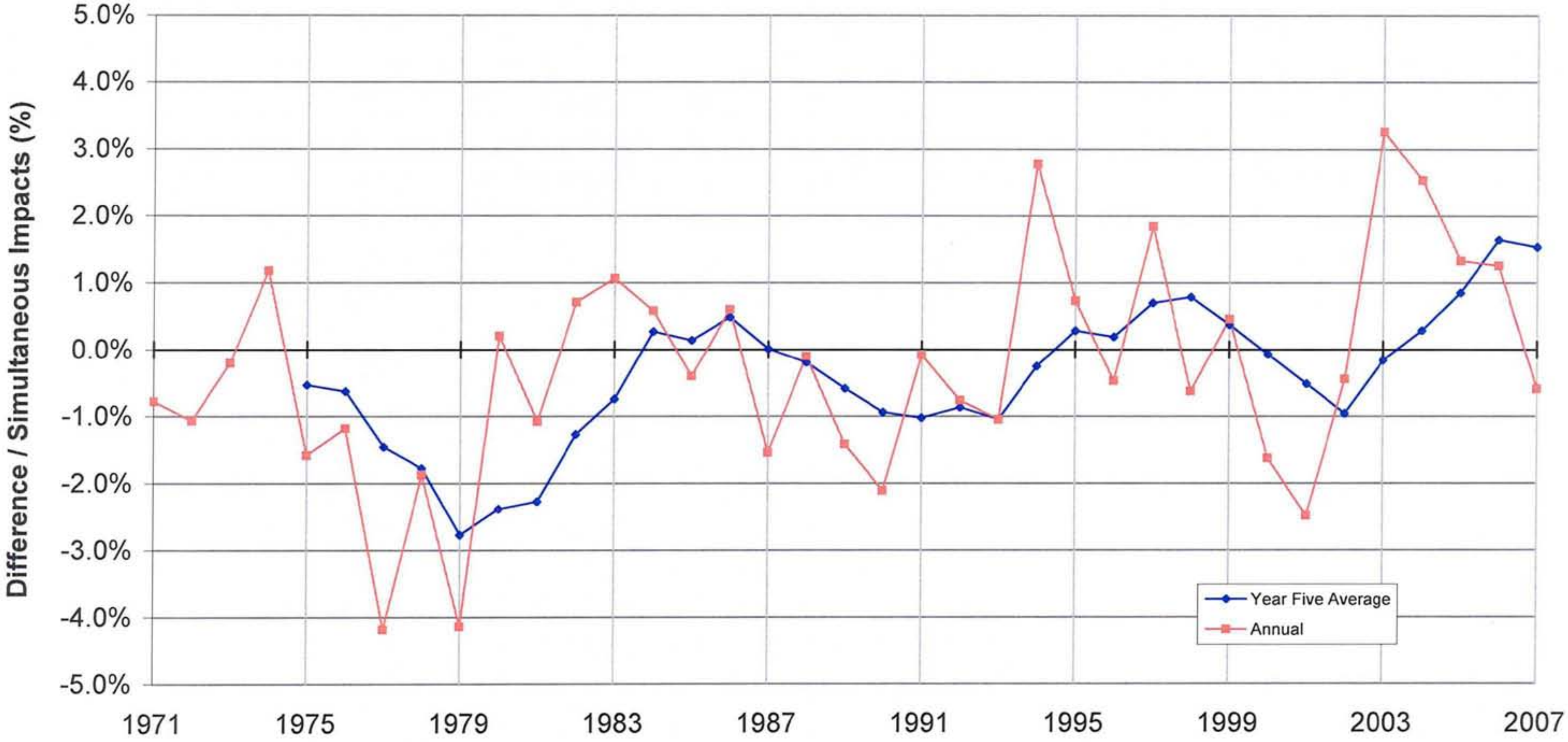
Imported Water Supply (IWS) as a Percent of Total Platte River Recharge
1981 - 2006
Five Year Running Average



Note: Current IWS from areed upon RRCA accounting. Proposed IWS from Nebraska's proposed accounting (2001 - 2006) (Ahlfeld, et al., 2009) and generated by KDWR (1981 - 2000).

Figure 6

Difference Between the Sum of the Individual Impacts [1]
and the Simultaneous Impacts as a Percent of the Simultaneous Impacts
(Year Five Average and Annual % Difference)
1971 - 2007



Notes:
(1) Sum of the Individual Impacts = $CBCU_C$ + $CBCU_K$ + $CBCU_N$ - IWS

<u>Kansas' Review of Nebraska's Request for Change in Accounting Procedure</u>
<u>September 18, 2007</u>

This memo is intended to summarize Kansas' understanding of the Nebraska's proposal for changing the agreed upon method of computing pumping impacts using results from the Republican River Compact Administration Groundwater Model (Model) and to summarize our initial response to the proposal.

Nebraska believes that the calculation of pumping impacts using results from the groundwater model improperly includes the consumption of imported water. Nebraska argues that because some of the water pumped by wells is or could be water that originated from imported water, the consumption of that water should not be counted in determining the virgin water supply in the accounting process. This argument is difficult to understand since no one has ever determined the specific origin of groundwater that is pumped and consumed. In other words, whether the origin of the pumped water is from natural recharge within the Republican River basin, natural recharge outside the Republican River basin, stored groundwater, or imported water has never been determined and probably cannot be determined with any degree of reliability.

In terms of the use of the Model to determine compliance with the Compact, however, the specific origin of the water that is pumped and consumed is not the determining factor. The only question with respect to the Model's result s that affect compact compliance is the extent to which activities in a state, either pumping or importation of water, affect base flow in the Republican River. To the extent these activities affect base flows in the river, they must be counted. In other words, it is not the source of water that counts, but the depletion or accretion to base flow that is associated with the activity that determines the amount of impact that must be considered in the compact accounting process. This concept is precisely what is included in the Accounting Procedures adopted by the Settlement and what the special master based his rulings on in determining that those effects to stream flows in the Republican River are regulated by the compact. As it is stated in the <u>Final Report of the Special Master's With Certification of Adoption of Republican River Compact Administration Groundwater Model</u>, September 2003: "*... the RRCA Groundwater Model which would, for use in the accounting formulas for administering the Republican River Compact, determine both stream flow depletions caused by groundwater pumping and streamflow accretions resulting from recharge by imported water*" (Page 1). It is clear that only quantification that is relevant to the compact accounting is the depletion or accretion to Republican River stream flow.

The quantification of depletion or accretion to Republican River base flow is not limited to activities that are solely within the boundaries of the Republican River Basin. Recharge from imported water can cause accretion to Republican River base flow even if the recharge occurs outside the boundary of the basin. To the extent that such recharge provides accretions to Republican River base flow, it is counted in the accounting process. Similarly, pumping from locations outside the basin can cause depletions to Republican River base flow. To the extent that such pumping causes depletions to base flow, it is counted in the accounting process. Thus both positive effects (accretions) and negative effects (depletions) on Republican River base flows caused by activities outside the physical boundaries of the basin are treated equally.

In order to provide this quantification using the groundwater model, it was agreed in the settlement that the impact of each state's pumping or water importation would be determined by comparing the model-computed historical base flow condition to the model-computed base flow condition without that activity. The states recognized that the sum of the impacts of these individual activities would not necessarily exactly equal the model-computed impact of all of the activities considered simultaneously. If the groundwater model were mathematically linear, it would, in fact, be the case that the sum of the individual affects would equal the affect determined by considering all of the activities simultaneously. However, because the groundwater model is mildly non-linear, this mathematical equality does not occur.

It should be noted that if the impact of all activities considered simultaneously were used, it would be necessary to have a method for apportioning the impact among the various activities. Such a process was considered unnecessary and it was agreed that the impacts from each state's activity would be computed separately in spite of the fact that the sum of those impacts may not exactly equal the impact of all activities considered simultaneously.

Nebraska has proposed an alternative method of computing the impacts associated with each state's activity. This alternative has been proposed to correct what they see as an inappropriate accounting of consumed water. While the connection between Nebraska's proposed alternative accounting method and their concept of what water is actually consumed is far from apparent, we have evaluated the merits of this alternative method regardless of its basis.

The ultimate goal of the RRCA Groundwater Model is to provide a measure of what base flows would have been if the States had not pumped groundwater or recharged imported water. That overall measure could be determined by comparing the model-computed historical stream flows to the model-computed stream flows with all pumping and recharge of imported water removed from the analysis (herein referred to as the "virgin water supply metric"). This measure gives us the total impact on stream flows caused by the States' pumping and the recharge of imported water. As described above, however, this result does not apportion the impact among the States. Conceptually, the condition with no pumping and no imported water represents what the stream flows would have been if none of this activity had occurred. In that sense, it represents a "virgin water supply" condition with respect to the modeled elements of the groundwater model and their impact on Republican River stream flows.

This measure does provide a metric for comparing the accounting method agreed to in the settlement with Nebraska's alternative accounting proposal. It is a relatively straightforward process to add up the impacts using the accounting method agreed to in the settlement or to add up the impacts from Nebraska's alternative accounting proposal and compare those totals to the virgin water supply metric described above. If the Nebraska alternative accounting proposal provides a better approximation of this metric, it is worthy of further consideration.

Our calculations, as summarized in the table below, show that the accounting agreed to in the settlement provides a better approximation of the virgin water supply metric than the Nebraska proposed accounting method. The table shows that the accounting agreed to in the settlement results in both positive and negative annual differences from the virgin water supply metric. The resultant average for the years 1990 – 2000, the last ten years of the calibration of the model is -

150 acre-feet. For the last six years, 2001-2006, the average difference is 2,053 acre-feet. The Nebraska alternative accounting proposal departs significantly further from the virgin water supply metric than the accounting method agreed to in the settlement, has a negative bias, and for the period studied is increasing.

It remains our view, based on our understanding of the agreement of the States at the time of the settlement and these results, that the current accounting methods are appropriate.

Table: Comparison of total impacts under adopted procedures and as proposed by Nebraska versus the virgin water supply metric.

Year	Virgin Water Supply Metric	Compact Method Total	Nebraska Proposed Alternative	Difference [Compact Method – Metric]	Difference [Nebraska Proposal – Metric]
1990	180542	176749	170646	-3793	-9896
1991	200582	200424	191432	-158	-9150
1992	206037	204478	195938	-1559	-10099
1993	213153	210926	212593	-2227	-560
1994	188954	194203	186345	5249	-2609
1995	219075	220673	213807	1598	-5268
1996	229586	228517	228167	-1069	-1419
1997	208878	212730	202992	3852	-5886
1998	210089	208778	200587	-1311	-9502
1999	230055	231109	222053	1054	-8002
2000	203222	199934	192856	-3288	-10366
2001	236771	230905	221333	-5866	-15438
2002	196546	195685	183123	-861	-13423
2003	221307	228528	210485	7221	-10822
2004	231704	237594	219651	5890	-12053
2005	237802	240969	224287	3167	-13515
2006	219356	222122	204589	2766	-14767
Averages:					
1990-2000	208198	208047	201583	-150	-6614
1990-2006	213745	214372	204758	627	-8987
2001-2006	223914	225967	210578	2053	-13336

Attachment 5: RRCA groundwater model analysis (revised)
Impact of Nebraska pumping and proposed remedy

Samuel P. Perkins[1] and Steven P. Larson[2]
January 4, 2008
(see Appendix A for an explanation of revisions)

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Introduction

The analysis described in Attachment 4 has shown that annual groundwater consumptive use in Nebraska must be reduced to 175,000 acre-feet in order to achieve sustained compliance with the compact. The approved RRCA groundwater model was used to determine the reduction in pumping necessary for Nebraska to meet this requirement and thereby achieve sustained compliance with the Republican River Compact. This memo describes the basis for the projected depletions computed by the groundwater model under both status quo and reduced pumping scenarios.

In order to reach and then sustain a groundwater consumptive use of 175,000 acre-feet (AF) needed to comply with the Compact over the next 50 years, the proposed remedy case imposes the following conditions on future groundwater pumping for irrigation within the Republican River basin in Nebraska: first, a no-pumping zone for irrigation is imposed within 2.5 miles of RRCA groundwater model stream cells; second, groundwater irrigation area is held at 2000 levels at distances greater than 2.5 miles from stream cells; third, commingled irrigation area is held at 2006 levels at all distances from stream cells within the Republican River basin in Nebraska. Under this scenario, future groundwater irrigation area in Nebraska is reduced by 514,610 acres, including 350,970 acres within the no-pumping zone and 163,640 acres outside the no-pumping zone. For comparison, Nebraska's reported groundwater irrigated acreage within the Republican River basin has increased by 211,000 acres since 2000 and by 309,900 acres since 1990.

The proposed remedy is intended to allow recovery of streamflow as quickly as groundwater response will allow by focusing on groundwater pumping near the Republican River and its tributaries. The groundwater model was used to represent impacts of Nebraska groundwater pumping on Republican river streamflow and of imported water supply from the Platte River. Model scenarios were run to represent both status quo conditions and the proposed remedy. Projected Nebraska impacts for a 51-year future time period, as well as computed Republican River streamflow, are presented here under both scenarios.

Projected average annual impacts over 51 years (2007-2057) on Republican River streamflow under status quo conditions are 268,000 acre-feet per year (afy) for Nebraska groundwater pumping, reduced by 11,700 afy for imported water supply credit from Platte River imports, for a net impact of 256,300 afy. The corresponding impacts under the reduced pumping scenario are 164,700 afy for Nebraska pumping, reduced by 27,600 afy for imported water supply credits, for a net impact of 137,100 afy. Compared with the base case scenario, the proposed remedy scenario shows an average decrease in pumping impact of 103,300 afy and increase in imported water supply credit of 16,000 afy, for a reduction in Nebraska's net impact of 119,300 afy. However, the net impact under the proposed remedy shows an initial decline followed by an upward trend for years 2015-2057, indicating a possibly larger net impact beyond the simulated time period.

Using a sequence of historical years to represent futures

Model datasets for historical years 1990-2006 were used to construct future scenarios. These years were chosen initially because of the higher quality of Kansas water use reporting data beginning in 1990. The sequence of historical years 1990-2006, beginning with year 1990, was repeated three times to represent future scenarios for years 2007-2057. Median annual precipitation for years 1990-

2006, spatially averaged over the groundwater model domain, is 19.58 inches/year. Compared against the model's years of record 1918-2006, this corresponds to a probability of 54.5 percentile, which is slightly above median rainfall of 19.28 in/yr for years 1918-2006. This indicates that the sequence is a reasonable projection, at least with respect to the historical record. Additionally, the sequence consists of a relatively wet period (1990-1999) followed by a relatively dry period (2000-2006).

Hydrologic conditions for future years were represented by the conditions of the historical sequence of years. These conditions include mean monthly streamflow and reservoir elevations at the end of each month, both of which are specified for the stream (STR) package, and evapotranspiration (for the EVT package) as input to Modflow (mf2k). Groundwater recharge, pumping and irrigated area are also based on conditions of the historical sequence of years, but with adjustments to specify conditions for the specific cases as input files to the pumping (WEL) and recharge (RCH) packages. Irrigated area is a consideration due to the dependence of precipitation recharge on whether or not the land is irrigated. Input files to Modflow were assembled by the preprocessor programs mketff (EVT package), mkstrff (STR package) and rrppf (RCH and WEL packages) [version: rrppf_v519].

Status quo scenario

Recharge and pumping for the status quo scenario were represented by historical conditions with adjustments as follows.

Kansas data for irrigated area, groundwater pumping and return flow in future years were based on corresponding historical years' data, but with adjustments to reflect 2006 conditions with respect to return flow (based on improvements in irrigation systems), metering and development.

Data for irrigated area served by groundwater and commingled pumping as reported in 2006 by Colorado and Nebraska were used to represent all future years under base case conditions. Irrigated area served by surface water in future years was represented by data for the corresponding historical years. For Colorado, 2006 groundwater irrigated area was substituted for the corresponding historical years' area as a correction to the Colorado dataset from authorized area, as specified in years 1990-2000, to reported area used for irrigation, as specified in years 2001-2006. No corresponding adjustment was made to groundwater pumping for Colorado.

In the case of Nebraska, 2006 groundwater and commingled irrigated area were substituted for corresponding historical years' data in order to represent continued development through 2006. Groundwater pumping by Nebraska in future years was represented by reported pumping in the corresponding historical years to reflect hydrological conditions. To reflect the change in development associated with irrigation from a given historical year to the year 2006, historical pumping corresponding to each grid cell was multiplied by the ratio of total groundwater and commingled irrigated area in 2006 to the total area for the corresponding historical year. In order to reflect differences in development across Natural Resource Districts in Nebraska, this ratio was calculated for each NRD within the groundwater model domain, and applied to total reported pumping and groundwater return flow for each model grid cell within the corresponding District. NRD boundaries are shown in Figure 1.

The assumptions of historical conditions for the Nebraska dataset that are projected into the future include return flow from groundwater pumping for irrigation, which is assumed to be 20 percent. This is considered to be a generous assumption, even for recent historical years, and may warrant revision for scenario refinements, especially if allocations imposed by Natural Resource Districts are to be incorporated.

Proposed remedy case: reduced Nebraska pumping scenario

Conditions for the reduced Nebraska pumping scenario are summarized above in the Introduction. The conditions are explained in greater detail as follows.

No-pumping zone

The no-pumping zone was specified in terms of model grid cells as an approximation of an actual zone, which would likely be independent of the model grid; for example, it might reference a boundary based on the Public Land Survey System. The grid-based approximation has the advantage of allowing the affected pumping in Nebraska to be selected from datasets previously prepared by Nebraska for the model, including groundwater pumping, recharge and irrigated area. Additionally, defining the no-pumping zone with reference to model stream cell centers is intended to be consistent with prior decisions made during model development to represent the stream network.

Figure 1 shows the extent of the proposed no-pumping zone on Nebraska groundwater pumping for irrigation within the Republican River basin as gray-shaded grid cells. Model cells representing streams and federal reservoirs (turquoise) are included in the no-pumping zone. By selecting model grid cells whose centers lie within two miles of stream cell centers, the resulting no-pumping zone applies to groundwater diversions within 2.5 miles of the stream. The model grid cells corresponding to the no-pumping zone were selected in GIS and converted into a "mask", i.e., an array of 1's and 0's that was written to a text file for input to a preprocessor to identify grid cells for which pumping is to be excluded.

2000 irrigated area

Outside the no-pumping zone, groundwater irrigation area for the year 2000 was substituted for corresponding historical years' data to hold development at 2000 levels. Groundwater pumping by Nebraska in future years was represented by reported pumping in the corresponding historical years to reflect hydrological conditions, multiplied by a factor to reflect the change in irrigated area, given by the ratio of groundwater irrigated area in 2000 to groundwater irrigated area in the corresponding historical year. Ratios were calculated for each Natural Resource District (NRD) and applied to corresponding pumping within the NRD.

An implicit assumption of the above conditions for the proposed remedy scenario is that pumping within the no-pumping zone cannot be transferred outside the zone.

The combined effects of imposing the no-pumping zone and fixing irrigated area at 2000 elsewhere in the Republican River basin are to reduce groundwater irrigated area within the Republican River basin by 514,600 acres, or 43 percent, from 1,200,600 acres under the status quo scenario to 686,000 acres under the proposed remedy.

Commingled irrigated area

In applying the proposed remedy, the condition to hold groundwater irrigation area to 2000 levels is not applied to commingled irrigation area, which is instead held at 2006 levels for all of Nebraska within the RRCA groundwater model domain. Within the no-pumping zone, commingled irrigation area is retained, under the assumption that commingled area could be irrigated if surface water is available. Total 2006 commingled irrigated area in Nebraska was 119,000 acres. Within the no-pump zone, 2006 commingled irrigation area was 11,040 acres; Within the Republican River basin and outside the no-pump zone, 2006 commingled area was 2,230 acres.

Evaluation of impacts of Nebraska pumping under status quo and reduced pumping conditions

In order to compute Nebraska impacts of both groundwater pumping and imported water supply, three additional cases were run for comparison against the status quo and reduced pumping cases, above. Conditions for the third case specify no groundwater pumping in Nebraska for the entire simulation period, beginning in 1918, but are otherwise the same as conditions for the base case. Similarly, conditions for the fourth case specify no imported water supply from the Platte River in Nebraska for the entire simulation period, beginning in 1918, but are otherwise the same as conditions for the base case. The fifth case is identical to the reduced pumping cases (above), except for the assumption that future imported water supplies from the Platte River are excluded.

Based on these five future scenario runs, impacts of Nebraska pumping and imported water supply were evaluated with respect to both baseline and reduced pumping conditions. First, the impact of Nebraska pumping under status quo conditions was evaluated as the difference given by computed Republican River flows for the "no Nebraska pumping" case minus corresponding flows for the status quo case. Second, the impact of Nebraska pumping under the proposed remedy is evaluated as the difference given by computed Republican River flows for the "no Nebraska pumping" case minus corresponding flows for the proposed remedy case. Similarly, imported water supply credits were evaluated twice: first, with respect to status quo conditions, and then with respect to reduced pumping conditions under the proposed remedy case.

Results: impacts of Nebraska pumping and imported water supply from Platte River

The reduction in groundwater irrigated area of 514,600 acres within the Republican River basin under the proposed remedy results in a groundwater pumping reduction of 619,900 acre-feet/year. Impacts of this reduction on streamflow are presented here.

Table 1 lists computed annual impacts of Nebraska pumping on Republican River streamflow and of imported water supply under both the status quo and reduced pumping scenarios for years 2007-2057, and averages over the same period. The rightmost column of Table 1 lists the reduction of impacts achieved under the reduced pumping scenario.

Table 1 shows that projected average annual impacts over 51 years (2007-2057) on Republican River streamflow under baseline, conditions are 268,000 acre-feet/per year (afy) for Nebraska groundwater pumping, reduced by 11,700 afy for imports from the Platte River, for a net impact of 256,300 afy. The corresponding impacts under the reduced pumping scenario are 164,700 afy for Nebraska pumping, reduced by 27,600 afy for imported water supply for a net average impact of 137,100 afy. Compared with the base case scenario, the proposed remedy scenario shows an average decreased pumping impact of 103,300 afy, and an increase in imported water supply credit of 16,000 afy, for an average net Nebraska impact reduction of 119,300 afy. However, the net impact under the proposed remedy shows an initial decline followed by an upward trend for years 2015-2057 that indicates a possibly larger net impact beyond the modeled time period.

Nebraska impacts on Republican River streamflow are shown graphically in Figures 2 and 3. Figure 2 shows the separate impacts of Nebraska pumping and imported water supply credit under both scenarios. Figure 3 shows the net sum of pumping impact and imported water supply credit for each scenario.

Figure 2 shows historical impacts of Nebraska pumping on Republican River streamflow and imported water supply credit according to the RRCA groundwater model for years 1960-2006. The historical impact of Nebraska pumping reached peak levels of 212,900 acre-feet/year in 2001 and 213,100 acre-feet/year in 2004, and was 198,400 acre-feet/year in 2006. Figure 2 also shows projected impacts of Nebraska pumping on Republican River streamflow and imported water supply credit under both the status quo scenario and the reduced pumping scenarios for years 2007-2057.

The impact of Nebraska pumping on Republican River streamflow in future years under the status quo scenario shows greater variability than under the reduced pumping scenario because of the greater magnitudes of the pumping under the status quo scenario. Projected pumping impacts under both scenarios appear to have upward trends, although impacts under status quo conditions show a decreasing rate of change. Imported water supply credits under the proposed remedy are greater and show less variability than do those under status quo conditions.

Table 1. Projected impacts of Nebraska pumping and Platte River imports under both status quo conditions and the proposed remedy (acre-feet/year)

year	Status quo conditions			Proposed remedy			Impact reduction
	pumping	imports	Net impact	pumping	imports	Net impact	
2007	206,685	15,945	190,740	189,290	17,476	171,814	18,926
2008	228,723	10,519	218,204	185,972	18,160	167,812	50,392
2009	232,212	10,058	222,154	184,619	24,438	160,181	61,973
2010	268,248	28,216	240,032	188,316	28,869	159,447	80,585
2011	234,826	18,396	216,430	167,740	23,517	144,223	72,207
2012	257,288	16,004	241,284	169,116	25,785	143,331	97,953
2013	279,390	19,589	259,801	170,714	27,116	143,598	116,203
2014	253,960	20,178	233,782	161,514	25,630	135,884	97,898
2015	239,184	13,010	226,174	153,278	24,317	128,961	97,213
2016	259,639	12,697	246,942	162,518	27,757	134,761	112,181
2017	235,315	12,933	222,382	149,632	23,936	125,696	96,686
2018	249,836	11,921	237,915	151,570	26,762	124,808	113,107
2019	220,215	8,478	211,737	137,938	20,590	117,348	94,389
2020	239,380	9,005	230,375	151,122	25,655	125,467	104,908
2021	249,061	9,087	239,974	155,209	27,349	127,860	112,114
2022	248,073	9,400	238,673	152,490	25,855	126,635	112,038
2023	232,745	9,054	223,691	148,589	26,396	122,193	101,498
2024	241,650	9,967	231,683	150,586	25,203	125,383	106,300
2025	260,704	8,756	251,948	158,291	26,119	132,172	119,776
2026	261,893	9,493	252,400	159,352	27,569	131,783	120,617
2027	310,470	20,000	290,470	168,124	29,958	138,166	152,304
2028	266,199	17,524	248,675	157,838	27,737	130,101	118,574
2029	288,790	11,750	277,040	161,625	29,072	132,553	144,487
2030	315,741	13,507	302,234	167,204	30,214	136,990	165,244
2031	281,880	17,106	264,774	161,227	29,113	132,114	132,660
2032	268,225	9,908	258,317	155,858	27,867	127,991	130,326
2033	287,840	10,699	277,141	165,875	30,366	135,509	141,632
2034	260,095	9,511	250,584	155,124	27,216	127,908	122,676
2035	275,704	9,444	266,260	157,893	29,493	128,400	137,860
2036	240,324	7,342	232,982	146,034	23,234	122,800	110,182
2037	253,962	8,401	245,561	159,222	28,213	131,009	114,552
2038	268,318	8,603	259,715	163,913	29,615	134,298	125,417
2039	272,377	9,011	263,366	161,569	28,314	133,255	130,111
2040	254,226	8,699	245,527	158,492	28,645	129,847	115,680
2041	262,968	8,440	254,528	160,150	27,552	132,598	121,930
2042	281,574	8,280	273,294	169,229	28,218	141,011	132,283
2043	282,715	9,153	273,562	170,738	29,665	141,073	132,489
2044	340,444	14,502	325,942	180,788	32,343	148,445	177,497
2045	285,259	15,373	269,886	168,711	29,938	138,773	131,113
2046	310,820	9,985	300,835	173,741	31,303	142,438	158,397
2047	339,785	11,229	328,556	180,301	32,442	147,859	180,697
2048	302,494	15,013	287,481	174,016	31,491	142,525	144,956
2049	286,563	8,973	277,590	167,400	29,872	137,528	140,062
2050	305,555	10,562	294,993	179,129	32,415	146,714	148,279
2051	278,614	8,926	269,688	167,245	29,129	138,116	131,572
2052	293,521	9,281	284,240	170,714	31,589	139,125	145,115
2053	250,743	6,952	243,791	156,746	24,702	132,044	111,747
2054	265,943	8,337	257,606	171,879	29,872	142,007	115,599
2055	280,141	8,709	271,432	176,507	31,446	145,061	126,371

2056	287,984	8,969	279,015	174,543	30,068	144,475	134,540
2057	270,883	8,707	262,176	169,789	30,174	139,615	122,561
2007-2057	268,023	11,678	256,345	164,696	27,643	137,053	119,292

Figure 2 shows that the impact of Nebraska pumping under the proposed remedy is projected to fall below 175,000 acre-feet/year for the first time in 2011, or in the fifth year of the future scenario, and then occasionally exceeds 175,000 acre-feet/year beginning in 2044. Based on linear trends for years 2011-2057, the impact of Nebraska pumping increases by 394 acre-feet/year under the proposed remedy, and by 1,055 afy under status quo conditions.

Figure 3 shows that the net impact of Nebraska pumping and imported water supply under the proposed remedy is projected to fall below 150,000 acre-feet/year for the first time in 2011, and then stay below 150,000 acre-feet/year for the remaining years of the simulation. Based on linear trends for years 2011-2057, the net impact of Nebraska pumping and imported water supply increases by 261 acre-feet/year under the proposed remedy, and by 1,179 afy under status quo conditions.

Figure 4 shows computed Republican River flows contributed by groundwater for the historical period 1960-2006 and for the two scenarios 2007-2057. Under status quo conditions, computed annual flows for years 1960-2057 diminish at an average rate of 2.5 percent per year, based on an exponential trend for years 2011-2057, as shown in Figure 4. Under the proposed remedy scenario, computed flows after 2006 show relatively rapid recovery during the first few years, followed by an average rate of decline of 0.23 percent per year, based on an exponential trend for years 2011-2057.

Future hydrologic conditions

It is important to keep in mind that the projections, particularly on an annual basis or in the short term, are dependent on the hydrological conditions of the assumed sequence of years. Because of this, the time required to reduce the impact of Nebraska pumping to less than 175,000 acre-feet/year, and the net impact of Nebraska pumping and imported water supply to less than 150,000 acre-feet/year, will be influenced by future and unknown hydrological conditions.

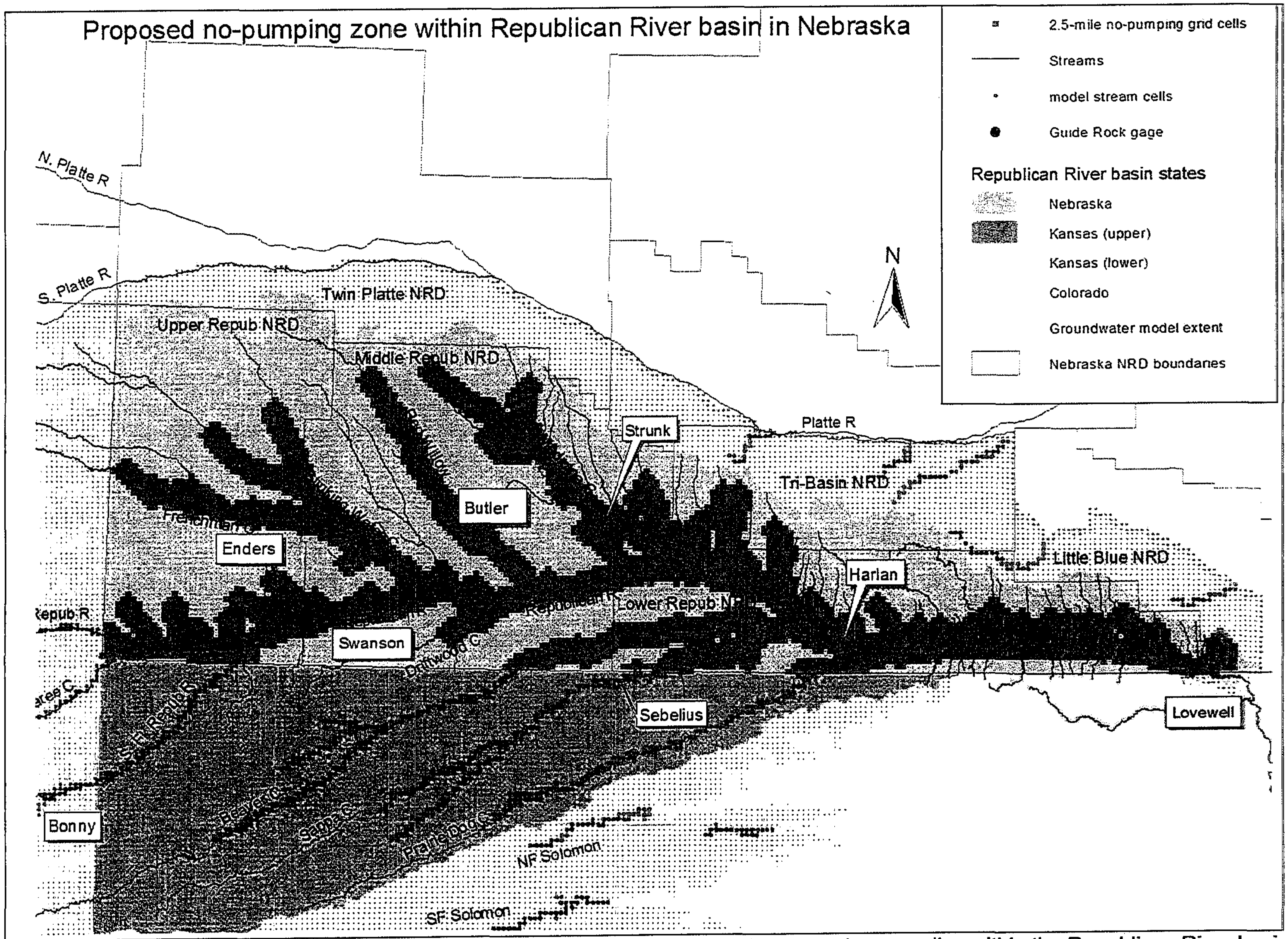

Fig. 1. Map showing part of RRCA groundwater model grid domain. Proposed no-pumping zone lies within the Republican River basin in Nebraska. Grid cells shaded dark gray are those whose centers lie within two miles of centers of stream cells (turquoise).

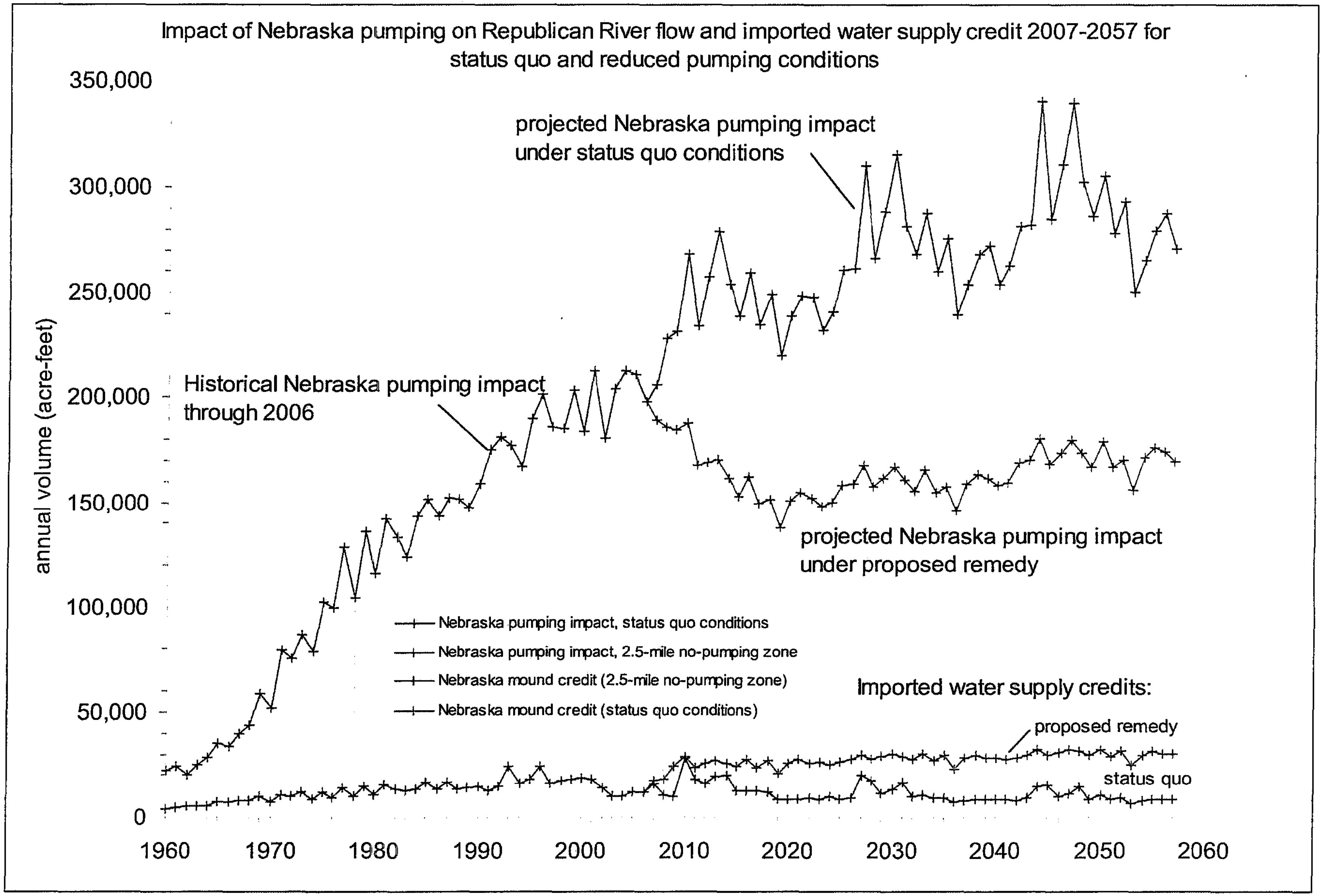

Fig. 2. Nebraska pumping impact on streamflow and imported water supply credit for both status quo and proposed remedy scenarios.

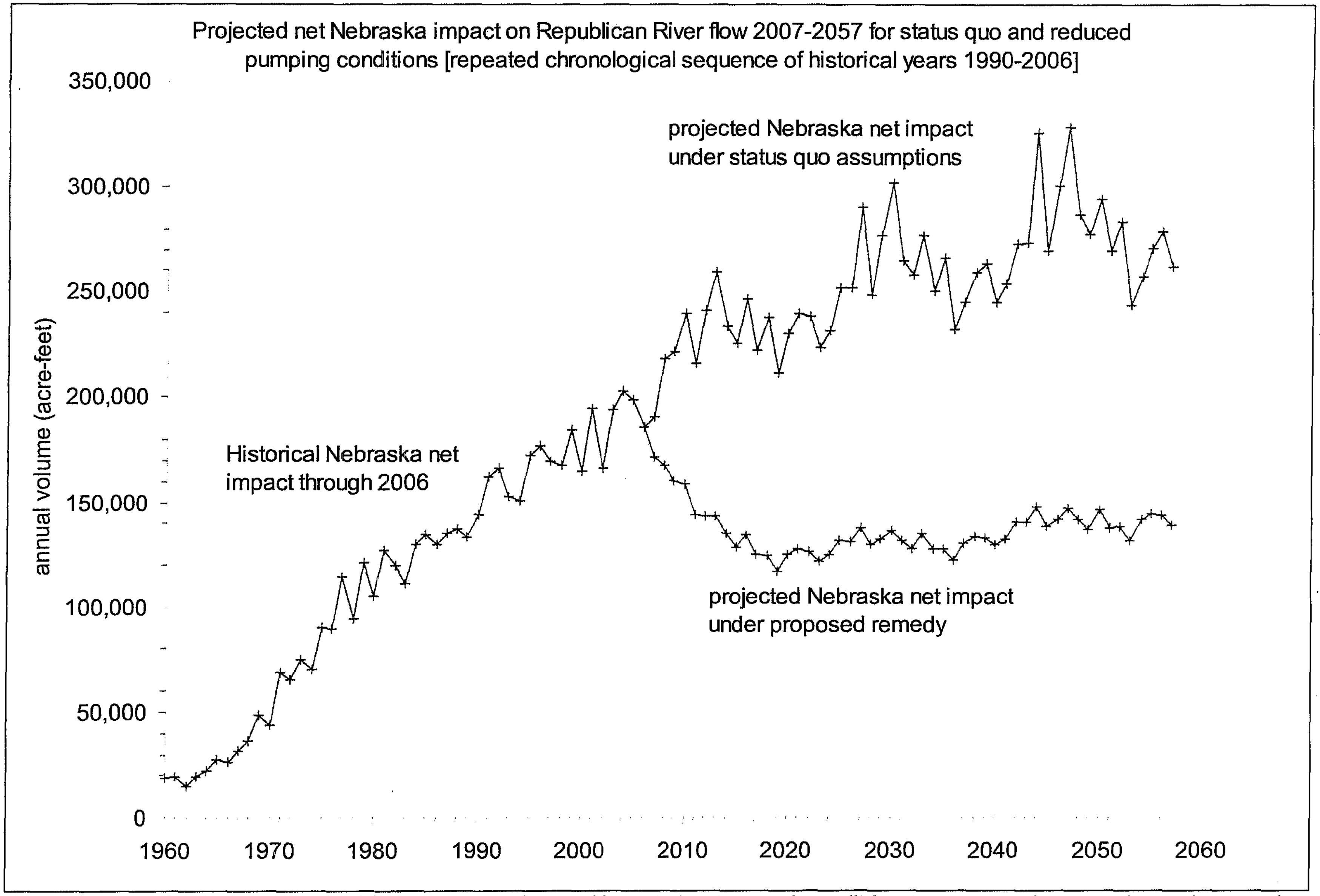

Fig. 3. Net sum of Nebraska pumping impact on streamflow and imported water supply credit for status quo and proposed remedy scenarios.

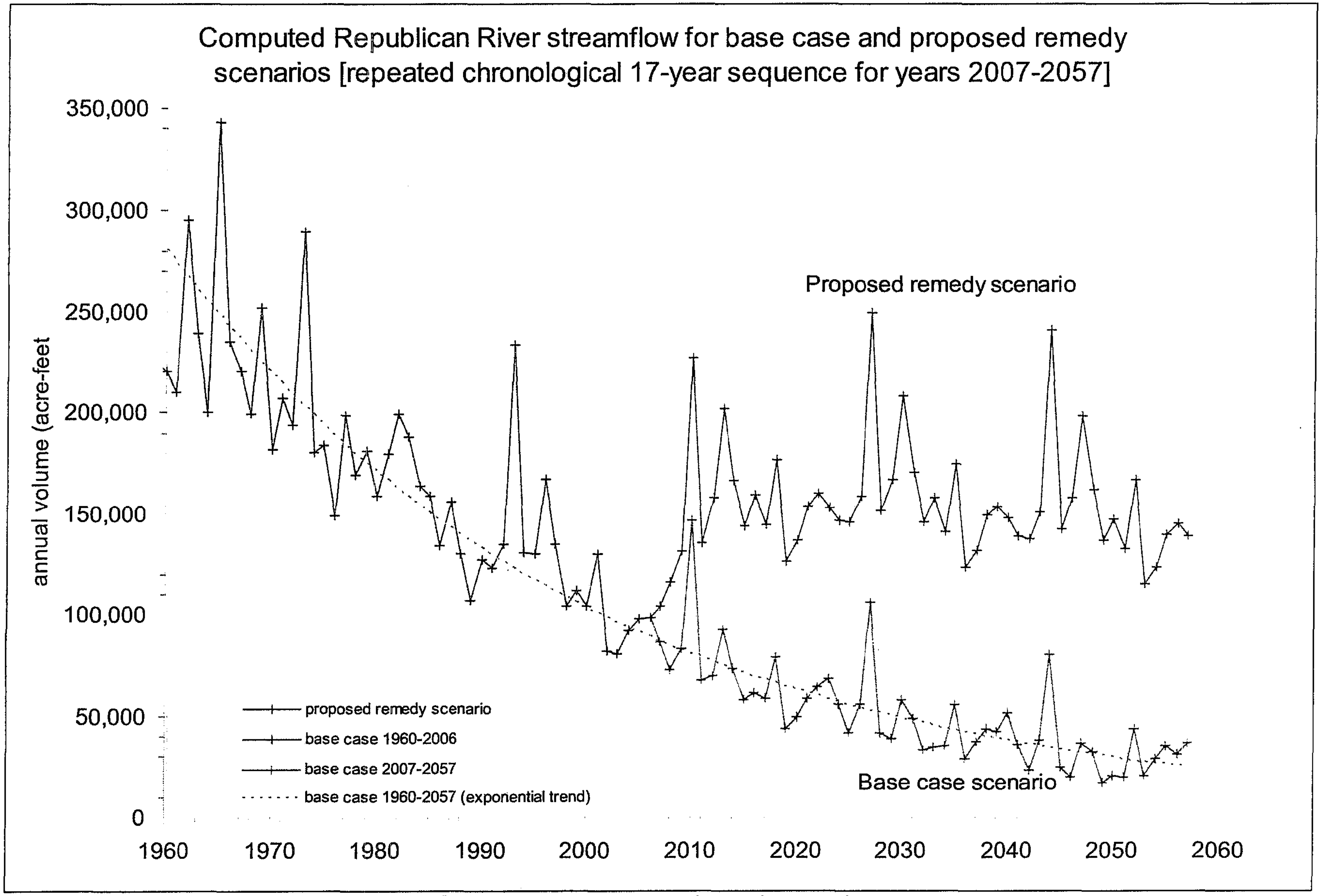

Fig. 4. Computed Republican River streamflow for status quo and proposed remedy scenarios.

Appendix A. Revisions to Attachment 5: RRCA groundwater model analysis Impact of Nebraska pumping and proposed remedy

Samuel P. Perkins[1] and Steven P. Larson[2]

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Four revisions were made to the future scenario model runs and their effects are described here. The first three of these are related to groundwater or commingled irrigation area, which mostly affect results for the status quo scenario and have a much smaller effect on the proposed remedy scenario. Annual changes in impacts of the first three revisions are shown in Table A1. Annual impacts and computed streamflow under the status quo and proposed remedy scenarios as originally reported and with revisions 1-3 are compared in Figures A2-A4. The fourth revision has to do with output control and has negligible effects on results, as shown in Table A3. The first three revisions are as follows.

1. Hold commingled irrigated area at 2006 levels under both future scenarios.
In applying the proposed remedy, the condition to hold groundwater irrigation area to 2000 levels was also applied to commingled irrigation area. This was revised so that commingled irrigation area is held instead at 2006 levels for all of Nebraska within the RRCA groundwater model domain. This change had a slight effect on Nebraska impacts under the reduced pumping scenario.

2. Scale groundwater pumping according to changes in groundwater irrigation area within each NRD.
Groundwater pumping scaling factors for the status quo scenario were based on statewide irrigation area ratios instead of NRD-specific irrigation area ratios, which were used for the reduced pumping scenario. Status quo cases were re-run using NRD-specific irrigation area ratios. This change affected impacts under only the status quo scenario.

3. Exclude commingled irrigation area from sums for the purpose of scaling groundwater pumping.
Sums of irrigation area that were used to compute scaling factors for groundwater pumping included both groundwater and commingled irrigated area. In order to represent increased development of groundwater irrigation correctly, these sums should have included only groundwater irrigation area. This change affected impacts under both scenarios, but more significantly under the status quo scenario. The sums of groundwater irrigated area within NRDs for years 1990-2006 that were used to calculate groundwater pumping scaling factors under the status quo and reduced pumping scenarios are listed below in Tables A4 and A5, respectively.

Effects of revisions 1-3: calculated impacts on computed streamflow

Under "Results," the original version of Attachment 5 stated: "The reduction in groundwater irrigated area of 514,600 acres within the Republican River basin under the proposed remedy results in a groundwater pumping reduction of 564,400 acre-feet/year." With the above revisions, average annual groundwater pumping under the proposed remedy is reduced by 619,900 acre-feet/year.

Table A1 summarizes calculated impacts on computed streamflow as originally reported in Attachment 5 ("Original impacts"), impacts after incorporating the first two revisions, impacts after incorporating the all three revisions, and the net effects of the three revisions on calculated Nebraska impacts. Under the status quo scenario, the revisions have the effect of increasing the net Nebraska impact on Republican River streamflow by 9,700 afy, whereas, under the proposed remedy scenario, the revisions increase the net Nebraska impact by 1,300 afy. Table A1 also shows the reduction in Nebraska's net impact under the proposed remedy was 110,800 afy as originally reported and 119,200 afy with revisions, for an increase of 8,400 afy in the proposed remedy's reduction in Nebraska's net impact. Table A2 lists the annual differences between the revised and original versions of Table 1 in Attachment 5. Figures A2 through A4 superimpose the original and revised graphs of computed impacts and flows shown in Figures 2-4 of the respective versions of Attachment 5.

Table A1. Summary of how revisions 1-3 affect Nebraska impacts on Republican River streamflow.

	Status quo scenario			Proposed remedy scenario			Reduction in net NE impact
	Pumping impact	Import credit	Net NE impact	Pumping impact	Import credit	Net NE impact	
Original impacts	259,900	13,300	246,600	163,500	27,700	135,800	110,800
Impacts with revisions 1 and 2	263,300	12,500	250,800	165,000	27,600	137,500	113,400
Impacts with revisions 1-3	268,000	11,700	256,300	164,700	27,600	137,100	119,200
Effect of revisions (1-3)	8,100	-1,600	9,700	1,200	-100	1,300	8,400

As noted above, the revisions have a much greater effect on impacts under the base case scenario. This can be seen by comparing computed Republican River flows under the base case scenario in Figure 4 with the same figure in the original version of Attachment 5. With the revisions, note that the exponential trend line for these flows appears to fall below 50,000 afy in 2030, which is about eight years earlier than that shown in Figure 4 of the original Attachment 5. On the other hand, computed flows under the proposed remedy scenario show a relatively small decrease, corresponding to the increase in net Nebraska impact of 1,300 afy with the revisions.

4. Output control file for revised runs specify that cell-by-cell flows for all budget terms be written for the second time step of each stress period instead of the first.

For final versions of future scenario cases, output control was specified by file TS2_88yrs.oc, which specifies that cell-by-cell flows are to be written only at the end of each stress period. This is consistent with the original historical simulations for years for years 1918-2000, and is considered sufficiently accurate for the future scenarios. TS2_88yrs.oc is a version of file 11_thru_2005.oc, which was constructed for a 1918-2005 run, and which begins with a steady-state stress period, whereas the future runs are continuations of transient runs. The second and third lines of file 11_thru_2005.oc were deleted to create file TS2_88yrs.oc. Output control files for the historical RRCA model runs beginning with year 2001 specify that cell-by-cell flows are written at the end of each time step, or twice per stress period. This distinction is recognized in specifying input to versions of the postprocessor readccf to read and summarize cell-by-cell flows.

Future scenario cases preceding the final versions of Dec 28, 2007 were run using file 11_thru_2005.oc, which had the unintended consequence of writing out the cell-by-cell flows at the end of the first time step of each stress period instead of the second time step, i.e., flows for the first half of each stress period instead of the second half. This is because the above file includes lines for the steady-state period, but there is no corresponding steady-state period for the future scenario runs. Consequently, model results for these cases will not appear exactly the same as they would be if based on flows at the end of each stress period. However, the resulting differences should be very small, and comparisons between cases should be only negligibly affected. Model results would be more accurately represented by writing out cell-by-cell flows for every time step, as they are for the annual historical runs 2001-2006, although this would be only a slight improvement in accuracy and would have a negligible effect on comparisons.

By referencing the output control file 11_thru_2005.oc (above), all previous comparisons of model budgets for reduced pumping scenarios against the base case scenario have been made on the basis of cell-by-cell flows for the first time step of each stress period. To verify that differences between model results based on one or the other time step are small, a previous version of the status quo scenario was run both ways, using either of the output control files named file 11_thru_2005.oc or TS2_88yrs.oc to specify that cell-by-cell flows are written for either the first or the second time step of each stress period, respectively. Model budget flows for the two versions of the base case, denoted TS1 and TS2, were also averaged to represent flows based on both time steps, TSavg = (TS1 + TS2)/2. Differences between budget flows based on the first time step and those based on the average of both time steps were calculated as [TS1 – TSavg], summed over the Republican River basin component of the model domain.

Table A2. Changes in Table 1, "Projected impacts of Nebraska pumping and Platte River imports under both status quo conditions and the proposed remedy (acre-feet/year)"

year	Status quo conditions			Proposed remedy			Impact reduction
	pumping	imports	Net impact	pumping	imports	Net impact	
2007	1,845	-127	1,972	106	3	103	1,869
2008	4,211	-731	4,942	115	6	109	4,833
2009	3,887	-349	4,236	548	-176	724	3,512
2010	5,877	-1,609	7,486	1,205	100	1,105	6,381
2011	7,051	379	6,672	651	-42	693	5,979
2012	7,929	-2,466	10,395	864	-22	886	9,509
2013	9,589	-3,953	13,542	1,207	26	1,181	12,361
2014	6,647	1,576	5,071	1,023	-17	1,040	4,031
2015	6,591	-1,658	8,249	847	-23	870	7,379
2016	6,740	-1,312	8,052	1,201	11	1,190	6,862
2017	6,695	-1,615	8,310	875	-50	925	7,385
2018	7,926	-1,602	9,528	1,038	40	998	8,530
2019	7,116	-1,711	8,827	826	-26	852	7,975
2020	6,182	-842	7,024	976	-88	1,064	5,960
2021	5,385	-757	6,142	1,316	8	1,308	4,834
2022	5,331	-739	6,070	1,201	-14	1,215	4,855
2023	4,773	-668	5,441	1,219	11	1,208	4,233
2024	7,021	-1,811	8,832	1,040	-15	1,055	7,777
2025	7,157	-918	8,075	1,167	-46	1,213	6,862
2026	7,357	-719	8,076	1,369	-44	1,413	6,663
2027	11,434	-5,412	16,846	1,729	19	1,710	15,136
2028	8,910	-1,155	10,065	1,183	-46	1,229	8,836
2029	10,670	-2,636	13,306	1,397	-39	1,436	11,870
2030	12,432	-4,688	17,120	1,680	-7	1,687	15,433
2031	10,015	-2,846	12,861	1,393	-46	1,439	11,422
2032	9,180	-2,183	11,363	1,159	-55	1,214	10,149
2033	8,311	-1,054	9,365	1,529	-14	1,543	7,822
2034	9,221	-2,327	11,548	1,145	-49	1,194	10,354
2035	9,784	-1,591	11,375	1,292	-6	1,298	10,077
2036	7,907	-1,140	9,047	1,000	-47	1,047	8,000
2037	7,924	-1,102	9,026	1,214	-127	1,341	7,685
2038	7,324	-1,062	8,386	1,552	15	1,537	6,849
2039	7,274	-964	8,238	1,374	-12	1,386	6,852
2040	6,475	-836	7,311	1,392	-3	1,395	5,916
2041	7,466	-910	8,376	1,191	-17	1,208	7,168
2042	8,150	-1,094	9,244	1,361	-58	1,419	7,825
2043	9,265	-978	10,243	1,546	-41	1,587	8,656
2044	13,059	-5,464	18,523	1,928	14	1,914	16,609
2045	10,210	-2,690	12,900	1,292	-56	1,348	11,552
2046	11,231	-2,218	13,449	1,539	-41	1,580	11,869
2047	12,581	-3,377	15,958	1,849	-16	1,865	14,093
2048	11,694	-3,390	15,084	1,513	-65	1,578	13,506
2049	9,500	-1,495	10,995	1,237	-65	1,302	9,693
2050	9,256	-1,038	10,294	1,689	-19	1,708	8,586
2051	9,082	-1,121	10,203	1,181	-66	1,247	8,956
2052	10,084	-1,226	11,310	1,351	-20	1,371	9,939
2053	8,543	-1,348	9,891	1,021	-53	1,074	8,817
2054	8,661	-1,104	9,765	1,210	-116	1,326	8,439
2055	8,251	-873	9,124	1,584	14	1,570	7,554
2056	7,897	-1,078	8,975	1,413	-18	1,431	7,544
2057	7,809	-840	8,649	1,354	12	1,342	7,307
2007-2057	8,135	-1,586	9,721	1,218	-27	1,245	8,476

Model budget flows, averaged over years 2007-2057, are listed in Table A3. The line labeled "TSavg" in Table A3 shows the average of the first two lines (TS1 and TS2) for each budget term. The fourth line ("TS1 – Tsavg") shows the difference in acre-feet/year between the first line and the third. The fourth line shows these differences as fractions of the average values in line 3. The small differences, expressed either in acre-feet (line 4) or as fractions (line 5) and confirm that differences in model budget flows based on one or the other time step (TS1 or TS2) are negligible.

Table A3. Average model budget flows (afy) based on first and second time steps of each stress period.

time step	STO	CHD	EVT	WEL	DRN	RCH	STR
TS1	870353	-3013	-378322	-2231932	-2178	1692805	-58308
TS2	865473	-3013	-372438	-2231932	-2178	1692805	-59342
TSavg	867913	-3013	-375380	-2231932	-2178	1692805	-58825
TS1 – TSavg	2440	0	-2942	0	0	0	517
TS1 – TSavg / TSavg	0.0028	-0.000025	0.0078	0	0.000016	0	-0.0088

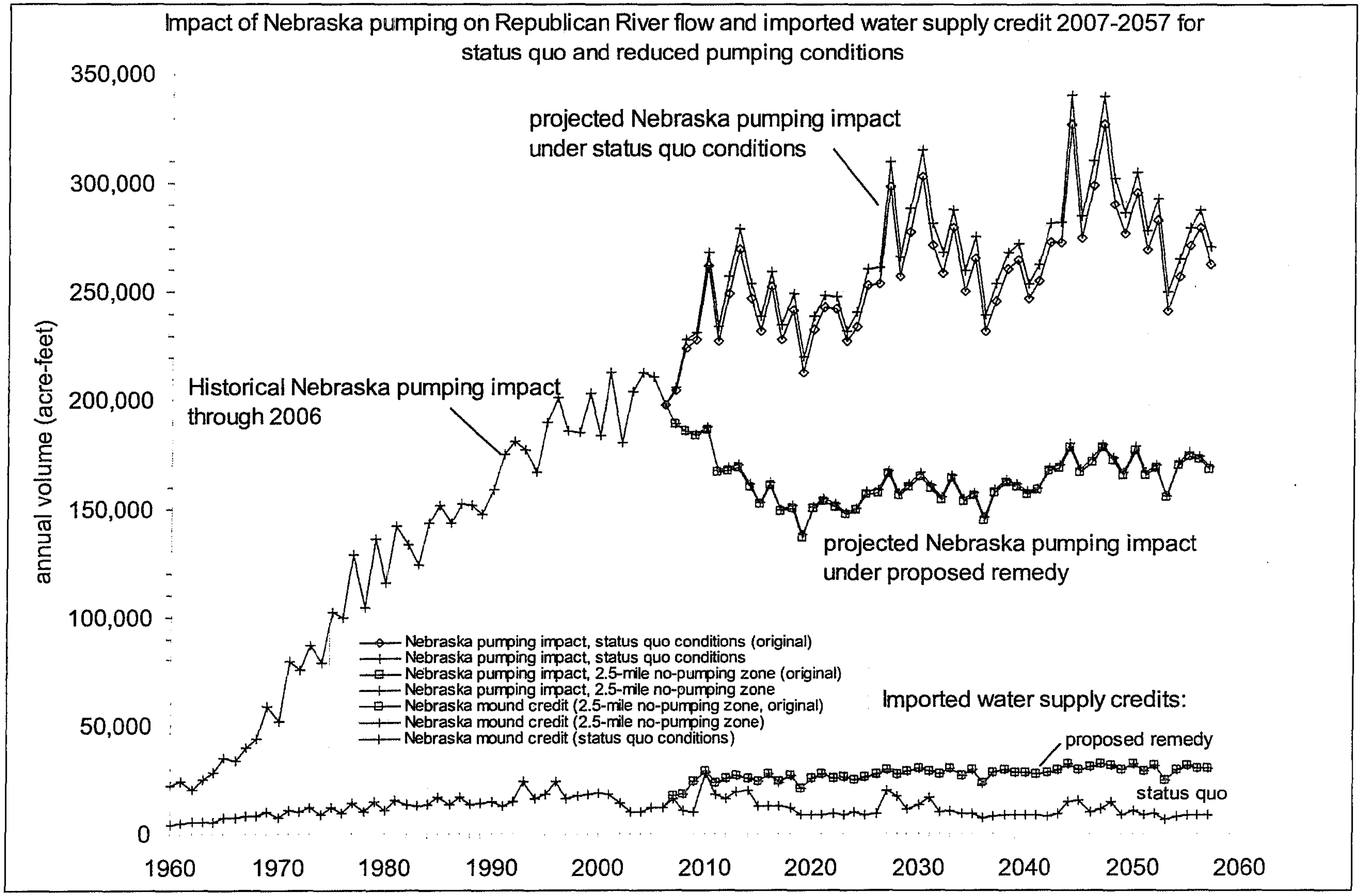

Fig. A2. Nebraska pumping impact on streamflow and imported water supply credit for both status quo and proposed remedy scenarios. Comparison of revised flows with originals shown in Fig. 2, Att. 5, Dec 18, 2007.

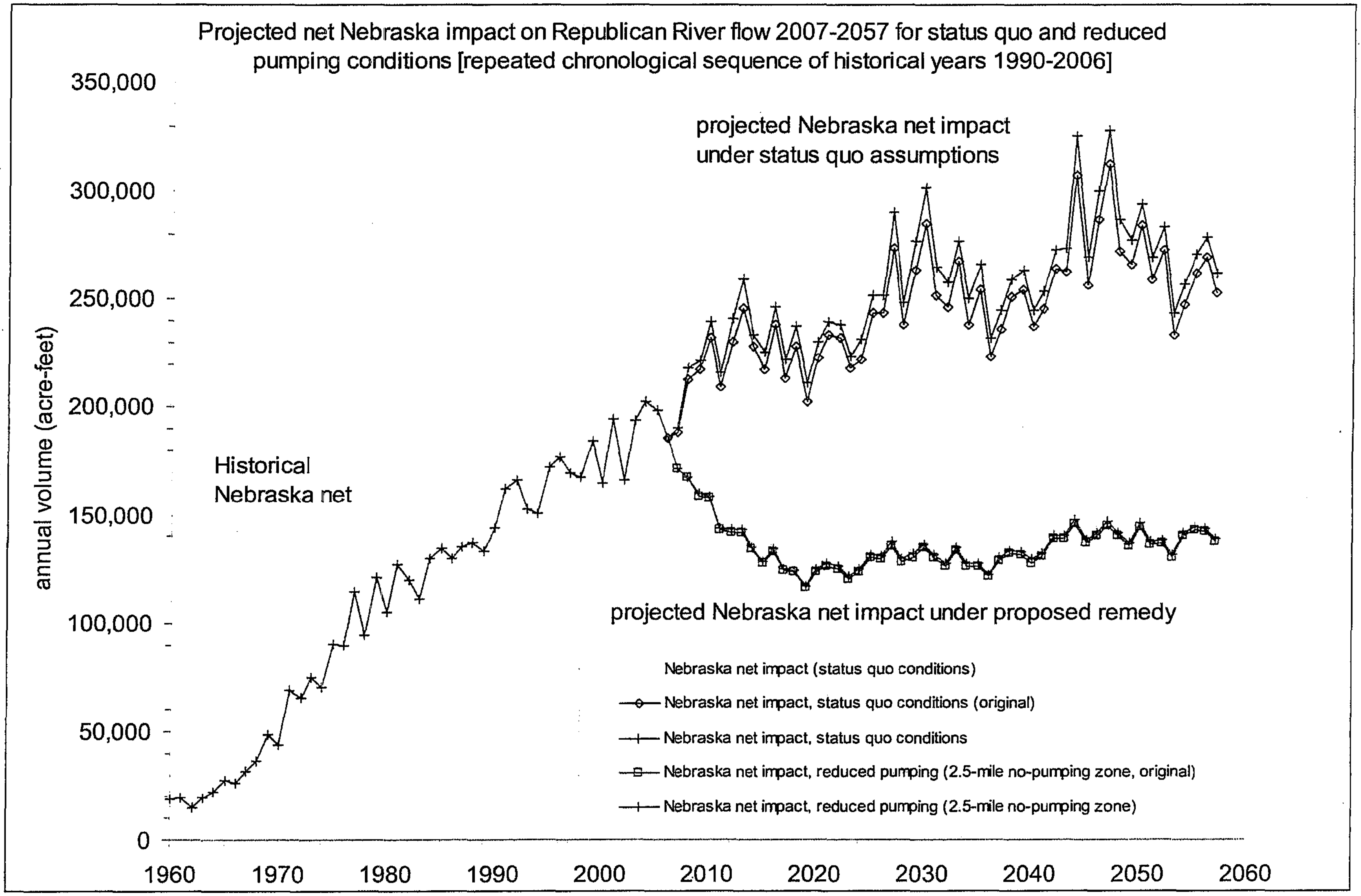

Fig. A3. Net sum of Nebraska pumping impact on streamflow and imported water supply credit for status quo and proposed remedy scenarios. Comparison of revised flows with originals shown in Fig. 3, Att. 5, Dec 18, 2007.

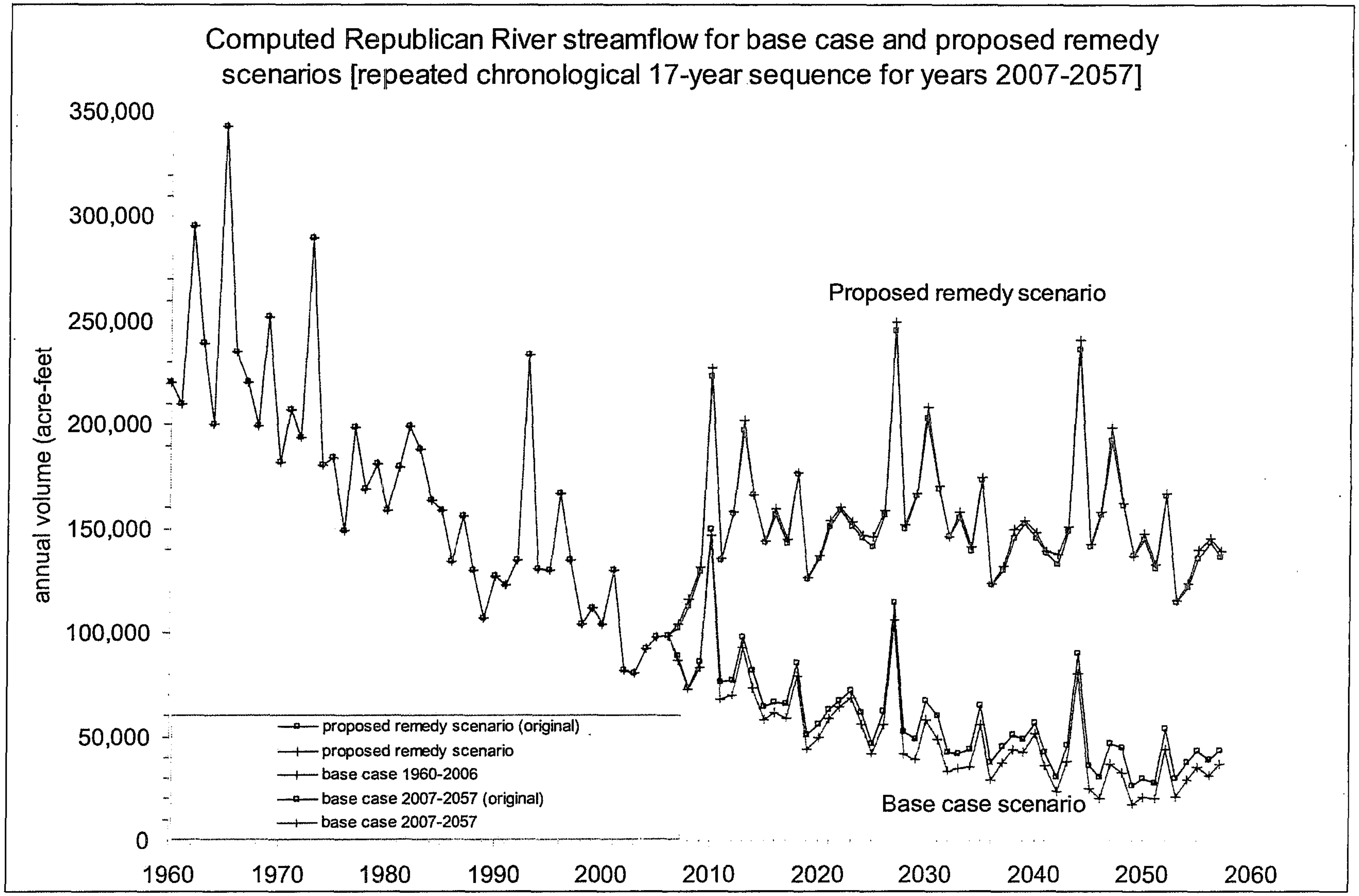

Fig. A4. Computed Republican River streamflow for status quo and proposed remedy scenarios. Comparison of revised flows with originals shown in Fig. 4, Att. 5, Dec 18, 2007.

Table A4. Sums of reported groundwater irrigation area within each state and each Natural Resource District in Nebraska 1990-2006; used to calculate groundwater pumping scaling factors under the status quo scenario.

year	CO gw Ac	KS gw Ac	NE gw Ac	Little Blue	South Platte	Twin Platte	Central Platte	Upper Repub	Middle Repub	Lower Repub	TriBasin
1990	673353	393706	1275917	42798	3282	90060	33273	355654	186740	188242	376017
1991	673632	395998	1304917	44722	3282	92992	33813	369960	187687	188066	384542
1992	673575	372655	1284484	44829	3277	90133	31189	368184	187152	186954	372903
1993	673587	374311	1218625	43464	3274	84523	31305	360123	169446	179631	346982
1994	673824	401827	1313617	45599	3276	92357	33070	369022	185585	193217	391628
1995	673797	391913	1287157	44630	3334	94187	32032	374808	172750	186606	378942
1996	673876	409561	1350855	46054	3278	105124	32890	384993	191323	193731	393597
1997	673885	418548	1370984	46281	3279	104292	32855	377365	196208	214664	396180
1998	673849	416564	1369353	49553	3280	108293	34310	371790	198687	211661	391912
1999	673840	413896	1371085	52792	3218	104779	35811	369231	195683	209422	400274
2000	673893	427428	1429348	52170	3216	108335	37174	384207	204587	223689	416119
2001	569357	412397	1510096	52083	3456	110615	36621	442733	219727	220605	424370
2002	569383	421964	1523417	52078	3452	109198	35774	443940	227604	223038	428462
2003	568630	424564	1565018	50562	3005	113183	34906	449725	240150	250007	423647
2004	568686	422715	1630667	53663	2855	124460	38821	441583	250351	280484	438583
2005	579368	417095	1639947	53188	2777	123911	38000	474615	239845	270383	437343
2006	573501	416729	1682593	52051	2853	113438	42218	459849	277778	292087	442442

Table A5. Sums of reported groundwater irrigation area within each state and each Natural Resource District in Nebraska 1990-2006, but excluding groundwater irrigation area within the proposed no-pump zone shown in Figure 1; used to calculate groundwater pumping scaling factors under the reduced pumping scenario.

year	CO gw Ac	KS gw Ac	NE gw Ac	Little Blue	South Platte	Twin Platte	Central Platte	Upper Repub	Middle Repub	Lower Repub	TriBasin
1990	673353	393706	1000929	42711	3282	90060	33273	269602	115627	91813	354562
1991	673632	395998	1025485	44628	3282	92992	33813	279076	117121	91832	362741
1992	673575	372655	1009142	44734	3277	90133	31189	279796	116258	91747	352009
1993	673587	374311	958557	43377	3274	84523	31305	274431	105511	89356	326781
1994	673824	401827	1036816	45507	3276	92357	33070	281974	116387	94148	370097
1995	673797	391913	1021193	44538	3334	94187	32032	287112	110830	91264	357897
1996	673876	409561	1068337	45952	3278	105124	32890	293536	122175	93869	371514
1997	673885	418548	1076867	46188	3279	104292	32855	286644	123839	106296	373475
1998	673849	416564	1079082	49443	3280	108293	34310	285366	126900	103703	367786
1999	673840	413896	1086754	52668	3218	104779	35811	283808	125743	104102	376624
2000	673893	427428	1125750	52074	3216	108335	37174	294682	132068	107259	390942
2001	569357	412397	1175475	51890	3456	110615	36621	323261	141222	110761	397650
2002	569383	421964	1181320	51882	3452	109198	35774	323841	144033	111551	401589
2003	568630	424564	1213099	50370	3005	113183	34906	347124	146019	122964	395527
2004	568686	422715	1256648	53470	2855	124460	38821	343812	152324	132343	408564
2005	579368	417095	1262877	53017	2777	123911	38000	370276	143745	126436	404715
2006	573501	416729	1331586	51867	2853	113438	42218	362774	182938	162804	412696

Talking Points for August 13, 2008, RRCA Annual Meeting

- Kansas continues to **appreciate efforts** made by Colorado and Nebraska towards compliance.
- Yet, Nebraska and Colorado have been clearly on notice as to nature of their Compact obligations since the end of 2002 when the Final Settlement Stipulation was signed. The Stipulation recognized that it would take time for Nebraska and Colorado to come into compliance. Thus the FSS included an implementation schedule (Appendix B) that delayed the first possible water short compliance period until 2005-2006, and the end of the first normal year compliance until 2007, based on the 5-year period of 2003-2007.
- While **the FSS gave the States a great deal of latitude of how to come into compliance, compliance is not optional; and the tests for compliance are very clear.**
- **The accountings completed for 2003, 2004, and 2005 have shown both NE and CO used more than their allocation for each of those individual years.**
- While the EC has not agreed upon final numbers, but numbers for 2006 and 2007 clearly show there still is a problem. Cast the blame where you will, but the clear fact is that **Nebraska is out of compliance** for the first two tests of compliance under the water-short year tests for 2005-2006 and 2006-2007. Both Nebraska and Colorado are **out of compliance for the first 5-year test** of compliance test for 2003 through 2007. [I might note that Kansas' allocation has exceeded its consumptive use in all years from 2003-2007 and therefore Kansas is in compliance with its first five year test in Northwest Kansas.]
- Although some **limited progress** has been made by Nebraska and Colorado in reducing use, **consumptive use in both Nebraska and Colorado still significantly exceeds their allocations**. Kansas' calculations show that in the last five years that Nebraska's consumptive use exceeded its allocation by about 117,000 acre-feet and that Colorado was more than 52,000 acre-feet over its allocation. **Show graph of Allocation vs. use.** [Even under Nebraska's interpretation of disputed matters, the numbers still show that Nebraska's consumptive use has substantially exceeded its allocations for its first water-short-year tests and its first five year compliance test.]
- Nebraska failed its water-short year compliance check for years 2005 and 2006. [show accounting page of results] **For this period, Kansas calculations show that Nebraska used over 84,000 acre-feet more than its allocation above Guide Rock, creating a shortage of roughly the same amount to Kansas.**
- Due to Nebraska actions and some fortuitous rainfall events, Nebraska passed its water short year compliance test for the period 2006 and 2007. For this period, Kansas calculations show that Nebraska used 10,530 acre-feet less than its allocation above Guide Rock. For that Kansas is greatful.
- The fundamental problem causing Nebraska Compact violations is excessive groundwater use in Nebraska. According to Kansas estimates based on the EC data, consumptive use caused by groundwater pumping in 2006 in Nebraska was 198,412 acre-feet. Consumptive use caused by groundwater pumping in 2007 in

Nebraska was ____ acre-feet In contrast, Nebraska's surface water consumptive use was 34,599 acre-feet in 2006 and ____________ acre-feet in 2007. (**See bar chart**). Groundwater depletions are the dominant CU by NE.

- [You might note that in the same table that reports Nebraska and Colorado overuse, Kansas is reported to have used significantly less than its allocation. [We don't have a graphic for this yet; I likely will skip this point] A significant portion of that allocation has not been physically available for Kansas to divert due to NE and CO overuse [Graph of Hardy + Courtland vs. allocation], and Kansas beneficial consumptive use of water passing the Hardy gage is not included in the Compact accounting.]
- As a result of Nebraska's overuse, Kansas has not received its water for the Kansas Bostwick Irrigation District and its mainstem users. All of the 40,000 irrigable acres of in Kansas Bostwick Irrigation District above Lovewell Reservoir have been significantly impacted. A base allocation in the District is 15 inches of water. The Upper District of approx 13,500 acres above Lovewell Reservoir received an average of about 3.8 inches of water in 2003, 7 inches in 2004, less than an inch in 2005; 2.7 inches of water in 2006; and ____ inches in 2007. [Graphic] The lower district of 26,000 acres received approx. half of its base allocation over these same years. Obviously, Kansas Bostwick has not had a full supply of water in four of the last five years. In four of the five years KBID would have used more water, if more water had been available. Most of the KBID lands do not have alternate water supplies from wells available.
- For that portion of the basin downstream of Hardy, there are numerous surface and groundwater users affected with the river being virtually dry until recently. At Concordia and Clay Center, the river has also been extremely low. [graph of Hardy flows during 2003 to current] This has meant a large number of surface water users and groundwater pumpers have been heavily regulated from 2003 through _______.
- The Settlement Stipulation was drafted to deal with the very real concern about shortages which had occurred in the past and it brought the expectation that things would be better. The Stipulation clearly deals with the entire range of water flows from wet to dry, and specifically with water short years. Kansas believes the Settlement Stipulation recognized drought and that the Compact was predicated on shared shortages of water supplies. All streamflow in the basin is allocated by the Compact. Excess uses in the upper part of the basin deprive users in the lower part of the basin of their rightful supply. Thus due to overuse in Nebraska and Colorado, Kansas has not gotten its equitable share of the waters of the Republican River Basin during the past four years of drought. **Drought is hard on everyone, but it has been especially hard on Kansas because Kansas was not even been able to obtain its equitable share of the reduced water supply that has been available in the basin during this drought from 2002 through 2006.. This is unacceptable and cannot continue.**

- Nebraska has and is taking some action to get into compliance. In letters dated April 25 and July 18, 2007, Nebraska advised Kansas as to the measures it was taking due to water-short year administration. In addition to reductions in beneficial use through the use of CREP, EQIP, and NRD allocations, in 2007 Nebraska and the NRD's purchased additional stored water and natural flow to be made available to Kansas. If this practice continues into the future, Kansas suggests that a more collaborative approach be used, that involves both Kansas and KBID, to maximize the benefit to both states from the timing and management of this water.

- The preliminary accounting for 2007 shows that Nebraska's CU did not exceed its allocation for 2007, but there is no individual year accounting test under the FSS.
- Unrealistic plans will result in additional future violations and continued shortages to Kansas. As Nebraska considers alternatives for future action, I would offer the following:
    - Augmentation plans may be part of the solution, but, they must first be approved in advance by the RRCA. Under the FSS "Augmentation plans and related accounting procedures submitted under this Subsection III.B.1.k. shall be approved by the RRCA prior to implementation."
    - Removal of phreatophytes can be part of the solution, but I would urge caution in relying on this as a means to compliance. Most likely, Nebraska will only see small increases in the Computed Water Supply and Nebraska's allocation. Nebraska will receive an increased allocation for only a portion of the increased streamflow. That with a proportionate reduction in ET salvage, further decreases the benefit to Nebraska.
- It seems to Kansas that Nebraska does not have a realistic plan to come into compliance. For example:
    - Groundwater pumping is the primary cause of Nebraska's overuse of its Compact allocations. These depletions are growing each year. Any plan to come into compliance must contain significant restrictions on groundwater pumping. Nebraska must keep in mind how many wells were drilled and additional irrigated acreage developed after Kansas filed suit in 1998. Yet, even while NE is significantly out of compliance, additional groundwater restrictions do not appear to be part of the solutions being discussed in NE. Current NRD allocation's are not sufficient to bring Nebraska into compliance. [redacted]
    - [The RRCA groundwater model was developed by three of the best groundwater modelers in the United States—at least one from each state. It was approved by each modeler, each state's negotiating team, the Special Master and the United States Supreme Court. Despite criticism from some Nebraskans, Kansas is not aware of any problem with the model. [Nebraska has suggested a change in the approved accounting procedures and that requires approval of all 3 states. Kansas has analyzed Nebraska's request and sees no justification for it.]
    - Nebraska has also failed to comply with the terms of the FSS concerning timely production of data to the other two states. For example, Nebraska has failed to furnish to Kansas the data input files for the 2007 accounting. According to the FSS, the preliminary input files were due April 15, 2007 and the final input files due on July 15, 2007. To date neither of these

deadlines have been met by Nebraska. Compact business cannot be conducted on an orderly and timely basis when one or more states do not meet their required deadlines to produce data as required by the FSS. Nebraska has also failed to submit the following data in a timely manner: [See letter dated August ___, 2008, with a detailed listing of Nebraska's failures to provide data in a timely manner as required by the FSS, which I would like to be made a matter of record in this meeting and attached to the annual minutes.]

<u>In conclusion, Nebraska needs to do better.</u>

<u>Handouts</u>

- Graph of NE's and CO's allocations and consumptive use for 1995 through 2007
- Table of allocations and consumptive use by state for 2003 through 2007
- Table of water-short year allocations and CU for NE at Guide Rock for 2005-2006 and 2006-2007
- Graph of Nebraska surface water use versus Nebraska's groundwater use [maybe include CU by phreatophyes???]
- [See graph showing effect of NRD allocations, current compliance, and Kansas' proposal]
- Letter dated August ___, 2008, with an attached listing of Nebraska's failures to provided data requested by the FSS