Nebraska Responsive Expert Report Concerning Nebraska's Future Compliance

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I have prepared this expert report on behalf of the State of Nebraska. A true and accurate copy of my curriculum vitae is attached hereto as Appendix A. The opinions contained in this report are made to a reasonable degree of scientific certainty. In preparing this report, I utilized theories and methodologies that are accepted within the scientific community and which have been subject to peer reviewed analysis and publication.

I have prepared this report as a part of my regular duties as an employee of the State of Nebraska and have received no compensation outside of my normal salary and benefits.

James C. Schneider, Ph.D.

EXECUTIVE SUMMARY

Nebraska is currently in compliance with the Republican River Compact and the Final Settlement Stipulation. In fact, Nebraska has underused her Compact entitlements by approximately 320,000 acre-feet over the last five years. Furthermore, there is no threat of non-compliance in the foreseeable future. Groundwater pumping in Nebraska has been substantially reduced since the adoption of the Final Settlement Stipulation. Groundwater pumping rates will remain below a regulatory cap; this cap may become more stringent in the future, as needed to maintain compliance. The effectiveness of this regulatory cap is validated by the Kansas analysis, which indicates that the impact of groundwater pumping in Nebraska on Republican River streamflows (i.e., depletions due to groundwater pumping) will decrease over the next decade.

The analysis presented by Kansas of Nebraska's potential non-compliance in the future is extremely hypothetical. A very narrow set of assumed conditions would have to occur over the next thirty to forty-five years for the results presented by Kansas to have any practical meaning. These include the following:

1. The climatic conditions experienced from 1995 to 2009 would repeat over and over into the future;
2. The Compact allocations for Nebraska during 2047-2051 would be identical to those that occurred during 2002-2006;
3. The levels of groundwater pumping estimated by Kansas to occur within Nebraska would actually have to occur.
4. Nebraska would prefer that surface water diversions be allowed to increase in Nebraska as part of a Compact compliance plan, requiring a greater decrease in groundwater pumping than necessary for Compact compliance alone;
5. The Republican River Basin (Basin) in Nebraska would be an essentially closed system, unaffected by any external driving forces, resulting in a period of nearly absolute stasis lasting sixty years; and
6. Approaches to and levels of water management within the Basin would not change for the next sixty years.

Indeed, a scenario in which all of the above conditions are present represents nothing more than one of an infinite number of hypothetical future conditions. Therefore, it is nearly certain that this hypothetical future scenario will not actually transpire.

Furthermore, Kansas has not addressed the flaws in their analysis that were identified by the arbitrator. In particular, the arbitrator recognized that the future scenario developed by Kansas was wetter than average. Although wetter conditions do increase water supplies, they also result in greater depletions due to groundwater pumping (given

the same amount of groundwater pumping). The Kansas analysis included the increased depletions due to groundwater pumping but neglected the increased water supplies. This resulted in an overstatement of the difference between Nebraska's allowable use (derived from the available water supply) and her actual use under the hypothetical future condition presented, inflating the perceived problem and thus the proposed remedy required to address the problem.

Kansas did apparently attempt to address the arbitrator's criticism in the analysis provided with their petition to the U.S. Supreme Court by utilizing a future scenario that was based on long-term average precipitation. Their expert reports presented in these proceedings, however, show that they have presented a future scenario that is ***even wetter*** than that presented to the arbitrator, while continuing to neglect the effect of this wetter condition on the water supply. This again serves to overstate their hypothetical problem, resulting in the overreaching remedy that Kansas currently proposes.

Nebraska employs an adaptive management approach to ensuring Compact compliance with a fundamental guiding principle. This principle requires that, over the long term, depletions due to groundwater pumping must be maintained at levels such that management actions whose results manifest rapidly will always be sufficient to ensure Compact compliance. This principle is a key to Nebraska's ability to utilize its allocation most efficiently. Nebraska has accomplished this principle by employing a comprehensive water management process, statutorily mandated to ensure compliance in the future under all conditions. This process has already led to several iterations of planning and regulations that have resulted in continued reductions in groundwater pumping and the development of specific dry-year requirements. The latter were most recently advanced in response to perceived shortcomings identified by the arbitrator.

Kansas' analysis of these plans is piecemeal, demonstrating their lack of knowledge in general but also specifically with regard to the synergistic nature of Nebraska's water management strategy. The complementary near- and long-term benefits of the management actions incorporated in Nebraska's management process are designed to provide general long-term adaptability and specific near-term requirements. Nebraska has repeatedly invited officials from Kansas[1] to engage in detailed discussions of these plans, but to no avail. Furthermore, Kansas has not demonstrated that Nebraska's water management strategies will lead to non-compliance in the future. Kansas merely offers a more or less random set of questions with regard to these strategies and moves on to develop an alternative compliance plan for Nebraska.

The remedy proposed by Kansas is not required for Nebraska's compliance. Generally speaking, the Kansas analysis that led to their proposed compliance plan is not current with respect to Nebraska's water management plans. Moreover, analyzing these current plans by back-testing against one of the driest periods ever recorded in the Basin

[1] See transcripts from 50th Annual Meeting of the RRCA, August 12, 2010, page 56; and the 51st Annual Meeting of the RRCA, August 31, 2011, page 19.

demonstrates their effectiveness. The results of this test for the 2002-2006 period are presented in Figure ES-1. This method of testing Nebraska's water management strategies against a known condition that has actually occurred is far superior to the Kansas approach of hypothesizing about a future condition that almost certainly will not transpire.

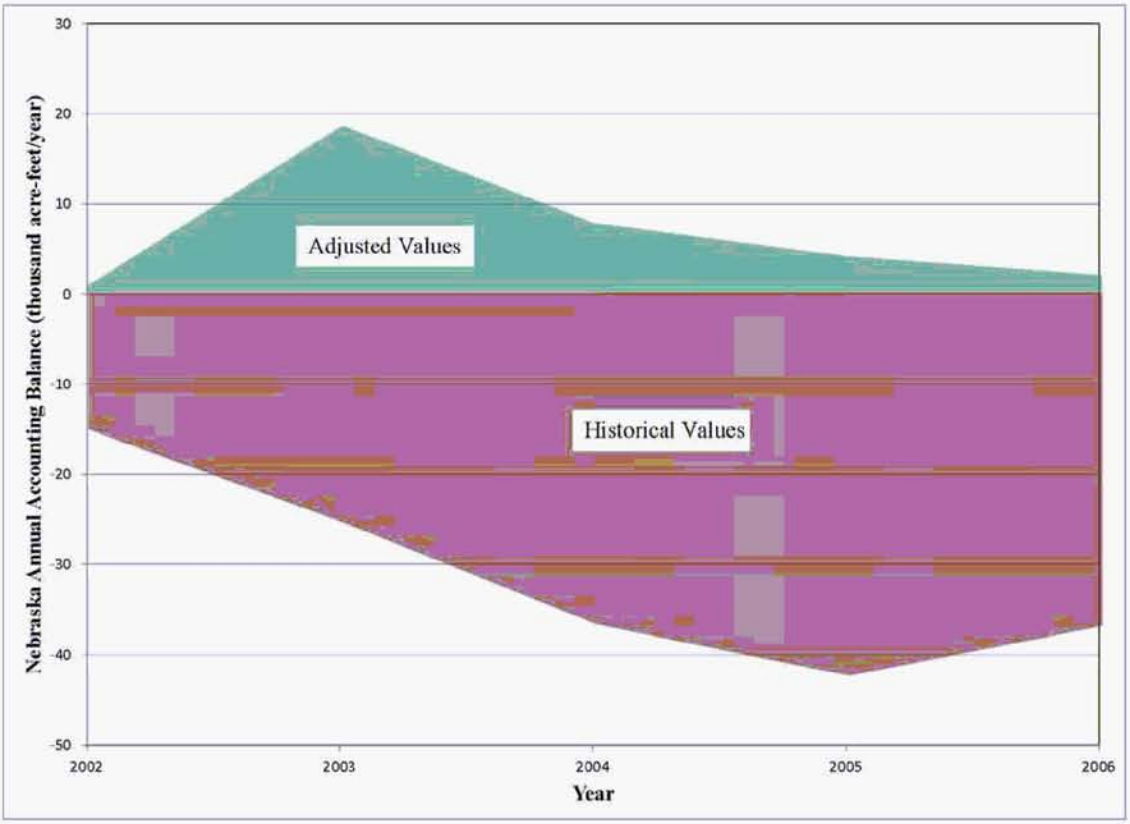

Figure ES-1. Nebraska's annual balances under the historical condition (Historical Value) and with a curtailment of groundwater use in the Rapid Response Region (Adjusted Value).

Finally, one clear result of imposing the Kansas plan for Nebraska's future compliance is that it will provide a windfall of water to Kansas. Nebraska would be forced to underutilize her Compact entitlements by approximately 48,000 acre-feet per year, effectively altering the terms of the Compact. Furthermore, if this plan were implemented, Nebraska would not be allowed to have a single year with a negative annual balance for many decades. This would negate one of the key provisions of the Final Settlement Stipulation, a system of multi-year averaging that allowed for overuse in one year to be balanced by underuse in other years (within certain prescribed intervals). The Kansas Remedy is not the minimum remedy necessary for Nebraska's future compliance. Nebraska, through its water management strategies, can efficiently utilize

her Compact entitlements while ensuring that non-compliance will not occur in the future.

1.0 CURRENT COMPACT COMPLIANCE IN NEBRASKA

The Final Settlement Stipulation (FSS) was signed by all states on December 15, 2002. Under the provisions of the FSS, the States agreed to Compact accounting[2] that would be used to evaluate each state's compliance under the Republican River Compact (Compact).[3] One part of this accounting is sometimes referred to as Normal Year Administration (NYA). Under NYA, the annual accounting balances are applied in a five-year running average to determine Compact compliance. Kansas has focused on the NYA accounting results in their assessment of Nebraska's future compliance (Book, 2011). Additional Compact accounting is also completed when Water Short Year Administration (WSYA) is in effect.[4] For Nebraska, this includes the evaluation of a two-year running average of annual accounting results, as well as a specific assessment of Nebraska's uses of its tributary allocations (tributary accounting).[5]

1.1 Results of Recent Compact Accounting

Nebraska is currently in compliance with the Compact and the FSS. The most recent five-year interval for the purpose of NYA is 2007-2011. The results for Nebraska during this accounting period are shown in Table 1. The five-year average annual balance for Nebraska is a positive 63,685 acre-feet per year over this period (Table 2). In other words, Nebraska has underused her Compact allocation by a total of 318,426 acre-feet during this time period, and Kansas has received the benefit of this water, which represents approximately four times the shortage on which Kansas' damage claims are based. Also included in Table 2 are the five-year average values for the accounting periods ending in the years 2008 (i.e., 2004-2008), 2009, and 2010.

[2] For a detailed description of the Compact accounting procedures, see Schneider, 2011.
[3] Final Settlement Stipulation, Section IV.D and V.B.
[4] WSYA is in effect when the irrigation supply from Harlan County Lake, as determined by the U.S. Bureau of Reclamation and according to Appendix K of the FSS, is less than 119,000 acre-feet (Final Settlement Stipulation, Section V.B.1.a).
[5] The two-year average used for WSYA applies only to the annual accounting balance as determined above Guide Rock, Nebraska (the NYA accounting applies to the entire Basin above Hardy, Nebraska). Nebraska has always been in compliance with the tributary accounting, and Kansas has never expressed concern over future compliance regarding this accounting; therefore, the tributary accounting will not be discussed further in this report.

Table 1. Nebraska annual accounting balance for the Basin above Hardy during 2007-2011.

Year	Annual Balance (acre-feet/year)
2007	30,683
2008	84,460
2009	9,453
2010	116,856
2011	76,974

Table 2. Nebraska's average annual balances for the five-year averaging periods ending in 2008 through 2011.

Period	Average Annual Balance (acre-feet/year)
2004-2008	1,412
2005-2009	10,631
2006-2010	42,467
2007-2011	63,685

1.2 Compact Accounting Results into the Future

The most recent year in which WSYA was in effect was 2007. The current projections from the U.S. Bureau of Reclamation (USBR) for the irrigation supply from Harlan County Lake during 2012 indicate this supply will be in excess of 130,000 acre-feet, which is a full supply. Consequently, WSYA will not be in effect in 2012, and only NYA will be in effect (i.e., five-year average 2008-2012).

In addition to the WSYA projections conducted by the USBR, Nebraska has established statutorily-mandated protocols for annually forecasting the allocation available to its water users; the statutory authority for this forecast and the methods utilized are discussed in Appendices B and C, respectively. The most recent forecast, conducted in December 2011[6], indicates that Nebraska will be in compliance with the Compact in 2012. The Early Warning System component of Nebraska's forecast also strongly indicates that WSYA is very unlikely in 2013, which virtually guarantees compliance again in 2013 without the need for

[6] Letter from Brian Dunnigan to the Basin NRDs, December 29, 2011. The underlying data and analyses are included in the back-up material (2012_OfficialForecast_Dec2011_charts_reformated_6Mar12.xlsx), along with a file that details the process (ReadMeFilefor_Forcast_App.docx).

additional management actions by Nebraska (Appendix C). There is no threat of a violation by Nebraska for at least the foreseeable future.[7]

The administrative agencies charged with managing hydrologically connected water within the Republican River Basin (Basin) are the Nebraska Department of Natural Resources (DNR) and the natural resources districts (NRDs), primarily the Lower Republican NRD (LRNRD), the Middle Republican NRD (MRNRD), and the Upper Republican NRD (URNRD). The statutory authorities[8] granted to these administrative agencies are described in Appendix B. Nebraska's forecast and the controls that it utilizes to manage the hydrologically connected surface and groundwater in the Basin are contained in statutorily-mandated integrated management plans (IMPs) jointly developed by these agencies (LRNRD, 2011; MRNRD, 2010; URNRD, 2010). These plans are described in detail in Appendix C.

Kansas has suggested that Nebraska will have difficultly complying with the NYA and WSYA tests ***thirty to forty-five years into the future*** (Book, 2011). As the primary evidence for this proposition, Kansas has attempted to demonstrate that the depletions due to groundwater pumping, also termed the "groundwater computed beneficial consumptive use" (GWCBCU), in Nebraska will increase over time to some unmanageable level. This assessment is fundamentally flawed, as described in the next Sections.

[7] This view is shared by Kansas Chief Engineer David Barfield. See for example the deposition of David Barfield on 1/26/12, pages 64-65.
[8] Nebraska Groundwater Management and Protection Act, *Neb. Rev. Stat.* § 46-701 through 46-754

2.0 THE KANSAS ANALYSIS IS FLAWED AND CANNOT SHOW A THREAT OF NONCOMPLIANCE

Kansas has proposed a regulatory framework for Nebraska (the "Kansas Remedy") to implement in the future (Barfield, 2011). This is not the first proposal of this nature that Kansas has offered. In 2007, Kansas proposed to Nebraska that she permanently shut down 515,000 irrigated acres within the Basin.[9] That proposal was apparently based on analyses conducted by Kansas that utilized a certain hypothetical future condition.[10] Nebraska pointed out in the arbitration that this hypothetical future scenario devised by Kansas was fundamentally flawed for several reasons.[11]

Kansas abandoned that analysis and the associated regulatory proposal and, instead, prepared an alternate hypothetical future scenario that was utilized in their petition to the U.S. Supreme Court (Kansas Petition at C20). This scenario has also been abandoned by Kansas. Now, Kansas has devised a third hypothetical future (Perkins and Larson, 2011). Kansas has offered no explanation as to why their currently adopted hypothetical future (the "Kansas Baseline") is any more reliable or useful than the previous versions. Indeed, the most important development since the arbitration, namely the revised blueprint for water management in Nebraska contained in the newly revised IMPs, is essentially ignored in developing the Kansas Baseline. The Kansas Baseline also suffers from many of the same flaws as the previous hypothetical future condition devised by Kansas.

This section begins by generally describing the methodology followed by Kansas in development of the Kansas Remedy. This is followed by a discussion of the Kansas Baseline itself, which primarily focuses on the assumptions about future conditions that have been made either explicitly or implicitly. For example, explicit assumptions include the hypothetical future climate and the level of groundwater pumping in Nebraska.

2.1 The Development of the Kansas Remedy

The Kansas Remedy is anchored to the hypothetical future scenario embedded in the Kansas Baseline. Hypothetical future values for the Nebraska GWCBCU and the Imported Water Supply Credit (IWS Credit) under the Kansas Baseline are computed by Kansas using the Republican River Compact Administration (RRCA) Groundwater Model (Model) (Perkins and Larson, 2011, KS000691). These results, however, are never analyzed with respect to Nebraska's potential future non-compliance. For example, Kansas provides no assessment of

[9] Letter from David Barfield to Ann Bleed, December 19, 2007.
[10] See Barfield, 2009; Book, 2009; Perkins and Larson, 2008; Larson and Perkins, 2009..
[11] See Schneider and Williams, 2009.

when Nebraska would first be out of compliance under these hypothetical conditions. Instead, Kansas simply deemed these results unacceptable, apparently because the Nebraska GWCBCU increases under the Kansas Baseline between 2010 and 2069, though this increasing trend does not begin until after 2021 (see Section 3.1). In other words, Kansas starts from the assumption that Nebraska will be out of compliance at some point in the future and then sets out to develop a remedy for this assumed non-compliance. The actual onset of said non-compliance, however, forms no part of the analysis.

To formulate the Kansas Remedy, Book (2011) creates a criterion for an acceptable future combination of Nebraska surface water computed beneficial consumptive use (SWCBCU), GWCBCU and IWS Credit ("Nebraska Net Impacts") during the years 2047-2051. This time period occurs during the third of four cycles of 1995-2009, and represents the third time that the years 2002-2006 are repeated in the future. Kansas's apparent justification for this approach is to establish "pumping reductions necessary at the present" to limit the Nebraska Net Impacts to such a level through ongoing actions required to begin now, that will provide Compact compliance during a period thirty to forty-five years in the future (Book, 2011, KS000439). In other words, Kansas would require Nebraska to take extraordinary actions now to ensure Compact compliance thirty to forty-five years into the future without regard for Nebraska's ability to manage and use its allocations. Kansas did not demonstrate, however, that the Kansas Remedy would ensure future compliance.[12] Therefore, even in developing a compliance plan seemingly on Nebraska's behalf, Kansas has failed to show that such a plan would actually ensure Nebraska's future compliance.

To establish the acceptable level of Nebraska Net Impacts during this hypothetical future five-year period (2047-2051), Kansas assumes that the allocations that Nebraska received during 2002-2006 would be repeated identically during 2047-2051. No justification is offered for this assumption. The allocation received by Nebraska during these years represents five of the six smallest values that occurred from 1959 to 2007 (Barfield, 2011, KS000764-765). It is highly improbable that the general climatic conditions (e.g., average annual rainfall across the Basin) over the next sixty years will mimic the pattern from 1995 to 2009 identically in four successive periods (see Section 2.2.1). Even if this particular condition did occur, however, it is even more unlikely that the Virgin Water Supply (VWS) in the Basin, and the resulting allocations, will be exactly identical to those experienced in the past during these representative years. The annual VWS values depend on many factors other than average annual rainfall amounts, including the spatial and temporal distribution of rainfall within the year, specific characteristics of individual precipitation events, spatial distribution and types of land uses, and many other factors.

[12] See, for example, deposition of David Barfield on 1/26/12, pages 68-69.

Furthermore, the assumption that allocations that Nebraska received during 2002-2006 would be repeated identically during 2047-2051 is completely contrary to the Model results presented by Kansas. Based on the Kansas Baseline, Kansas concludes that:

1) The Nebraska GWCBCU will increase by 1,000 acre-feet per year (KS000687);

2) The IWS Credit will remain essentially constant or decrease slightly (KS000691); and

3) The baseflow will decrease by 550 acre-feet per year (KS000689).

All other things being equal (which they are assumed to be in the Kansas analysis), an increase in GWCBCU of one acre-foot should cause a decrease in baseflow of one acre-foot. If baseflows are not decreasing at the same rate that the GWCBCU is increasing, then the water supply (and resulting allocations) must be increasing. These results were inexplicably ignored by Kansas. This is a major and obvious flaw in their development of the Kansas Remedy.

Next, Kansas works out an elaborate relationship between Nebraska's GWCBCU and Nebraska's SWCBCU. Kansas developed this relationship on the assumption that SWCBCU will be greater in a given hypothetical future year than it was during the corresponding past year due to the imposed reductions in GWCBCU. Kansas assumed that Nebraska would have a "preference" for the termination of irrigation on just over 300,000 acres while allowing surface water users in the same area, which cause a greater impact on streamflow per irrigated acre, not only to continue their historical uses (i.e., the historic values for SWCBCU would recur) but actually to increase those uses.[13] This assumption is made despite 1) the existing controls in Nebraska's IMPs that would limit surface water use during periods when groundwater users are curtailed; and 2) the claim that Kansas is attempting to employ the most efficient approach to ensuring Compact compliance.[14] The result of this assumption is that the Kansas Remedy requires reductions in Nebraska's groundwater use to increase streamflows into Kansas ***and*** to increase SWCBCU in Nebraska. The relationship developed by Kansas is predicated on false assumptions, and the resulting Kansas Remedy is far in excess of what is required for Nebraska's Compact compliance.

Finally, Kansas evaluates potential reductions in groundwater use within several different geographic areas (Perkins and Larson, 2011). The geographic area chosen for further evaluation is a five-mile corridor around the stream cells in the Model, arbitrarily chosen because reductions in this area "could produce

[13] See the deposition of Dale Book on 2/16/12, specifically page 164, and more generally discussion between pages 138-164.
[14] See the deposition of Dale Book on 2/16/12, page 152.

sufficient reductions in Nebraska's GWCBCU for purposes of this analysis" (Perkins and Larson, 2011, KS000683). No analysis of alternatives is presented to show that using this area maximizes the resulting GWCBCU reductions while simultaneously minimizing the reductions in groundwater pumping. Then, Kansas evaluates the results of a number of Model simulations with some quantity less than 100% of the baseline pumping in the five-mile zone around the Republican River and tributaries. Based on the above assumptions and the Kansas Baseline run, Kansas settles on the framework for her proposed Remedy, which amounts to a 90% reduction in groundwater irrigated acres in Nebraska within this five-mile zone. Despite the apparent lack of any analysis of alternatives, Kansas then concludes that this is the action that is required to achieve the criterion established by Kansas for compliance in 2047-2051.

2.2 The Kansas Baseline

The Kansas Baseline represents a hypothetical future climatic condition and an assumed pattern of groundwater pumping in Nebraska in the future (Perkins and Larson, 2011). All other conditions in this hypothetical future are assumed to be static. This hypothetical future is defined by repeating the conditions during the sequence of years 1995-2009 four times to represent the climate during 2010-2069. The justifications offered for the validity of this future condition are as follows:

1) This period contained wet and dry conditions, with an average precipitation that closely matched the average precipitation over the last fifty years;

2) The producer practices during this time period are representative of current (not future) practices; and

3) Nebraska has also previously performed Model runs of a similar nature.

Kansas cannot and does not attempt to establish that these climatic conditions and producer practices will happen in the future. Furthermore, Nebraska and virtually the rest of the groundwater modeling community have acknowledged that long-range future predictions are destined for failure because, among other reasons, the future is unknowable (e.g., Anderson and Woessner, 1992; Bredehoeft and Konikow, 1993; Hassan, 2004; Konikow and Bredehoft, 1992; Oreskes et al., 1994; Oreskes and Belitz, 2001; Rojstaczer, 1994).

The Kansas Baseline cannot be used to draw the type of sweeping conclusions required to justify the Kansas Remedy. These types of simulations can be useful for learning, but they are not reliable for the determination of absolute conditions and should not be used as the sole basis for future water management decisions. The conclusions made by Oreskes and Belitz (2001, p. 38) are very pointed in this regard:

> *The inherent uncertainties in models of complex natural systems provide a strong argument for monitoring when models are used in support of public policy. Model predictions will be wrong. This is inescapable. We hope that they will be wrong in inconsequential ways, but we cannot guarantee this. Therefore, any action guided by model results... should be subject to continued monitoring. The more serious the consequence of error, the more important such monitoring is. Modelers can play an important role in public policy as advocates for monitoring, by emphasizing modeling as a heuristic process, and by resisting the demand for predictions that are likely to be misleading or simply wrong.*

In what is generally referred to as a model post-audit, authors have re-evaluated predictive scenarios a number of years after they were originally completed, and they are generally found to have incorrectly predicted the future in some respect. The reasons for incorrectly predicting the future include the following:

1) The calibration period was insufficient to capture an important element of the model;

2) The underlying conceptual model was not complete;

3) Certain model parameters were not well understood; and

4) The values used for future stresses (e.g., groundwater pumping) were not accurate (Bredehoeft and Konikow, 1993; Hassan, 2004).

In fact, the fourth point illustrates a particularly difficult issue, that is, "estimation of future stresses requires that the modeler foresee the future" (Anderson and Woessner, 1992, page 172). In other words, the modelers must know the future conditions necessary to predict accurately the future hydrology.

The only way to deal with the uncertainty associated with the future and the necessary assumptions thereof would be to look at ranges of conditions (climate, management, etc.). Even so, there are so many areas of uncertainty, and so many interdependencies that attempting to understand the potential results under any probable range of likely future conditions yields an essentially infinite number of possibilities. In order to attempt to address this issue, a modeler generally makes a number of assumptions in order to control the number of future possibilities. This obviously does not place any limits on what can actually happen in the future; it merely limits the number of model runs that must be completed.

2.2.1 Kansas Baseline Climate

Kansas has attempted to construct a future climatic condition using the historical climatic conditions from 1995 to 2009 and repeating those conditions four times in the future. Figure 1 shows the average annual precipitation between 1920 and 2010 for the precipitation gages located in Nebraska (used by the RRCA for the Model simulations). Overlaid on this data is the climatic condition used in the Kansas Baseline. There is obviously a good fit between the years 1995-2009. Comparison of the historic data between 1920 and 1994 with the hypothetical climate used in the Kansas Baseline shows that repeating the years 1995-2009 is a generally poor predictor of the actual conditions.

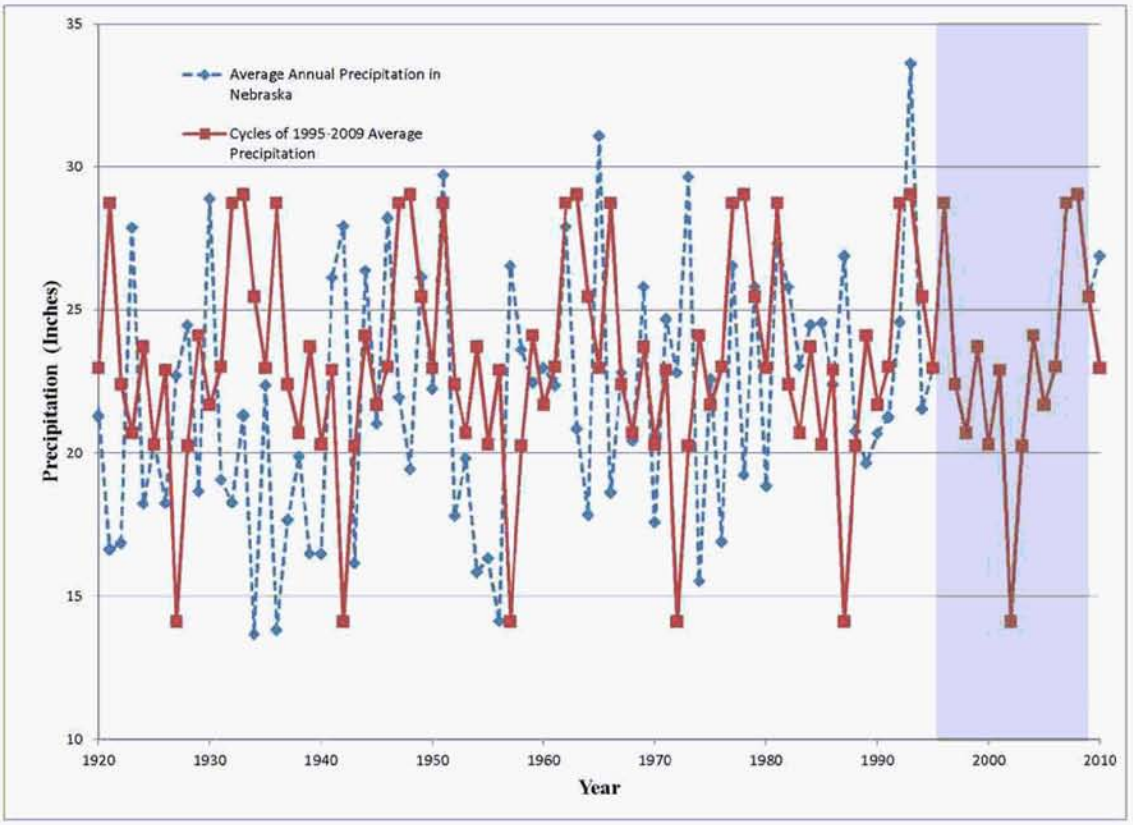

Figure 1. Historical average precipitation in Nebraska (blue line) compared to cycles of 1995-2009 average precipitation (red line). There is perfect fit during 1995-2009 (shaded area) as the two sources of data are the same, but there is poor fit before 1995 and after 2009.

By cross-plotting the two datasets for the period 1920-1994 (Figure 2), one can statistically evaluate the ability of the 1995-2009 data to predict the historical precipitation. The two datasets are not correlated (i.e., the 1995-2009 cycles are not a good predictor of the actual historic precipitation). If they were, most of the data on this figure would fall on or near the diagonal line (the "1:1" line) shown on

Figure 2. Clearly, however, the vast majority of the data do not display this 1:1 relationship. In other words, there is absolutely no correlation between the actual precipitation that occurred from 1920-1994 and the precipitation that would be predicted by repeating 1995-2009 over this time period. ***There is no reason to believe that this cycle (1995-2009) will provide an accurate prediction of the future precipitation.*** Moreover, the predicted precipitation in 2010 (the first year of the Kansas Baseline) is wrong (Figure 1).

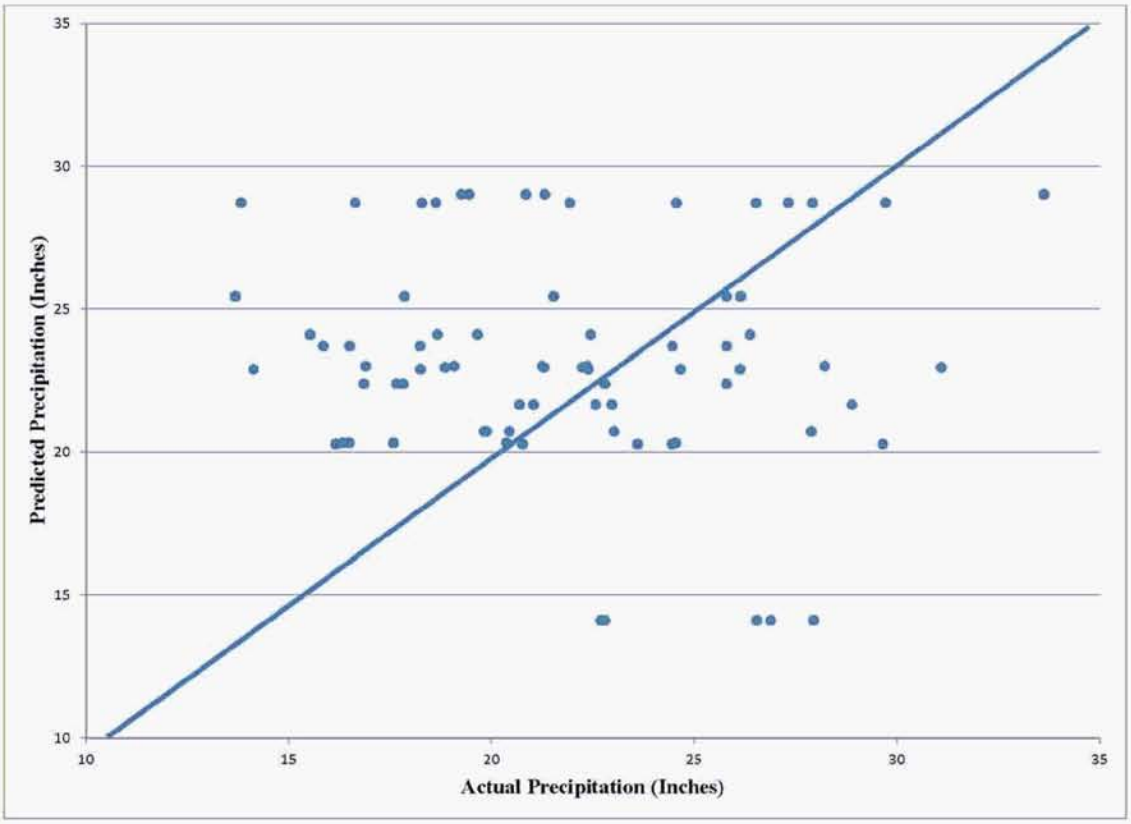

Figure 2. Cross plot of historical average precipitation from 1920-1994 and the predicted value from the cycles of 1995-2009. Each point reflects the historical value from the x-axis and the value from the 1995-2009 cycles from the y-axis.

During the arbitration, Kansas used a baseline climate scenario different from that used in the Kansas Baseline in developing a remedy. This involved repeating the climatic conditions that occurred from 1990 to 2006. The arbitrator found that Kansas had used a climate condition in that baseline run that was above average, given the historical period of record of 1918-2006. Specifically, the arbitrator agreed with the Nebraska assertion that their chosen period of 1990-2006 was equivalent to the 60% percentile, "meaning that the annual precipitation for this period of years was above average and equaled or exceeded 60 percent of

the measurements of annual precipitation over the long term of 1918 through 2006" (Dreher, 2009, pages 49-50).

The arbitrator agreed (Dreher, 2009) with Nebraska's assessment that the use of a wetter than average climatic condition would result in an overstatement of future levels of management that might be needed (i.e., GWCBCU was inflated by the use of a wetter than average period). Despite this admonishment from the arbitrator, Kansas has chosen a period of years (1995-2009) that was ***even wetter*** than the period of 1990-2006. Based on the precipitation data used for the Model, the average precipitation in Nebraska during 1990-2006 was 22.7 inches, and the average precipitation during 1995-2009 was 23.2 inches.

Kansas recognizes that, given a defined total volume of pumping that will occur on average regardless of climate, the GWCBCU will increase at a greater rate under wetter than average conditions than it would under average conditions.[15] Kansas attempts to justify their choice of years by stating that 23.2 inches is close to the average precipitation "over the past 50 years" (Perkins and Larson, 2011, KS000683). However, it does not reflect the average conditions of the entire period of record.[16] If the future is wetter than the past, then water supplies (and the resulting Compact allocations) in the future will be greater (see discussion in Section 2.1). Kansas has not addressed this. Therefore, the Kansas Baseline suffers from the same critical deficiency identified by the arbitrator (Dreher, 2009), this time to an even greater extent.[17]

2.2.2 Kansas Baseline Groundwater Use in Nebraska

The development of the Kansas Baseline involved the selection of a baseline level of pumping in Nebraska (Perkins and Larson, 2011). This process was apparently intended to reflect the limitations on groundwater use that will be imposed by the current IMPs. The Kansas Baseline fails to reflect these limitations properly, however, and instead includes only the limitations in the previous IMPs. The additional elements in the current IMPs that should have been used in developing the Kansas Baseline are discussed in Section 3.

The Kansas Baseline assumes that the average groundwater pumping volumes will be limited to eighty percent of the average pumping that occurred during 1998-2002. This limitation is part of the compliance standards laid out in the IMPs and discussed in Appendix B. The Kansas Baseline then attempts to

[15] See the deposition of Steven P. Larson on 2/15/12, page 71.
[16] Mr. Book appeared comfortable with the Kansas Baseline based on his communication with Mr. Larson, which led him to believe that it is "representative of the much longer term record of precipitation that we have." See the deposition of Dale Book on 2/16/12, page 153.
[17] This is in spite of the fact that, even before the arbitration, Kansas developed a more sophisticated approach to building a future scenario that is much more reflective of the historical period of record. See Perkins (2007).

simulate additional restrictions on groundwater use that would occur as a result of the limitations on total groundwater pumping per irrigated acre imposed by the individual NRDs. The resulting pumping depths are represented in Table A of Perkins and Larson (2011, KS000690a). Supporting materials provided by Kansas (KS001105) show an attempt to achieve this additional limitation, but this attempt is not reflected in the aforementioned Table A.

2.2.3 Static Conditions in the Kansas Baseline

In contrast to the future climatic condition and the associated groundwater pumping, essentially every other necessary assumption in the Kansas Baseline results in static future conditions (Perkins and Larson, 2011). Examples of assumed conditions, and the reason why these are not likely to be static in the future, fall under the following headings:

1) A stationary climate. Although this assumption has been frequently used by hydrologists in the past, it is no longer appropriate (Milly et al., 2008).

2) Agricultural practices. Historically, the amounts and types of crops grown in the Basin have varied considerably (Appendix D, Section D.1). In addition, producer practices, such as preferred methods of tillage, have changed over time (Appendix D, Section D.2).

3) Technology. A driving force in the changes in agricultural practices in the past has been innovations in related technology (Appendix D, Section D.3).

4) Socioeconomics. Many factors related to the development of the Basin have involved changing socioeconomic variables (Appendix D, Section D.4).

These and many other conditions in the Basin have changed over time, suggesting that future conditions in the Basin will be similarly dynamic. Of course, the degree of potential change is impossible to know before the fact, but some amount of change is reasonably expected to occur in the future. The Basin is an open system, and many external forces have caused or contributed to past changes and, similarly, will certainly result in changes in the future. Therefore, establishing at the outset of the modeling exercise that all of these conditions will be static for a period of sixty years into the future is neither justified nor realistic.

In addition to the conditions listed above, Kansas also assumed that the level of water management in the Basin will be static. In other words, Kansas assumed that Nebraska will continue to manage water for the next sixty years in exactly the same way. Nebraska's water management, however, is much different from the static regulation that Kansas inferred. The assumption that management would never change, for any length of time into the future, is not supported by the

nature of water management in general.[18] In fact, recent developments in the field of water management (e.g., Sophecleous, 2000), and specifically in Nebraska's water management policy, recognize the value and necessity of adaptive multi-disciplinary strategies for responsive and responsible management.

There can be no doubt that Nebraska, along with many other states, has seen an ever-increasing trend of water management activities over the last forty years. These activities have included increased regulatory authority over water use; increased implementation and enforcement of these authorities; increased funding for water management activities; increased scientific understanding of the physical system; and an increased level of sophistication in the integration of this scientific understanding into the regulatory and non-regulatory frameworks of water management. Nebraska's understanding related to efficient and effective management approaches has never been greater. Indeed, Nebraska is poised to implement projects and practices that can address the water management issues both today and in the future (See Appendix C).

The clear trend is toward an ever-increasing level of water management activities. This is evident from even a brief description of the management activities implemented by the three successive IMPs that have been adopted for the LRNRD, the MRNRD, and the URNRD:

1) The first IMPs (2005) imposed the first-ever allocations on water use in two of the three NRDs and further reduced allocations in the third NRD;

2) The second IMPs (2008) provided for a further reduction in the then-current level of groundwater pumping; and

3) The third IMPs (2010-2011) provided for an even further reduction in the level of groundwater use and the directive to curtail groundwater users in areas with the most rapid impact on stream baseflows and surface water users when needed to ensure Compact compliance.

This is certainly an incomplete summary of the IMPs, but it is sufficient to demonstrate the trend of increasing management actions over time. The Kansas Baseline, however, depends on the assumption that there will be no change in water management in Nebraska over the next sixty years. The rate at which Nebraska may increase management activities even further over time is not clear at the present time, but any set of Model assumptions that does not encompass this clear historic trend is not supported by the known facts.

Finally, the Kansas Baseline depends on the assumption that the Model and all of the assumptions that went into its development will likewise remain static

[18] See the deposition of David Barfield on 1/26/12, pages 43-44.

for the next sixty years. The Model was not completed until 2003 and has been actively used for implementation of the FSS for only eight years. Yet Kansas has already pointed out one Model assumption that Kansas feels should be changed in the future. This is the percentage of applied water from groundwater irrigation that is not consumed by the crop but rather returns to the aquifer as recharge (Perkins and Larson, 2011). Given that Kansas is already proposing changes such as this one to the RRCA, it is unreasonable to believe that the Model will continue to be utilized in exactly the same manner as it is used today, with exactly the same data and assumptions, for the next sixty years. This would be akin to assuming that the technology used to distribute music commercially (i.e., compact discs, cassette tapes, eight-track tapes, LP records) will be the same in 2069 as it is today.

Consider for a moment the changes that have taken place over the last sixty years. A future projection of some kind based on technologies available sixty years ago would never have postulated such inventions as the microwave oven, the communications satellite, the cellular phone, the personal computer, high-yield rice, and genetic sequencing. Yet these innovations fundamentally shape our lives today. In the Republican River Basin of sixty years ago, there was no center pivot irrigation and no genetically modified seed, and the producers of that time would not have envisioned such things being available in the future. It is patently unreliable, then, to base future projections six decades into the future on the demonstrably fast-paced and innovative landscape of ever-improving technology.

Just as in other areas of innovation, the scientific state-of-the-art technology and understanding of the future, as related to groundwater models, will certainly have moved well beyond the constructs of the Model, which is limited by the technology currently available; presumably the RRCA will adapt to these changes as they arise. For example, the accounting methods employed by the RRCA in 1990 would surely predict a much different future condition in 2069 than the current Model and accounting methods do. Kansas proposes to use today's tools to calculate Nebraska's future compliance, or lack thereof, in thirty to forty-five years and proposes water management restrictions to be implemented today to prevent this projected state of future non-compliance. It is highly unlikely that the Model and the RRCA accounting procedures that will actually be employed during the 2047-2051 accounting period will be identical to those currently used. Consequently, using ***present tools*** to predict the outcome of a ***future set of calculations***, which are not likely to be made with those same tools, is illogical and inappropriate.

3.0 NEBRASKA'S INTEGRATED MANAGEMENT PLANS

Nebraska manages the hydrologically connected surface and groundwater in the Republican River Basin through a process of integrated management planning. The statutory authorities granted to the DNR and the NRDs for this process are described in greater detail in Appendix B. The current IMPs (LRNRD, 2011; MRNRD, 2010; URNRD, 2010) are described in detail in Appendix C. The pumping volumes used to develop the Kansas Baseline include only the reductions required by the previous round of IMPs, which were adopted in 2008 but which were superseded by those adopted in 2010-2011. This section will demonstrate the results of previous integrated management planning efforts in Nebraska; analyze the Kansas Baseline with respect to the recently revised IMPs; discuss the deficiencies with the future accounting analysis used to develop the Kansas Remedy; and discuss Kansas' attempts to analyze the IMPs.

3.1 The Effectiveness of Previous Integrated Management Plans

The amount of groundwater pumped in Nebraska each year has been reduced substantially since the signing of the FSS in 2002 and the implementation of integrated management planning in 2004. As shown in Figure 3, total pumping volumes in the LRNRD, MRNRD, and the URNRD have decreased from greater than 1,400,000 acre-feet in 2002 to approximately 700,000 acre-feet in recent years. In contrast, the Kansas analysis starts from the premise that 2010 groundwater pumping was 1,014,881 acre-feet.[19] The result is an overestimate of groundwater pumping for 2010 by approximately 335,000 acre-feet.

Kansas has demonstrated that the controls from the previous IMPs will result in lower pumping volumes in the future during periods of similar climatic conditions. For example, Kansas estimated the pumping that would occur in the future if conditions characteristic of the years 1995 through 2009 were to repeat, while attempting to impose the pumping limitations in the IMPs (Perkins and Larson, 2011). The estimated average pumping that actually occurred during the historical time period 2002-2006 and the hypothetical future pumping during 2047-2051 and the other five-year periods in which the conditions of 2002-2006 are assumed to occur again are shown in Table 3. By Kansas' own calculations, groundwater use in the future, if conditions present during 2002-2006 were to repeat, would be approximately 80% of what was actually pumped during these years. This shows that the Nebraska IMPs have been effective and, with the modifications included in the most recent IMPs, will reduce groundwater use to even lower levels.

[19] From the Kansas spreadsheet ScalingFactors_NRD_1995-2009_Revised_gwirrft_sheets_added_spp.xlsx (KS001105).

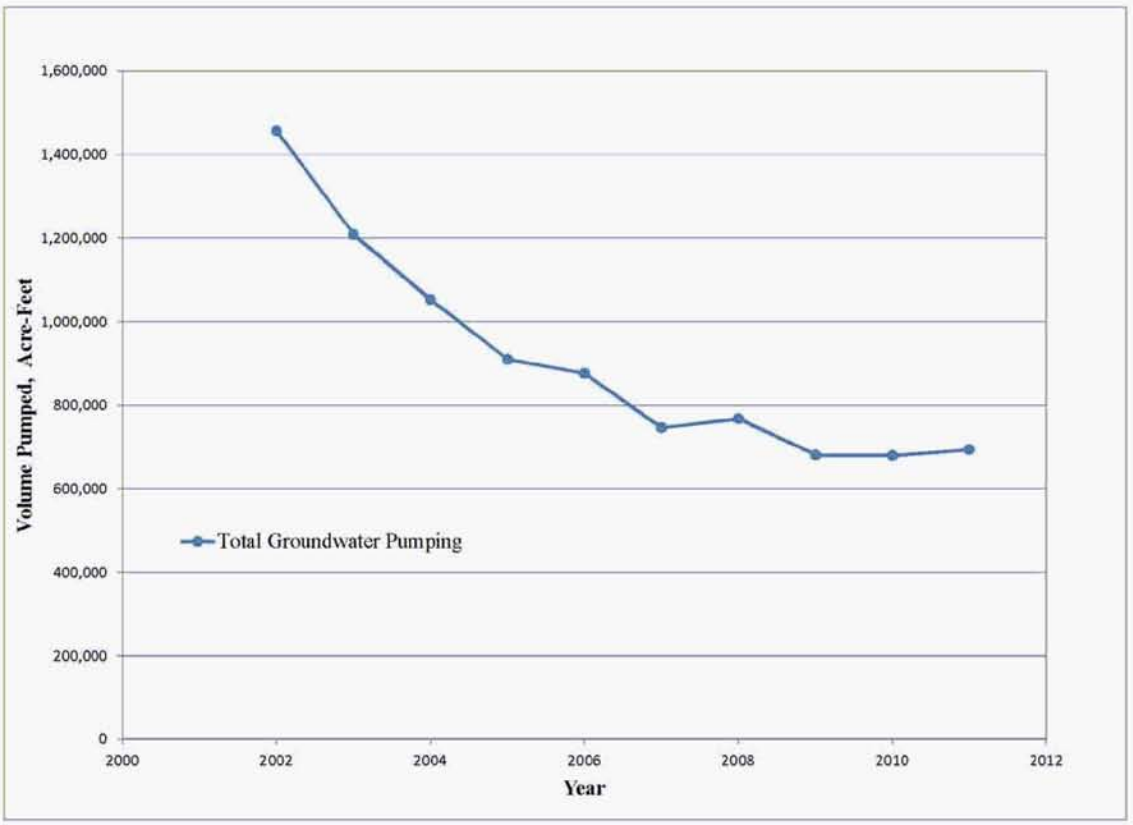

Figure 3. The combined total pumping volumes for the LRNRD, the MRNRD, and the URNRD.

Table 3. Comparison of historic pumping and potential future pumping under a similar climatic condition.[20]

Time Period	Historic Pumping (Acre-feet)	Kansas Estimated Future Pumping (Acre-feet)	Reduction (Acre-feet)
2002-2006	1,098,373	882,914	215,459

To understand the effectiveness of the pumping reductions implemented by Nebraska and acknowledged in the Kansas analysis, we can look at the results of the Kansas Baseline simulation that attempted to simulate this reduction (Figure 4). To be clear, this is the baseline Model run constructed by Kansas that incorporates only the 20% pumping reduction implemented in previous versions of Nebraska's IMPs; consequently, the Model run and its results show, at best, only a

[20] From the Kansas spreadsheet ScalingFactors_NRD_1995-2009_Revised_gwirrft_sheets_added_spp.xlsx (KS001105).

partial picture of the total effect of Nebraska's management activities to date. As discussed further below, Kansas failed to predict the Nebraska GWCBCU under Nebraska's current IMPs. In spite of this incompleteness, the Kansas results indicate that over the next ten years, Nebraska's GWCBCU will decrease by approximately 1,500 acre-feet per year, even without full consideration of all of the pumping reductions currently mandated in Nebraska's IMPs.

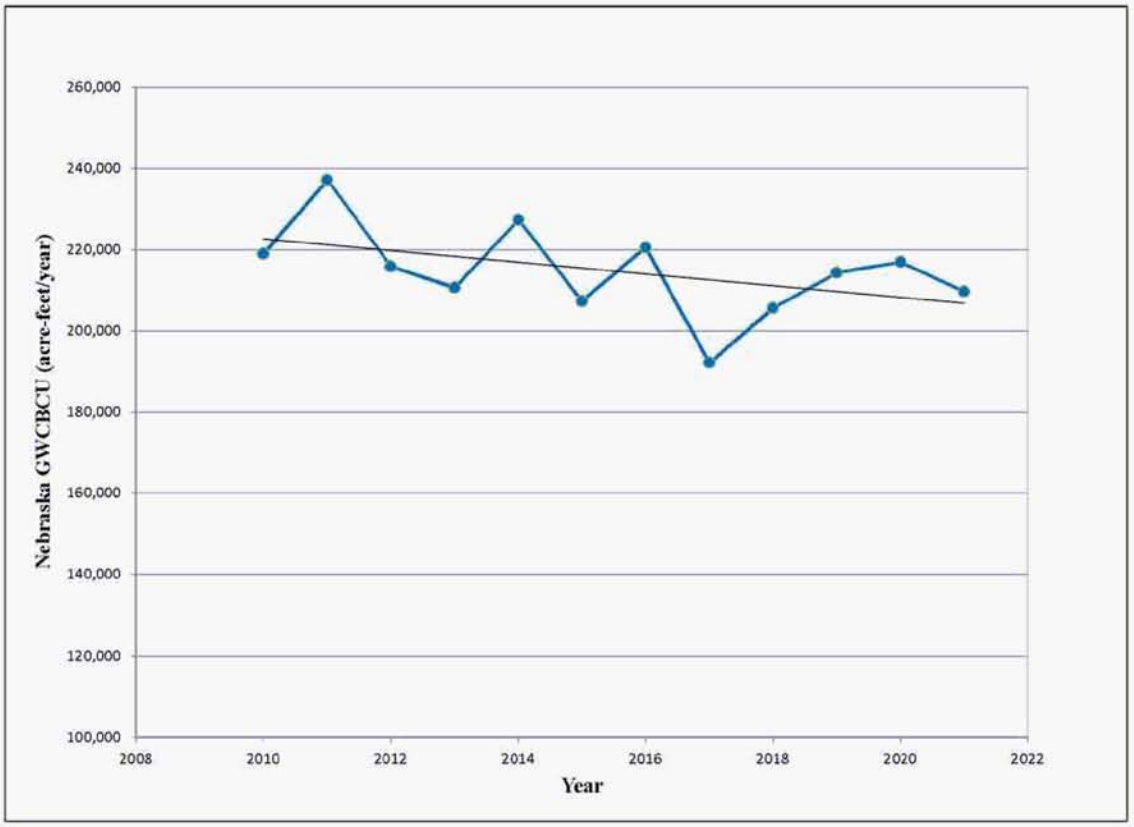

Figure 4. The trend of Nebraska's GWCBCU through 2021 as predicted by Kansas (from Perkins and Larson, 2011, KS000691). The straight black line is a best-fit linear trendline.

3.2 The Kansas Baseline Does Not Reflect the Current IMPs

There are numerous oversimplifications embodied in the hypothetical future scenario represented by the Kansas Baseline (Section 2.2). In addition, it does not take into account any of the compliance standards[21] added to the current IMPs. These additional compliance standards are designed to achieve by 2015 a reduction of 25% (i.e., an additional 5% beyond the 20% reduction mandated in previous versions of the IMPs) from the baseline pumping from 1998 to 2002.

[21] The compliance standards, along with the other components of the IMPs, are discussed in detail in Appendix C.

Kansas is aware of this additional standard, as evidenced by the analysis of the incremental effect of the additional 5% reduction included in Perkins and Larson (2011). However, Kansas fails to incorporate this key compliance standard in the IMPs into the Kansas Baseline.

The IMPs also include a decision point in 2015, at which time DNR will determine whether additional reductions are warranted. To summarize, an additional reduction of 5% will actually have been achieved no later than 2015, and additional reductions beyond that level may be implemented after 2015. None of this is included in the Kansas Baseline, however, resulting in a future level of groundwater pumping inflated by at least this 5% increment. The baseline pumping during 1998-2002 was 1,083,531 acre-feet/year. Kansas has only reduced this volume by 20%; this amounts to an overstatement of Nebraska's future groundwater pumping of at least 54,000 acre-feet per year (i.e., 5% of 1,083,531).

The second critical component of the compliance standards in the IMPs is a requirement that each NRD keep the GWCBCU in their NRD within the limit of their allowable groundwater depletions. This is an important point because, if reducing pumping by at least 25% from the 1998-2002 baseline is not sufficient to keep actual depletions to levels within Nebraska's allowable groundwater depletions, then pumping will be reduced further. These further reductions would include curtailment of pumping in the Rapid Response Region[22] when needed and could also include additional overall reductions in allowable pumping by the NRDs. In order to compile an appropriate baseline condition that, at a minimum, reflects the current IMPs, Kansas should have taken this compliance standard into account, but Kansas did not do so. ***Kansas has failed to represent the groundwater controls within the current IMPs accurately in the development of the Kansas Baseline.***

In developing the Kansas Remedy, Kansas applied the Model results in a simplified approach to attempt to balance the GWCBCU and IWS Credit from some hypothetical future condition with the historical allocations and a value for the SWCBCU from the 2002-2006 period. The value for the SWCBCU is based on the historical values from 2002 to 2006, but it is inflated to a level greater than these values, based on the assumption that reductions in GWCBCU will provide an increased supply of surface water for Nebraska irrigators. This assumption is not consistent with the surface water controls in the IMPs, making this a flawed approach.

The IMPs ensure Compact compliance during dry years in part by including procedures for determining and designating Compact Call Years (Appendix C). These are years in which the annual forecast for the upcoming year suggests that

[22] For maps, see URNRD, 2010, page 22; MRNRD, 2010, page 25; LRNRD, 2011, page 22.

Nebraska would be out of compliance if that year was, in fact, to be very dry and no additional management actions were taken. When a Compact Call Year has been designated, the DNR must close all natural flow and storage permits in the Basin until it has been determined that the water flowing into Kansas in the Republican River will be sufficient, such that Nebraska would not overuse her Compact allocation, given the appropriate multi-year averaging in place. In spite of this clearly-stated mechanism for closing all surface water permits under such circumstances, Kansas assumed that SWCBCU would ***increase*** during future dry years, as reductions in GWCBCU provide an increased water supply to surface water irrigators. In reality, the reduced GWCBCU resulting from such curtailment would be delivered to Kansas, not provided to surface water irrigators in Nebraska. ***Kansas has failed to accurately represent the surface water controls within the current IMPs in the development of the Kansas Remedy.***

3.3 Other Failures of the Accounting Analysis

Kansas has created a static and hypothetical future (see Section 2.2) that does not even properly represent the current management plans and practices in Nebraska (see Section 3.2). Several additional factors are similarly not taken into account by Kansas in developing the Kansas Remedy, and these factors would also have a significant effect on the results of Compact Accounting in future years. These factors are summarized as follows: 1) the proper allocation of the evaporation from Harlan County Lake; 2) changes in Basin water supply dynamics resulting from Colorado's use of the Compact Compliance Pipeline (CCP); and 3) other management actions that might be taken by Nebraska during these future years, as provided in the IMPs.

3.3.1 Harlan County Lake Evaporation

One of the issues currently under dispute is how the evaporation from Harlan County Lake should be allocated between Kansas and Nebraska during 2006. If the current accounting procedures are followed and are applied in the future, in a case in which Nebraska does not irrigate with the water supply from Harlan County Lake, then 100% of this evaporation would be allocated to Kansas. Kansas has proposed changes to the accounting procedures that would require some of the evaporation to be charged to Nebraska. No such change has been agreed to by the States at this time. Nevertheless, Kansas has unilaterally changed the accounting procedures for the purposes of their analysis in developing the Kansas Remedy. Such a change in the accounting procedures would increase the SWCBCU for Nebraska in 2006 by approximately 8,000 acre-feet, thereby reducing Nebraska's annual balance for that year by the same 8,000 acre-feet. That increased SWCBCU for 2006 is also used for 2051, thus increasing the amount of GWCBCU reductions that would be required under the Kansas Remedy.

3.3.2 Colorado's Compact Compliance Pipeline (CCP)

The accounting results for the State of Colorado were summarized from the RRCA accounting spreadsheets.[23] Table 4 shows the cumulative results for the years 2003 – 2006. For each year, Colorado's allocation and use (column CBCU) for each sub-basin is presented. Negative values in the column labeled "Allocation-CBCU" indicate a condition in which uses exceeded allocations.

Table 4. Cumulative Colorado accounting data for the period 2003-2006.

Sub-basin	Allocation	CBCU	Allocation - CBCU
North Fork	37,730	69,010	-31,280
Arikaree	5,760	2,520	3,240
Buffalo	0	1,190	-1,190
Rock	0	240	-240
South Fork	42,820	66,860	-24,040
Frenchman	0	160	-160
Beaver	2,950	0	2,950
Main Stem	0	-6,100	6,100
Total All Sub-basins	89,260	133,880	-44,620

Had Colorado's uses been within her allocation for the 2003-2006 period, Nebraska would have had access to up to an additional 44,620 acre-feet of water. Some portion of the South Fork water would likely have been consumed in northwest Kansas, but even if none of the South Fork water flowed into Nebraska, there would have been an additional 20,580 acre-feet of water flowing into Nebraska during this period. Therefore, there should have been an additional approximately 5,000-11,000 acre-feet per year of surface water in Nebraska.

Kansas has expressed concern that less surface water will be available in Nebraska during future dry periods (Barfield, 2011).[24] In part to address the issue of insufficient water passing into Nebraska from Colorado, as has occurred in past years (Table 4), Colorado is constructing the CCP.[25] This project will deliver water into the North Fork of the Republican River, immediately upstream of the Colorado-Nebraska state line, to mitigate any potential overuses in Colorado in the future. Therefore, this is a likely source of additional surface water in Nebraska

[23] Data compiled in CO_AcctBalanceSelectSubbasins2003-2006.xlsx and provided with report.
[24] See also the deposition of David Barfield on 1/26/12, page 70-72.
[25] More information on Colorado's CCP, currently scheduled for completion in 2012, can be found at http://www.republicanriver.com/Pipeline/tabid/101/Default.aspx.

during future dry periods. However, these volumes of water were not considered in the Kansas analysis.

3.3.3 Other Management Actions

Finally, Kansas has not considered the positive effect of any additional management actions taken by Nebraska in the future on potential accounting balances in the future. The IMPs clearly contemplate actions such as surface water purchases and augmentation of streamflows, for example, to assist in maintaining Compact compliance. In fact, during 2006-2008, Nebraska expended $18,722,500 to purchase approximately 98,368 acre-feet of water from surface water irrigation districts, thereby positively affecting Nebraska's annual balance during these years by 51,614 acre-feet.[26] Surface water purchases could involve the release of water already in storage within a federal reservoir in the basin, increasing allocations, and/or decreasing Nebraska's SWCBCU. Augmentation projects could take on many forms. Seeing the previous implementation of these actions and the great potential for other similar actions in the future, there is no justification for ignoring the benefits of these types of actions.

The Nebraska integrated management planning process is fundamentally adaptive in nature. This is evident in the multiple revisions that the IMPs in the Basin have already undergone since 2004, when these plans first became required by law. The practice of adaptive management is common and well supported in the scientific community. Williams et al. (2009, page 4) adopt the following definition of adaptive management from the National Research Council:

> *Adaptive management [is a decision process that] promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Careful monitoring of these outcomes both advances scientific understanding and helps adjust policies or operations as part of an iterative learning process. Adaptive management also recognizes the importance of natural variability in contributing to ecological resilience and productivity. It is not a 'trial and error' process, but rather emphasizes learning while doing. Adaptive management does not represent an end in itself, but rather a means to more effective decisions and enhanced benefits. Its true measure is in how well it helps meet environmental, social, and economic goals, increases scientific knowledge, and reduces tensions among stakeholder.*

[26] See the Declaration of Brian Dunnigan, Page App. 9, Brief of the State of Nebraska in Response to Kansas' Motion For Leave to File Petition, June 2010.

Nebraska's approach for Compact compliance is adaptive management with one fundamental principle at its core: long-term groundwater depletions must be maintained at manageable levels, such that management actions whose effects manifest rapidly (e.g., reductions in surface water use and reductions in groundwater use near the stream) will always be sufficient to ensure Compact compliance. This principle is also key to Nebraska's ability to utilize its allocation most efficiently.

The operational components of Nebraska's adaptive management process are laid out in the IMPs. Real and current information are used every year as a means to adapt management decisions to what was learned through the implementation and effects of previous management decisions. The IMPs follow this process in the following way:

1) Identify clear and measurable objectives (compliance);
2) Ensure stakeholder commitment to meeting compliance obligations;
3) Identify management actions;
4) Evaluate effectiveness of management actions through monitoring; and
5) Adjust actions as necessary.

This process allows for the incorporation of new information and new approaches that can improve the effectiveness of these IMPs.

3.4 Kansas Cannot Conclude that the IMPs Will Not Ensure Compact Compliance

To reiterate, Kansas has developed the Kansas Baseline in an attempt to simulate the effects of certain elements of the current IMPs on Nebraska's future Compact compliance. Kansas has also performed Model simulations that attempt to quantify the effect of certain additional elements of the IMPs. Other elements, such as surface water administration during a Compact Call Year, any potential surface water purchases like those that occurred during 2006-2008, or other management actions contemplated in the IMPs did not form part of the Kansas Baseline or the analysis that developed the Kansas Remedy.

Kansas did not make any attempt to incorporate any of the above elements (those from the Model runs or other management actions) into the Compact accounting. ***This necessary step would be the only true assessment of the effectiveness of the suite of management actions called for in the current IMPs.*** It is not clear why Kansas specifically avoided such an analysis. The above discussion shows clearly that Kansas has presented no actual quantification of the effectiveness (or ineffectiveness) of Nebraska's IMPs. The effectiveness of these IMPs will be presented in the next section.

4.0 THE KANSAS REMEDY IS NOT NECESSARY AND CREATES A WINDFALL FOR KANSAS

Section 3 demonstrated the fundamental lack of understanding on the part of Kansas with regard to Nebraska's IMPs. Furthermore, the analysis used to develop the Kansas Remedy did not properly reflect various components of these IMPs, as well as other critical points. In fact, Kansas apparently had no intention of directly analyzing the IMPs. Instead, Kansas has designed a compliance plan for Nebraska that would far exceed any perceived requirements for Nebraska's future compliance for at least the next three decades.[27] This section demonstrates the effectiveness of the IMPs and shows how the Kansas Remedy would result in a windfall of water for the State of Kansas.

Kansas has claimed that the Kansas Remedy is the "minimum remedy necessary" to ensure compliance by the State of Nebraska in the future (Barfield, 2011, KS000756). In making this claim, Kansas has analyzed only a single potential approach to providing for Nebraska's long-term compliance. Although corridors of several different sizes along the stream were analyzed to come up with the Kansas Remedy, such size variability is insufficient in itself to prevent this from being an extremely limited scope of analysis. The number of management-action combinations that could be considered in such a process is essentially infinite. These could include various combinations of approaches to reducing GWCBCU and/or SWCBCU, or increases in allocations or IWS Credits, involving many different combinations of immediate and stepwise implementation frameworks. No single modeling effort could possibly account for all of these variations, but Kansas did not at all consider any alternatives to the single set of management conditions chosen for the Model simulations.

Furthermore, Kansas has not properly analyzed the current provisions of the IMPs in order to determine whether or not they will be effective on their own to maintain Nebraska's compliance with the Compact. This section shows how the IMPs will ensure compliance. Nebraska's IMPs were developed to optimize the use of Nebraska's Compact entitlements in Nebraska while, at the same time, to ensure that Nebraska is and remains in compliance with the Compact. Kansas has not attempted any such optimization approach, in spite of the fact that the Kansas experts are apparently qualified to perform such analyses.[28] Instead, Kansas relies on projections into the distant future in order to justify the need for the Kansas Remedy. By doing so, Kansas would be provided a windfall of water far in excess of their Compact entitlements for at least many decades into the future.

[27] See the deposition of Dale Book on 2/16/12, page 155.
[28] See the deposition of Steve Larson on 2/15/12, pages 52-55.

4.1 Retroactive Application of the Integrated Management Plans Demonstrates They Ensure Compliance

In developing the Kansas Remedy, Kansas utilized a hypothetical future projection of Nebraska's CBCU and IWS Credit and then compared these values with a hypothetical Compact allocation during a time period thirty to forty-five years in the future. As discussed in Section 2.2, any such ***future projections***, based on such underlying assumptions as Kansas employed, ***will be wrong***.

The best way to demonstrate the effectiveness of the forecasting and regulatory mechanisms in the IMPs is to apply them to the actual hydrologic conditions experienced during the recent drought conditions of the early 2000s. In other words, Nebraska's analysis demonstrates the Compact Accounting results that would have been obtained if the current IMPs had been in effect during the 2002-2006 time period. The analysis below demonstrates that Nebraska's IMPs would have resulted in compliance in 2002-2006. They will be implemented in a vigilant manner to ensure compliance each and every year in the future. The forecasting mechanisms that will trigger additional management actions in the future are discussed in detail in Appendix C. These involve a suite of sophisticated analyses that were designed to address and avert all potential Compact noncompliance before it occurs.

For the period 2002-2006, the retroactive application of the forecast would yield the same outcome in every year, that is, each of these years would have been projected by the USBR to be subject to WSYA. Therefore, the combination of Nebraska's upcoming dry year forecast and actual previous year's annual balance (computed in a manner that includes a reduction in Nebraska's allocation, which serves as a cushion) would need to be positive in order to show Compact compliance without needing additional measures. This would not have been the case in any of these five years. Consequently, these years would have been designated as Compact Call Years, as they are termed in the current IMPs. This designation would have required the curtailment of groundwater uses in the Rapid Response Region – unless other sufficient streamflow replacement measures could be put in place – and the closing of all surface water natural flow and storage appropriators.

The Model run for the years 2002-2006 was modified so as not to include the groundwater use that actually occurred in the Rapid Response Region in the URNRD, MRNRD, and LRNRD during 2002-2006. The reductions in groundwater CBCU as compared to the historic values for those years are shown in Table 5.[29] The new values for groundwater CBCU and IWS Credit shown in

[29] The baseline results for this analysis should be substantially different than those presented by Kansas because of the accounting issues currently under dispute. Kansas has assumed in its calculations that the

Table 5 demonstrate the effect of this management action on the Compact accounting results. The annual values from Table 5, along with the historical values for these years, are displayed in Figure 5. The five-year average for this period changed from -31,000 acre-feet per year to 7,000 acre-feet per year. Because the reductions in groundwater CBCU were sufficient to result in Compact compliance, no reduction in surface water CBCU was included in this analysis (i.e., the Change in SWCBCU in Table 5 is zero), though any such reductions that would occur during Compact Call Year administration would result in a greater positive balance for Nebraska.

Table 5. The Compact accounting results from 2002-2006 with the GWCBCU and IWS Credit that would have occurred under the current IMPs. The Statewide Allocation and Surface Water CBCU data are from Book (2011, KS000451). The Groundwater CBCU and the IWS Credit were computed by Nebraska by running the Model during these years with no groundwater pumping in the Rapid Response Region.

Year	Statewide Allocation	Ground-water CBCU	Change in Surface Water CBCU	Surface Water CBCU	IWS Credit	Allocation - (CBCU - IWS Credit)
2002	237	165	0	85	15	1
2003	228	166	0	59	16	19
2004	206	176	0	40	18	8
2005	199	172	0	43	20	5
2006	187	167	0	38	20	2
Average	211	169	0	53	18	7

accounting procedures will be changed so that the evaporation from Harlan County Lake would be split between Nebraska and Kansas in 2006. This assumption decreases the annual balance for Nebraska in 2006 from -29,000 acre-feet to -37,000 acre-feet. None of the other Compact signatories has agreed to this change in the accounting procedures, yet this issue is part of the current dispute before the U.S. Supreme Court. Regardless, it is not necessary to show Nebraska's position on this issue in order to demonstrate that the current IMPs could achieve Compact compliance during this period. Therefore, the SWCBCU and annual balance values presented by Book for 2006 are used in this analysis (though Nebraska does not concede this issue by doing so).

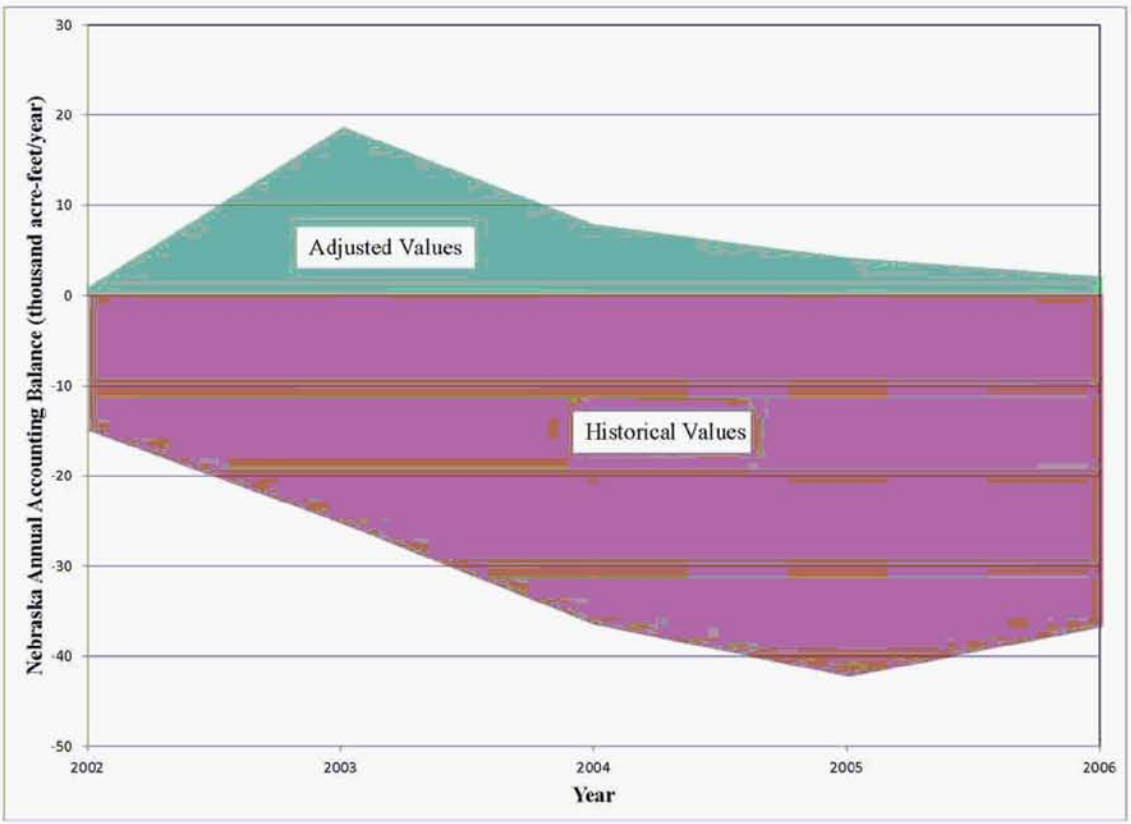

Figure 5. Nebraska's annual balances under the historical condition (Historical Value) and with a curtailment of groundwater use in the Rapid Response Region (Adjusted Value).

The Kansas Remedy does not focus on the next potential drought cycle in the future, but rather on the third potential drought cycle in the future, ignoring actual hydrologic conditions and the management actions required in the IMPs. This report has demonstrated that:

1. Nebraska is currently underusing her allocation by a large margin (see Section 1.1);

2. The controls in the current IMPs would have ensured Nebraska's Compact compliance during the historical period of 2002-2006 (as just demonstrated); and

3. The limitations on groundwater pumping provided for in the IMPs will result in decreasing values of GWCBCU over the next decade (see Section 3.1).

Therefore, it is clear that the current IMPs, without additional modification, will ensure Compact compliance during the next drought cycle.

4.2 The Kansas Remedy Provides a Windfall to Kansas

In order to demonstrate the full implication and effects of the Kansas Remedy on Nebraska, the analysis completed by Book (2011) for 2047-2051 would need to be expanded to include the entire period (2010-2069) analyzed within the Kansas Baseline. While this report has shown that the Kansas Baseline is highly unlikely to occur, completing Book's analysis for this entire period demonstrates the nature of the windfall of water that Kansas is requesting.

The annual results are presented in Figure 6. As can be seen, Nebraska's annual water use (minus the IWS Credit) would be less than her allocation every year until the year 2050. Therefore, the multi-year averages through 2050 used in Compact accounting will always be positive. If Nebraska is not allowed to have any single year with a negative annual balance, then the multi-year averaging that was incorporated into the FSS would become meaningless. The fundamental idea embedded in this concept is that a state did not have to keep its uses within its allocation for every single year, as long as those exceedances are balanced by an underuse within the same averaging period. The Kansas Remedy would essentially remove this concept from the Compact accounting procedures agreed to under the FSS.

Most importantly, over this sixty-year time period, Nebraska would underutilize her allocation by an average of approximately 48,000 acre-feet per year. To give this figure some context, this represents 20% of Nebraska's original Compact allocation of 234,000 acre-feet per year, which Nebraska would not be able to use every year. In this modeled sixty-year period, Nebraska would exceed her allocation in four individual years (i.e., not a single four-year period of time), for a total overuse in those four years of 18,000 acre-feet. In contrast, fifty-six years would yield a total underuse of Nebraska's allocation of 2,887,000 acre-feet.

Under the current IMPs, Nebraska's annual balances would be similar to those achieved under the Kansas Remedy in dry years such as those represented by the years 2002-2006. Because the current IMPs would be sufficient to meet Nebraska's compliance obligations, Nebraska would not be forced to make even more drastic reductions in every year, as the Kansas Remedy would prescribe, and Nebraska would be spared this necessity particularly in those years in which Nebraska's allocations would be well in excess of her uses under baseline conditions. In summary, the Nebraska IMPs and the Kansas Remedy are equally sufficient in ensuring Compact compliance during dry periods. As demonstrated, the Kansas Remedy applies an unnecessary additional and substantial restriction on Nebraska's use of the Basin's water far above the restrictions contained in the Compact or the FSS and well beyond what would be necessary to maintain Compact compliance.

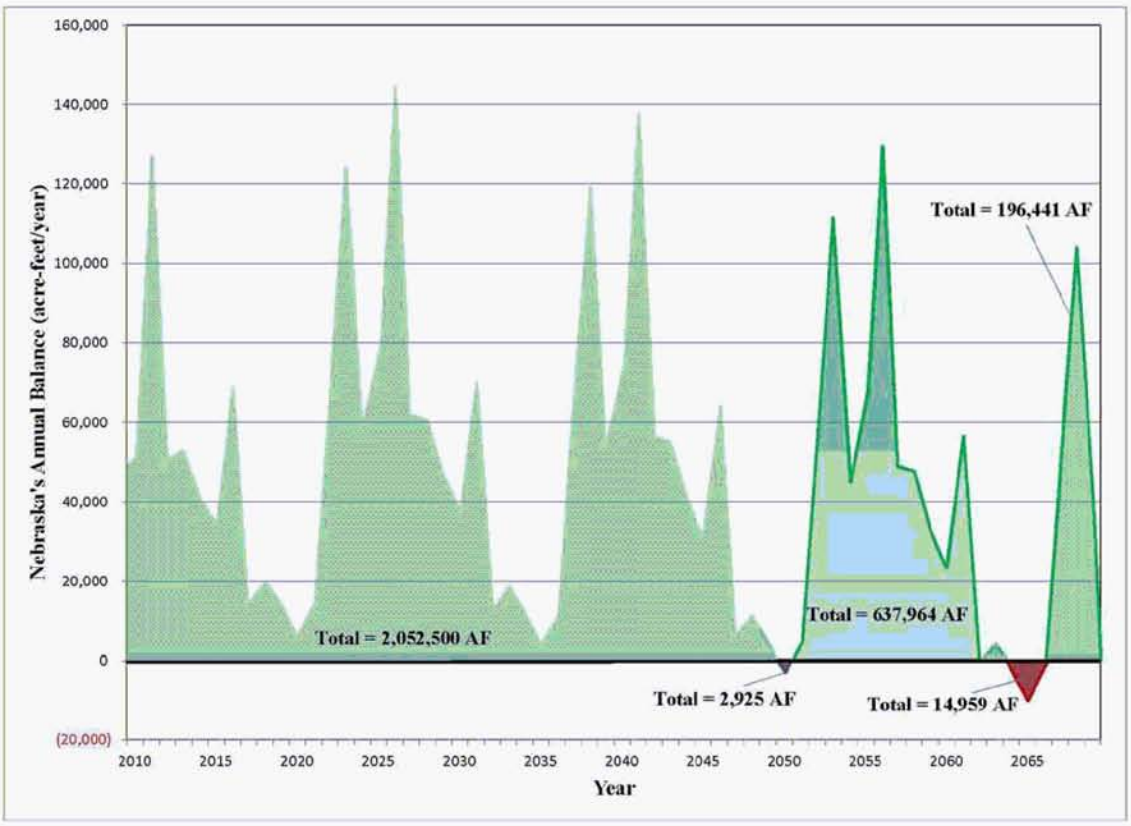

Figure 6. Nebraska's annual balance from 2010-2069 under the Kansas Remedy. Green shading represents underuses of Nebraska's annual allocation. Red shading represents overuses of Nebraska's annual allocation. Totals sum over- or underuses for consecutive years.

5.0 SUMMARY AND CONCLUSIONS

Kansas has asserted that the Kansas Remedy is necessary if Nebraska is to remain in compliance in the future. This assertion is based on an incomplete and inaccurate representation of past and current conditions, and a hypothetical future that bears no apparent relation to current conditions, essentially ignores current management plans, and is extremely unlikely to occur in fact. For example, Kansas would prefer to focus on groundwater irrigated acres (Barfield, 2011, KS000727), ignoring the actual volumes of irrigation that have occurred (Figure 3). Kansas would also prefer to focus solely on the GWCBCU portion of Nebraska's impacts to streamflow (Barfield, 2011, KS000742). RRCA accounting requires consideration of GWCBCU, SWCBCU, and the IWS Credit in determining whether Nebraska has overused or underused her annual allocation.

Table 6 shows the average of Nebraska's Net Impacts (GWCBCU + SWCBCU – IWS Credit) for the three most recent five-year periods. During 2002-2006, Nebraska's Net Impacts were reduced by more than 40,000 acre-feet per year relative to the previous five years. Application of the regulatory provisions of current IMPs during 2002-2006 would have resulted in an additional reduction of slightly less than 40,000 acre-feet per year (from Table 5). The combined results of the significant reductions in groundwater pumping that have occurred and the additional reductions that would occur under the current IMPs yield average Nebraska Net Impacts that are less than the average allocation during this period.

Table 6. The average values for Nebraska's Net Impact (SWCBCU + GWCBCU – IWS Credit), Nebraska's Allocation, and Nebraska's Annual Balances for the time periods shown. The 2002-2006 adj. values represent the results for those years with no groundwater pumping in the Rapid Response Region.[30]

Period	Nebraska Net Impact (thousand acre-feet per year)	Nebraska Allocation (thousand acre-feet per year)	Nebraska Annual Balance (thousand acre-feet per year)
1997-2001	283	309	26
2002-2006	242	211	-31
2002-2006 adj.	204	211	7
2007-2011	239	303	64

Most significantly, Nebraska's Net Impacts during 2007-2011 have remained approximately 44,000 acre-feet less than those experienced during 1997-2001, even though Nebraska's average allocations during 2007-2011 and 1997-

[30] Again, the SWCBCU and annual balance values presented by Book (2011) for 2006 are used in this analysis, though Nebraska does not concede this issue by doing so.

2001 were very similar. This demonstrates the effectiveness of Nebraska management plans in achieving a lasting, significant reduction in Nebraska's Net Impacts. If Kansas' projection that Nebraska's GWCBCU will shrink over the next decade proves to be accurate even in part, then, because of the existing IMP framework and plan modification process, Nebraska will be well situated to implement any additional reductions that may be needed should such very dry conditions return, thus ensuring Compact compliance in all years going forward.

Nebraska has the management provisions in place today to ensure Compact compliance in the future. Kansas has displayed an incomplete understanding of these plans and has not even attempted to show they are insufficient. Kansas has developed the Kansas Remedy, which would provide a windfall of water to Kansas for at least the next forty-five years. This Remedy is predicated on a static approach to water management that is unworkable in any dynamic hydrologic system, but especially in the Basin, where hydrologic conditions and management responses are constantly evolving. Nebraska's water management approach is designed to adapt to these changing conditions. Such adaptive management will occur in a proactive manner as ongoing forecasting directs water management decisions. Nebraska's water management approach represents a truly long-term commitment that will ensure Compact compliance over the long term.

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APPENDIX A. Curriculum Vitae for James C. Schneider, Ph.D.

Areas of Specialization

- Water resources management and planning
- Groundwater flow modeling
- Administration of interstate water Compacts, Decrees, and Agreements
- Hydrogeology
- Statistical analysis of hydrologic data
- Surface-water hydrology
- Environmental geophysics

Education

- Ph.D. in Geology (May 2003) - University of South Florida, Tampa, FL
- M.S. in Geology (May 1998) - Northern Illinois University, DeKalb, IL
- B.S. in Geology (May 1996) - Northern Illinois University, DeKalb, IL

Professional History

- **Deputy Director (2010-)** ***Nebraska Department of Natural Resources (DNR)***

  Responsibilities: Advising and assisting the Director in formulating and administering department policies, budget, organization, and work assignments; assisting in formulation of state water policies, particularly as they pertain to water quantity issues, including serving as liaison with the legislature, other state and local agencies, and public interest groups; overseeing the general administration of the department and assuming responsibility for the department's operation in the Director's absence; assisting the Director in administration of interstate compacts and decrees; serving as the State's Representative on technical committees for compacts and decrees; overseeing the work of consultants and preparing special reports related to surface water or surface and ground water interactions; assisting the Director in reviewing permit applications and groundwater management plans; and assisting the Director in water rights hearings and analysis of permit applications; supervising the Integrated Water Management Division.

- **Head, Integrated Water Management Division (2008-2009)** ***Nebraska DNR***

  Responsibilities: Manage the integrated water management planning process at the Department, including oversight of surface- and groundwater related studies, development and implementation of integrated management plans, supervision of the Integrated Water Management Division and coordination with other Department Divisions, Natural Resources Districts, and other State and Federal agencies.

- **Senior Groundwater Modeler (2007)** ***Nebraska DNR***

  Responsibilities: Serve as NDNR groundwater flow modeling expert.

- **Senior Hydrogeologist/Geophysicist (2006)** ***SDII Global Corporation***

  Responsibilities: Manage hydrogeology and geophysics projects and prepare contract reports and publications. Serve as company groundwater flow modeling expert. Serve as company geophysics expert.

- **Staff Geologist (2003–2005)** ***SDII Global Corporation***

  Responsibilities: Conduct hydrogeology projects and prepare hydrogeology contract reports and publications. Assist senior staff as technical resource for litigation and peer reviews of technical reports. Serve as company groundwater flow modeling expert. Serve as resource to subsidence investigation group.

- **Research Assistant (1998 – 2002)** ***University of South Florida, Geology Dept.***

  Responsibilities: Conducting field research, data interpretation, geophysical surveys and groundwater model development for a variety of projects throughout Florida as well as in other states and in Jamaica. Teaching undergraduate and graduate level lab and lecture courses.

Publications

Schneider, J.C., S.B. Upchurch, J. Chen, C. Cain, J. Good, 2008. Simulation of groundwater flow in North Florida and South-central Georgia. Peer reviewed technical report issued to the Suwannee River Water Management District.

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Interstate Organizations

- **Republican River Compact Administration (2007-)**

  Responsibilities: Participate in Engineering Committee and Compact Administration Meetings representing State of Nebraska. Serve as official representative on the Engineering Committee beginning in 2010.

- **Platte River Recovery Implementation Program (2007-)**

  Responsibilities: Participate in Water Advisory Committee and in implementation of Nebraska New Depletions Plan. Represent Nebraska on the Governance Committee (Chair 2011) and the Finance Committee beginning in 2010.

- **North Platte Decree Committee (2010-)**

  Responsibilities: Nebraska alternate to the North Platte Decree Committee.

- **Interstate Council on Water Policy (2010 -)**

  Responsibilities: Represent Nebraska on Committees and at annual meetings. Elected to the Board of Directors in 2011.

Expert Witness Testimony

- **Non-binding arbitration in *Kansas v. Nebraska & Colorado*, No. 126 Orig.**

  Responsibilities: Provided deposition and trial testimony in non-binding arbitration initiated in October 2008 relating to Kansas' claims for damages and future compliance, and Nebraska's proposal to fix accounting errors.

- **Non-binding arbitration in *Kansas v. Nebraska & Colorado*, No. 126 Orig.**

  Responsibilities: Provided deposition and trial testimony in non-binding arbitration initiated in May 2010 relating to Nebraska's Crediting Issue and Colorado's Augmentation Pipeline.

APPENDIX B. Statutory Framework for Implementation of the Current Integrated Management Plans

The authorities granted to the DNR and the NRDs for the development and implementation of IMPs are largely contained in the Nebraska Groundwater Management and Protection Act, *Neb. Rev. Stat.* § 46-701 through 46-754 (Act). For the purposes of integrated management in the Republican River Basin, the most relevant sections of the Act are summarized.

B.1 Integrated Management Planning Statutes

In 2004, the Nebraska Legislature passed Legislative Bill (LB) 962, which made major revisions to the Act. LB 962 was the result of approximately two years of work by the Water Policy Task Force, a 49-member group appointed by the Governor. The major changes to the Act included transitional provisions for areas already undergoing a joint planning process between the NRDs and the DNR, a proactive approach to determining when a joint planning process is needed in the other areas of the state, the requirements of that joint planning process, provisions for settling disputes within that process, and the surface water and groundwater controls available for that joint planning process.

B.1.1 Transition from Joint Action Plans to Integrated Management Plans

The transitional provisions of LB 962 are contained in *Neb. Rev. Stat.* § 46-720. Sub-section 3 of this section of the Act contains the relevant provisions for the URNRD, MRNRD, and LRNRD. Prior to July 16, 2004, the director of the DNR had made a preliminary determination "that there is reason to believe that the use of hydrologically connected ground water and surface water" in these three NRDs "is contributing to or is in the reasonably foreseeable future likely to contribute" to conflicts between users. The director also found that a joint action plan should be prepared by the NRDs and the DNR, though that plan had not yet been developed. Therefore, pursuant to *Neb. Rev. Stat.* § 46-720(3), the Upper Republican NRD (URNRD), the Middle Republican NRD (MRNRD), and the Lower Republican (LRNRD) were designated as fully appropriated on July 16, 2004, making them subject to the requirements of *Neb. Rev. Stat.* § 46-713 to 46-719.

Many areas of the state were not involved in a joint planning process at the time of the passage of LB 962. These areas became subject to the provisions of *Neb. Rev. Stat.* § 46-713, which require the DNR to conduct an annual evaluation of hydrologically connected water supplies for any areas of the state not currently designated as either fully appropriated or overappropriated. If this annual evaluation indicates the need for a fully appropriated designation, the DNR first

makes a preliminary determination of fully appropriated, then holds hearings to collect testimony, and then must determine whether to make a final designation of fully appropriated within 120 days. The DNR's most recent annual evaluation was released in December 2011.

B.1.2 The Requirements for Integrated Management Plans

The requirements for the development of an IMP are contained in *Neb. Rev. Stat.* § 46-715. An IMP is required to contain (from subsection 2):

a) Clear goals and objectives with a purpose of sustaining a balance between water uses and water supplies so that the economic viability, social and environmental health, safety, and welfare of the river basin, sub-basin, or reach can be achieved and maintained for the near term and the long term;
b) A map of the area subject to the IMP;
c) One or more groundwater controls;
d) One or more surface water controls; and
e) A monitoring plan.

Furthermore, the groundwater and surface water controls considered together and with any applicable incentive programs, are required to meet the following conditions (from subsection 4):

a) They must be consistent with the goals and objectives of the plan;
b) They must ensure that the state will remain in compliance with an interstate compact, decree, or agreement, or any other applicable state or federal law; and
c) They must protect the existing uses (at the time of the preliminary determination of fully appropriated) of surface water or groundwater uses dependent on streamflow for recharge from streamflow depletions that result from new uses of surface water or groundwater.

A final provision of *Neb. Rev. Stat.* § 46-715 that is applicable in the Republican River Basin is subsection 6, which requires an annual forecast of water available from streamflow. The annual forecast is required in any basin that is fully appropriated or overappropriated whenever necessary to ***ensure*** that the state is in compliance with an interstate compact, decree, or agreement. This provision was added to the Act after LB 962 as part of LB 701 in 2007. The DNR has conducted this annual forecast for the Republican River Basin every year since the first forecast was required by January 1, 2008. While this is not specifically required to be in the IMP, the process and procedures for conducting this annual

forecast are contained in the Republican River Basin IMPs. This will be discussed further below.

B.1.3 The Process for Developing an Integrated Management Plan

The process for developing and implementing an IMP is addressed in *Neb. Rev. Stat.* § 46-717 through 46-719. To begin, the DNR and the NRD(s) are required to utilize the best available science and other data. Futhermore, any existing rules and regulations that are in effect within all or portions of a fully appropriated basin must be considered. The DNR and the NRD(s) are each required to specify by rule and regulations the types of scientific data and other information that will be utilized in the development of an IMP.

During the process of developing an IMP, the DNR and NRDs are also required to consult with stakeholders and to hold public meetings or obtain public comments through some means. Certain stakeholders, such as irrigation districts or municipalities that rely on water from the fully appropriated stream, must be consulted, while the DNR and NRD(s) may also consult with any other stakeholders it deems necessary. Such consultation typically involves seeking the input of stakeholders on the goals and objectives of the IMP, as well as the regulatory and non-regulatory options for achieving those goals and objectives.

Once the DNR and the NRD(s) have reached agreement on the goals and objectives, the geographic area, and the controls and other non-regulatory action items in the IMP, they are required to hold one or more public hearings to receive testimony on the proposed plans. After considering the testimony received at such hearings, the DNR and the NRDs must jointly decide whether to implement the proposed plan (with or without modifications). In order to implement the IMP, the DNR and the NRD(s) adopt the plan through orders issued individually by each entity. The DNR order must also adopt the surface water controls within the IMP. The NRD order must also designate a groundwater management area for integrated management and adopt the groundwater controls in the IMP. The controls adopted by the DNR are implemented through existing statutory and other authorities (such as the Compact or the FSS). The controls adopted by the NRDs are implemented through their individual rules and regulations, which may require changes in order to be consistent with those IMP controls.

If the DNR and the NRD(s) cannot reach agreement on the contents of an IMP (either the initial IMP or a proposed revision), the matter is referred to an Interrelated Water Review Board (IWRB). The IWRB considers the proposed IMPs from the DNR and the NRD(s), holds hearing on those proposed plans, and then determines which of the proposed plans to adopt. The plan adopted by the IWRB must meet all of the criteria of *Neb. Rev. Stat.* § 46-715; those criteria are summarized in Section A.1.2 above. The DNR is required to implement and

enforce the surface water controls adopted by the IWRB. The NRD(s) is required to implement and enforce the groundwater controls adopted by the IWRB.

B.1.4 Surface Water and Groundwater Controls Authorized by Nebraska Statute

The DNR regulates and administers surface water throughout the State of Nebraska under its statutory authorities, many of which date back to the early 20th century. In addition to these pre-existing authorities, LB 962 identified several new or expanded authorities that may be implemented by the DNR through an IMP. These are contained in *Neb. Rev. Stat.* § 46-716, and include:

a) Increased monitoring and enforcement of surface water diversions;
b) A prohibition or limitation on new surface water uses;
c) The requirement of additional conservation measures; and
d) Any other reasonable restrictions on surface water use which are consistent with the requirements for an IMP.

NRDs have regulated groundwater, initially focused on addressing potential aquifer decline issues, since the 1970's. The Act allows an NRD to designate all or a portion of the district as a ground water management area to address ground water declines. Such a designation gives the NRD the authority to regulate ground water use for quality and quantity issues. NRDs can exercise the following control mechanisms (generally from *Neb. Rev. Stat.* § 46-739):

a) Allocating the amount of ground water that may be withdrawn by ground water users;
b) Implementing a system for rotating ground water use,
c) Adopting more restrictive well-spacing requirements;
d) Requiring well meters to measure ground water use;
e) Mandating reductions in irrigated acres;
f) Requiring the use of best management practices;
g) Requiring water quality monitoring;
h) Implementing a moratorium on the construction of new wells; and
i) Promulgating rules or regulations necessary to carry out the purposes of the management area.

Generally, the rules and regulations adopted for a groundwater management area are intended to be uniform. However, a NRD may adopt different controls for different categories of groundwater use or for portions of the management area that differ from each other due to varying climatic, hydrologic, geologic, or soil conditions. Most notably, for IMP purposes, a NRD may adopt different controls

for wells with different hydrologic relationships between groundwater and surface water. A district may also adopt different controls for uses begun after a groundwater management area is designated for the purpose of integrated management.

APPENDIX C. Republican River Basin Integrated Management Plans

The IMPs for the Republican River Basin address all of the requirements of the Act. Most importantly, they have been specifically designed to ensure that Nebraska remains in compliance with the Compact and the FSS. Accordingly, many of the provisions of the FSS are incorporated into these IMPs and the Compact Accounting is central to the monitoring plans in the IMPs.

These IMPs were jointly developed by the DNR and the three primary NRDs in the Basin. These NRDs are the Upper Republican (URNRD), Middle Republican (MRNRD), and the Lower Republican (LRNRD) NRDs. The IMPs became effective on November 1, 2010 (URNRD and MRNRD) and October 1, 2011 (LRNRD). These IMPs contain surface and groundwater controls that, in combination with the other mechanisms of the IMPs, will ensure that Nebraska will remain in compliance with the Compact and FSS in the future. The IMPs for the three Republican River Basin NRDs are largely identical in their organization and function. Therefore, they can be generally summarized, with details on any specific differences.

C.1 Goals and Objectives

The goals of the IMPs for the three Republican River Basin NRDs are largely similar, though several minor differences exist. They can be generally summarized by the following list, with the appropriate NRD IMP(s) noted after each goal (exact language varies but the general intent is reflected here):

1) In cooperation with the other basin NRDs and the Nebraska Department of Natural Resources, maintain compliance with the Compact as adopted in 1943 and as implemented in accordance with the FSS approved by the United States Supreme Court on May 19, 2003 (URNRD, MRNRD);

2) Ensure that groundwater and surface water users within the NRD assume their share, but only their share, of the responsibility to keep Nebraska in compliance with the Compact (URNRD, MRNRD, LRNRD);

3) Provide the NRD's share of compliance responsibility and impact be apportioned within the NRD in an equitable manner and to the extent possible, minimize the adverse economic, social and environmental consequences arising from compliance activities (URNRD, MRNRD, LRNRD);

4) Protect groundwater users whose water wells are dependent on recharge from the river or stream and the surface water appropriators on such river or stream from stream flow depletions caused by surface water uses and

groundwater uses begun after the date the river basin was designated as fully appropriated (URNRD, MRNRD);

5) Reserve any stream flow available from regulation, incentive programs, and purchased or leased surface water and groundwater required to maintain Compact compliance from any use that would negate the benefit of such regulations or programs, to the extent allowed by statute and the surface water controls of this IMP (URNRD, MRNRD); and

6) To sustain a balance between the water uses and water supplies within the NRD so that the economic viability, social and environmental health, safety, and welfare of the NRD can be achieved and maintained for both the near term and the long term (LRNRD).

As such, the objectives laid out in the plans to achieve these goals are also largely similar. They can be generally summarized by the following list, with the appropriate NRD IMP(s) noted after each goal (exact language varies but the general intent is reflected here):

1) Prevent the initiation of new or expanded uses of water, with limited exceptions, that increase Nebraska's computed beneficial consumptive use of water within the NRD, as required for Compact compliance and by Nebraska law (URNRD, MRNRD, LRNRD);

2) Ensure that administration of surface water appropriations in the Basin is in accordance with the Compact and Nebraska law and the surface water controls of this IMP (URNRD, MRNRD, LRNRD);

3) Reduce existing groundwater use within the NRD by 20% from the 1998-2002 baseline pumping volumes under average precipitation conditions (URNRD, MRNRD);

4) Achieve the required reductions in water use through a combination of regulatory and incentive programs designed to reduce beneficial consumptive use (URNRD, MRNRD, LRNRD);

5) Maintain, on average the NRD net depletions at or below a specified percentage of the allowable groundwater depletions (URNRD 44%, MRNRD 30%, LRNRD 26%);

6) After taking into account any reduction in beneficial consumptive use achieved through district or basin-wide supplemental projects and other projects developed at the basin or district level, make additional reductions in groundwater use in Compact Call years as are necessary to achieve a reduction in beneficial consumptive use in the NRD to a specified

percentage of Nebraska's allowable groundwater depletions to stream flow in such years (URNRD 44%, MRNRD 30%, LRNRD 26%);

7) The NRD and the DNR will investigate or explore methods to manage the impact of vegetative growth on stream flow (URNRD, MRNRD);

8) Develop a program to provide offsets for new consumptive uses of water so that economic development in the district may continue without producing an overall increase in groundwater depletions as a result of new uses (URNRD, MRNRD); and

9) The NRD and the DNR will continue to investigate and explore augmentation projects that would add to or retime the water supply within the basin (LRNRD).

C.2 Groundwater Controls

The groundwater controls included in the three IMPs are generally separated into two groups; the compliance standards, and other controls. The compliance standards provide further definition and clarification to objectives 3 and 5 above. These are similar in the three NRDs, with the exception that the allowable groundwater depletion assigned to each NRD is not the same. These values are based on the average groundwater depletion caused by each NRD during the period 1998-2002 and are 26% for the LRNRD, 30% for the MRNRD, and 44% for the URNRD. The other controls outside of the compliance standards are somewhat variable, with some common themes. These are designed to meet other objectives above that require groundwater regulations.

C.2.1 Compliance Standards

The intent of the compliance standards in the groundwater controls of these IMPs is to set general rules for each NRD. While these compliance standards are required to be met, the specific regulatory and non-regulatory programs implemented by each NRD can then be tailored to the preferred local approaches. The compliance standards have two forms; 1) a limit on average total groundwater pumping in the NRD, and 2) a limit on the average groundwater depletions caused by each NRD. These are discussed in turn.

The DNR and the NRDs have recognized that overall groundwater use in the basin must remain at or below some managed level. While water use will be variable from year to year based on climatic conditions and other factors, on average, these uses must remain within some defined limit. The primary reason for this is to keep the groundwater depletions relatively stable over time (i.e., non-increasing). Whereas it is not reasonable, realistic, or prudent to attempt to predict how groundwater depletions might change over forty, fifty, or sixty years or more,

we can look back at the recent past and attempt to look forward over the next decade or so to determine the trend of groundwater depletions over this time frame. Through this process, the DNR and the NRDs determined that pumping volumes of approximately 800,000 to 900,000 acre-feet on average should keep Nebraska's groundwater depletions from increasing significantly over this time period (i.e., the next decade or so).

In order to equitably divide this groundwater pumping volume among the three NRDs, a baseline period was established so that uniform percentage reductions could be made to pumping during those periods to achieve the above values. The period chosen was 1998-2002 as these are the five years leading up to the adoption of the FSS. The average pumping volumes during this period were 531,763 acre-feet, 309,479 acre-feet, and 242,289 acre-feet for the URNRD, MRNRD, and LRNRD, respectively. The variability between the NRDs is primarily due to the number of irrigated acres, climatic variability, and regulations in place during that time period. These values yield a total pumping volume of 1,083,531 acre-feet. Therefore, a reduction of 20% from the baseline pumping volumes for each NRD would yield a value of 866,825 acre-feet of total average pumping and a reduction of 25% would yield a value of 812,648 acre-feet. The compliance standards in the three IMPs require that the average pumping be 20% less that the baseline period immediately, and that a reduction of 25% from the baseline period be in place by 2015. As noted in the IMPs, at that time, the NRDs and the DNR would evaluate whether the 25% reduction is currently sufficient, or if continued reductions are warranted. This type of evaluation would continue indefinitely so that continued reductions could be made over time, as needed, in order to keep the groundwater depletions from increasing significantly into the future.

The second part of the compliance standards in the IMPs is more significant than the pumping limitations discussed above. This is the requirement that each NRD keep its average[31] groundwater depletions within the allowable groundwater depletions for that NRD. The allowable groundwater depletions for all three NRDs are computed by the following formula:

Allowable groundwater depletions = Nebraska Allocation + Imported Water Supply (IWS) Credit - Surface Water Computed Beneficial Consumptive Use (CBCU) - Other Groundwater Depletions

Nebraska's allocation is determined by Compact Accounting and the IWS Credit is determined by the RRCA groundwater model. The surface water CBCU includes all reductions in stream flow resulting from surface water irrigation (e.g., consumption by crops, evaporation from reservoirs). The other groundwater

[31] The averaging periods for this are the same as the currently applicable averaging periods for Compact administration, typically a two-year or five-year average.

depletions are the depletions caused by groundwater pumping outside of the URNRD, MRNRD, and the LRNRD (currently representing 5-7% of total groundwater depletions).

Once the total allowable groundwater depletions are known, the allowable groundwater depletions for each NRD can be computed. This is done by multiplying a set percentage for each NRD by the total allowable groundwater depletions. As noted in the IMP objectives above, these percentages are 44% for the URNRD, 30% for the MRNRD, and 26% for the LRNRD. For every year, the allowable groundwater depletions for each NRD are compared to the actual depletions caused by groundwater use in that NRD. Every NRD is required to maintain their actual depletions at or less than their allowable depletions, given the applicable averaging period then in place. This limitation exists even if Nebraska's total use is significantly less than its total allocation. If an NRD was not meeting this compliance standard at any time, there would be additional adjustments in total groundwater pumping in that NRD.

C.2.2 Other Controls and Management Activities

This section describes the basic controls for compliance with the Act, the Compact, and the FSS, such as moratoria, transfer provisions, and well-metering requirements. This section also describes the controls for management in a Compact Call year. A Compact Call year is designated pursuant to the monitoring plan of the IMPs, as discussed below. The controls included in the IMPs for implementation during a Compact Call year are 1) curtailment of groundwater pumping within the Rapid Response Region in each NRD; and 2) a one-year pumping allocation that would apply to the entire district and would limit groundwater use from each well regardless of any carry-over allocation from previous years.

The Rapid Response Region[32] has a different hydrologic relationship between surface water and groundwater than the rest of the Basin. In this area, a groundwater well will deplete the stream flow by at least 10% of the volume that the well pumps over a two-year period. Outside of this area, a well will have less than a 10% depletive effect over a two-year period. The extent of this area was determined using the RRCA Groundwater Model (Model). In the Model, the aquifer is divided into one-square-mile units called Model cells. All groundwater wells that fall within a given Model cell are treated the same in the Model. Therefore, understanding the effect of any well in that Model cell is sufficient to understand the effect of all wells that fall within that cell in terms of Model results; this is what is important within Compact accounting.

[32] For maps see URNRD, 2010, page 22; MRNRD, 2010, page 25; LRNRD, 2011, page 22.

Establishing the Rapid Response Region simply involved testing the effect of a hypothetical well within every cell of the Model. First, a baseline condition is established. Then, a well is added to a Model cell and the difference in stream baseflow produced by the Model is the effect of a well within that Model cell. For example, assume that stream baseflow in the Model is 100 acre-feet per year (without the addition of a well in some Model cell). Over a two-year period, this would translate to 200 acre-feet of stream baseflow. Now, if a well that pumped fifty acre-feet per year (or 100 acre-feet over two years) were added to that Model cell, the stream baseflow over the same two-year period might be reduced to 180 acre-feet. Therefore, the volume pumped over the two-year period is 100 acre-feet, and the stream depletion over the two-year period is twenty acre-feet. The depletive effect of a well in that Model cell is then calculated as twenty acre-feet divided by 100 acre-feet, or 20% of the volume pumped over a two-year period. This Model cell would then fall within the Rapid Response Region, because it has a greater than 10% depletive effect over two years).

A complicating effect of developing these relationships with the Model is the non-linear response generated by the Model, particularly in the presence of stream drying. When a stream in the Model has become dry (or is intermittently dry), stream depletions from the hypothetical well do not occur. The future condition of the stream is inherently uncertain, as future climate and additional management actions that will be taken are not currently known. The potential spatial variability of these factors makes the situation much more complicated. In order to address this issue, the Model was tested against two future baseline conditions. The first scenario assumes that all past groundwater use occurred, and that groundwater use will continue at currently mandated levels. The second assumes that no past groundwater use occurred, and no future groundwater use will occur. The first scenario represents a hypothetical "worst-case" scenario; the second scenario provides the opposite view. The likely condition in the future will be somewhere in between, though exactly where is not known. Therefore, a simple average of the two scenario results was utilized. In other words, the depletive effect in a cell was determined under both future scenarios and averaged. If that average value was 10% or greater, that Model cell was included in the Rapid Response Region. A final conservative adjustment was made to increase the size of the Rapid Response Region, so that all Model cells that contained a stream that was downstream of any other areas in the Rapid Response Region, were also included.

C.3 Surface Water Controls

The surface water controls of the IMPs include provisions required by the FSS and other provisions required to meet this intent of the Act and the IMPs' goals and objectives. They are very similar between the three IMPs, as summarized below.

1) Courtland Canal and Kanas Bostwick Irrigation District (KBID):

    a. Nebraska will recognize a priority date of February 26, 1948, for KBID;

    b. When the irrigation supply in Harlan County Lake is less than 130,000 acre-feet, Nebraska will close appropriators junior to that priority date;

    c. Storage water released from Harlan County Lake for delivery at Guide Rock (the point of diversion for the Courtland Canal) will be protected by Nebraska; and

    d. Nebraska will work with Kansas and the United States to minimize the amount of water that flows past Guide Rock.

2) Metering of surface water diversions:

    a. All surface water diversions are required to be metered at the point of diversion;

    b. Non-federal surface water canals will be metered at the point of delivery to the farm;

    c. Meters must meet DNR standards for installation, accuracy, and maintenance; and

    d. All appropriators will be closely monitored to ensure their diversions do not exceed permitted amounts.

3) A moratorium on new surface water permits;

4) Surface water transfers are subject to current Nebraska Statutes and DNR rules;

5) The DNR completed an adjudication of surface water rights in 2004 and will be proactive in adjudicating other water rights going forward;

6) Compact Call Year provisions, which are described further below.

Most of these controls are straightforward and have been included in the IMPs since the original plans were completed in 2005. The Compact Call Year provisions were added in the last revision to the IMPs and warrant additional explanation. The process for determining if the upcoming year will be a Compact Call Year, including the amount of water that would be administered under this provision, is included in the Monitoring Section and will be explained further below. Essentially, if a year is determined to be a Compact Call Year, the DNR

will issue closing notices to all surface water appropriators that divert natural flow, including the diversion of flows into a reservoir for storage. The appropriations for the use of water previously stored will not be closed. This water use has been factored into the calculations, as will be seen below and is therefore not problematic. Furthermore, the return flows from the use of previously stored water can be an important source of the water supply for Kansas in these years.

Although Harlan County Lake will not be allowed to divert water into storage under their appropriation, it is also understood that the reregulation of inflows between January and the beginning of the irrigation season is important for the efficient use of Kansas' Compact allocations. Therefore, Nebraska will allow the U.S. Bureau of Reclamation (USBR) to hold back inflows to Harlan County Lake temporarily during a Compact Call Year, in order to deliver that water to Kansas during the irrigation season when it can be beneficially used. A further benefit to this type of operation is that the consensus plan (Appendix K of the FSS) should function as it normally would with regard to the computations completed by the USBR that determine the water supply available in Harlan County Lake, an important trigger in Compact accounting. The USBR would be expected to release all water held in Harlan County Lake while under a closing notice during the same year. The water supply to the KBID would therefore be their portion of any previously stored waters (i.e., before the determination of a Compact Call Year), as well as any retained in Harlan County Lake while it is closed for the Compact Call Year.

Administration in a Compact Call Year is for a volume of water that is needed at either Guide Rock or Hardy, depending on the type of Compact Call administration in effect. This administration would end when the water that has flowed into Kansas has equaled or exceeded the amount necessary to ensure that Nebraska will not overuse its allocation. In this case, the extent to which Kansas would receive its full allocation in such a year would then depend only on the extent to which the State of Colorado is in compliance with the Compact.

C.4 Augmentation and Incentive Programs

A key component of the IMPs is the implementation of augmentation and/or incentive programs in the Basin. This section of the IMP does not attempt to identify the specific programs that will be implemented; this is for several reasons. First, ongoing feasibility analyses will be relied on to implement the most cost effective programs available. Second, the nature and availability of incentive programs, particularly those available through the federal government, change on an ongoing basis as funding and federal priorities change. So, it is not practical to keep a planning document, which requires several months of due process for adoption, up-to-date on programs that can change from year to year. Rather, this section of the IMP describes general principles to be followed in the

implementation of augmentation or incentive programs. These programs are a key component of the IMPs, but the successful implementation of these programs is in no way relied upon for meeting the goal of ensuring Compact compliance. In other words, these programs have the potential to improve the potential for Compact compliance significantly without other regulatory actions (such as those implemented in a Compact Call Year), but in the absence of any successfully implemented augmentation or incentive programs, Nebraska will ensure Compact compliance solely through regulatory means.

A key piece of the successful implementation of augmentation or incentive programs is a funding source. Since the passage of LB962, Nebraska has taken several significant steps toward ensuring that funding is available for such programs in the Basin. The first was the establishment of a Conservation Reserve Enhancement (CREP) Program, which included federal funding of $158 million and matching state contributions of up to $5 million. This program has temporarily (10-15 year contracts) retired approximately 38,000 irrigated acres in the Basin, with the potential for enrollment of another 52,000 irrigated acres. Additionally, the three NRDs have each secured an Agricultural Water Enhancement Program (AWEP) grant from the federal government. The AWEP program also provides monetary incentives in exchange for the temporary or permanent retirement of irrigated acres. Other incentive programs have also been implemented or are being pursued.

The other significant accomplishment has been the establishment of a significant and steady funding source for these types of management activities. The Water Resources Cash Fund (Fund) was established as part of LB 701 in 2007. The Fund currently receives an annual appropriation of $3.3 million from the state's general fund. The DNR is also directed to apply for an additional $3.3 million per year in grant funding from the Nebraska Environmental Trust, with any such grant receiving fifty bonus points in the application scoring. While the Fund will also be expended in other fully and overappropriated basins (primarily the Platte Basin), there is the potential for up to $6.6 million per year of State funding for augmentation and incentive programs in the Basin.

The other significant funding source comes from a local occupation tax that is levied by each NRD. While the original version of this occupation tax, also included in LB 701 in 2007, was subject to an unsuccessful court challenge, the statutes were revised with LB 862 in 2010. These provisions have not been challenged, and they allow the NRD to charge up to $10 per irrigated acre per year as long as this intent is stated in the IMP. All three IMPs contain this provision and all three NRDs charged an occupation tax as part of their 2011-2012 annual budget.

A significant effort has gone into studies and investigations related to potential streamflow augmentation projects. These studies have progressively honed in on the more feasible types of and locations for projects. The general goal is to provide the greatest level of streamflow enhancement given the available funding. Nebraska recognizes that, in order to obtain certain accounting benefits from an augmentation program, the State of Kansas has to agree to the calculation of those benefits. While Kansas has yet to agree to any proposed augmentation plan, Nebraska will work diligently within the RRCA to get concurrence from both Kansas and Colorado.

This level of funding for water management related activities in the Basin has previously never been available. The legislature has stated its intent to provide annual appropriations of $3.3 million to the Fund through 2019, and the additional $3.3 million from the NET could be available at least over the next six years. The occupation tax levied by the NRD is available on an ongoing basis. This level of funding will clearly result in a significant amount of increased management activity going forward. In other words, this funding and these programs indicate that water management activities will clearly increase going forward, and the current management activities merely represent a starting place, not a constant condition that will persist for many decades.

C.5 Monitoring and Studies

The monitoring and studies section of the IMPs is the foundation for the ongoing and long-term planning based on constant evaluation of the past, current, and, to the extent practical, likely future conditions regarding Nebraska's water supplies and water uses in the Basin. This section of the plans begins:

The overarching purpose of the Monitoring and Studies Section is to ensure that, in cooperation with the other Republican River Basin NRDs, the DNR and URNRD maintain compliance with the Republican River Compact as adopted in 1943 and as implemented in accordance with the FSS approved by the United States Supreme Court on May 19, 2003. The objective of the Monitoring and Studies Section of this IMP is to gather and evaluate data, information, and methodologies that could be used to increase understanding of the surface water and hydrologically connected ground water system; to test the validity of the conclusions and information upon which this IMP is based; and to assist decision makers in properly managing the water resources within the URNRD and the Republican River Basin as a whole.

A key component of the monitoring plan is communication (both regularly scheduled and as needed) between the DNR and the NRDs. This communication generally takes one of two forms, 1) face-to-face meetings, and 2) exchange of

data and information. A summary of regularly scheduled events is provided in Table C1.

Table C1. Important Dates and Objectives (from Table 1 of the IMPs – Monitoring and Studies Section

Date	Objective
Prior to February 1	URNRD will provide DNR with meter reading database and GIS coverage maps to be used for the RRCA annual Model update.
Prior to RRCA Annual Meeting	DNR will provide URNRD with their determination of whether the URNRD was in compliance with the compliance standards based on each previous year's annual Compact accounting.
September - October	Obtain power records and other estimates to determine pumping for T=0 ground water Model run.
Prior to October 31	Discuss results of monitoring and studies, preliminary accounting for current year, and early forecast of allowable stream flow depletions.
Prior to November 15	DNR will provide correspondence to URNRD notifying them of potential Compact Call Year determination for the coming year (T+1).
November 15 – January 1	URNRD and DNR will discuss potential management alternatives in the situation that the coming year (T+1) will be a Compact Call Year.
Prior to January 1	Provide final forecast of allowable stream flow depletions and determination of Compact Call Years.
Prior to January 31	URNRD will provide DNR with details regarding existing management alternatives in lieu of additional ground water regulations or controls to make up for the expected shortfall.

The first part of the monitoring section describes the tracking and reporting of water use information that the DNR and the NRD have agreed to implement. Generally, the NRD and the DNR both agree to exchange any and all information "necessary to determine Compact compliance." Among other things, this exchange facilitates the compilation and processing of data needed for the annual Compact accounting update performed by the RRCA in accordance with the FSS Accounting Procedures and Reporting Requirements.[33]

[33] Appendix C of the FSS, most recently revised by the RRCA on August 8, 2010.

The second part of the monitoring section contains the procedures for annually forecasting "the maximum amount of water that may be available from streamflow for beneficial use in the short term and long term", as required by *Neb. Rev. Stat.* § 46-715(6). The statutory use of the term "forecast" might seem to imply that this process should involve some procedure for predicting the climatic conditions (and resulting water supplies) that are expected in the future. Forecasting of near-term future climatic conditions would be possible; however any such prediction of longer-term future climatic conditions is inherently uncertain. Such uncertainty would be in direct conflict with the statutory mandate to ***ensure*** Compact compliance. For this reason, this forecast assumes very dry climatic conditions, and predicts the water supply that will be available under this very dry condition. The results of the forecast are combined with the recent results of Compact accounting to evaluate the need for additional management actions in the upcoming year.

The results of this process will, of course, match realistic conditions if the next year's climatic conditions are very dry. If conditions are more favorable, the forecast will underestimate water supplies available for use. If this dry forecast does indicate the need for additional management actions, then the IMPs already have in place stringent regulatory mechanisms that must be implemented preventatively, so that Nebraska does not fall out of compliance during the time in which dry conditions prevail. This raises the potential for over-regulation in the cases in which conditions turn out to be more favorable than anticipated, an unfortunate condition that results from the retrospective nature of the Compact Accounting; that is, because the Compact Accounting is performed after the fact, a non-compliance situation can be determined only after this outcome has actually occurred and after it could have been averted. ***In other words, in order to prevent this situation from arising, the forecasting methods and required management actions contained in the IMPs are purposely designed to place greater restrictions on Nebraska's use of Basin water supplies than the Compact and the FSS actually require.*** Following is a discussion of 1) the development and specific procedures used in the annual forecast, and 2) the application of the forecast results to determine the need for additional management actions in an upcoming year.

C.5.1 Forecast Procedures

There were several steps in the development of the forecast procedures contained in the IMPs. First, a simplified proxy for the fairly complicated process contained in the Accounting Procedures was developed. This was necessitated by the large number of variables in the Accounting Procedures, which can be combined into a small number of variables that represent the major elements of the Accounting Procedures. Next, a means of predicting the value for these major elements in an upcoming dry year was developed (the "calibration"). Finally, this

methodology was verified by applying it to past time periods outside of those used in the calibration to ensure the forecast would have been successful in all cases.

The Accounting Procedures ultimately calculate a value called the Computed Water Supply (CWS) for twelve separate sub-basins and the Mainstem based on approximately 250 different variables known as the input data. From this CWS value, an allocation is computed for each state for each sub-basin and the Mainstem (though some states do not receive an allocation from every sub-basin and the Mainstem). The sum of these allocations (and the IWS Credit in the case of Nebraska) is then compared to the total uses, termed computed beneficial consumptive use (CBCU), and the result of this comparison is then applied within the appropriate averaging period to determine Compact compliance. For a more detailed description of the Compact Accounting, see Schneider (2011).

In order to facilitate the forecasting of water supplies and uses in upcoming dry years, a simplified version of these Accounting Procedures was developed. The process requires the prediction of the eight major elements within Compact Accounting, and the result has been termed the Basin Water Supply (BWS). The eight major elements that are used are:

1) Surface Water CBCU in Nebraska,
2) Surface Water CBCU in Kansas,
3) Surface Water CBCU in Colorado,
4) Groundwater CBCU in Nebraska,
5) Groundwater CBCU in Kansas,
6) Groundwater CBCU in Colorado,
7) The IWS Credit, and
8) Streamflow at the Kansas-Nebraska state line.

Historic values for these major accounting elements are shown in Figure C1.

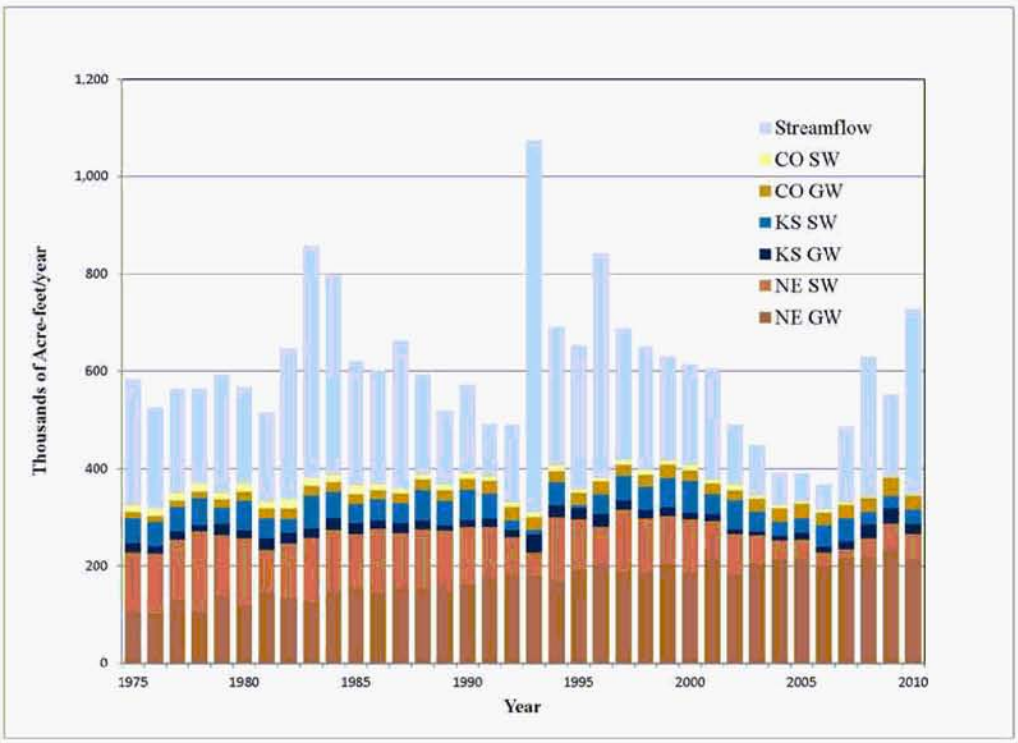

Figure C1. The Basin Water Supply, showing the breakdown by its major elements.

Nebraska's portion of the CWS is determined by fixed percentages which vary by sub-basin/Mainstem. As a result, the overall percentage of the total CWS that Nebraska receives in a given year is somewhat dependent on the relative origin of the water supplies. Under the original Compact values, Nebraska received an allocation equal to 49% of the total CWS. Analysis of the values for the BWS and actual historic Nebraska allocations indicated that Nebraska's allocation could be accurately predicted using a fixed percentage of the total BWS, equal to 50%. During 2005-2006, Nebraska received approximately 56% of the CWS as an allocation. The quality of the approximation of actual Compact Accounting results yielded from the BWS approach can be evaluated by comparing the ultimate outcome of such accounting under the two methods. This outcome is essentially the balance between Nebraska's water supply and its water use in any given year, and is obtained by the following formula:

Nebraska Annual Balance = Water Supply – Water Use

= (Allocation + IWS Credit) – (SWCBCU + GWCBCU)

Nebraska's historic water supply, using the allocation value derived from the BWS, is shown in Figure C2.

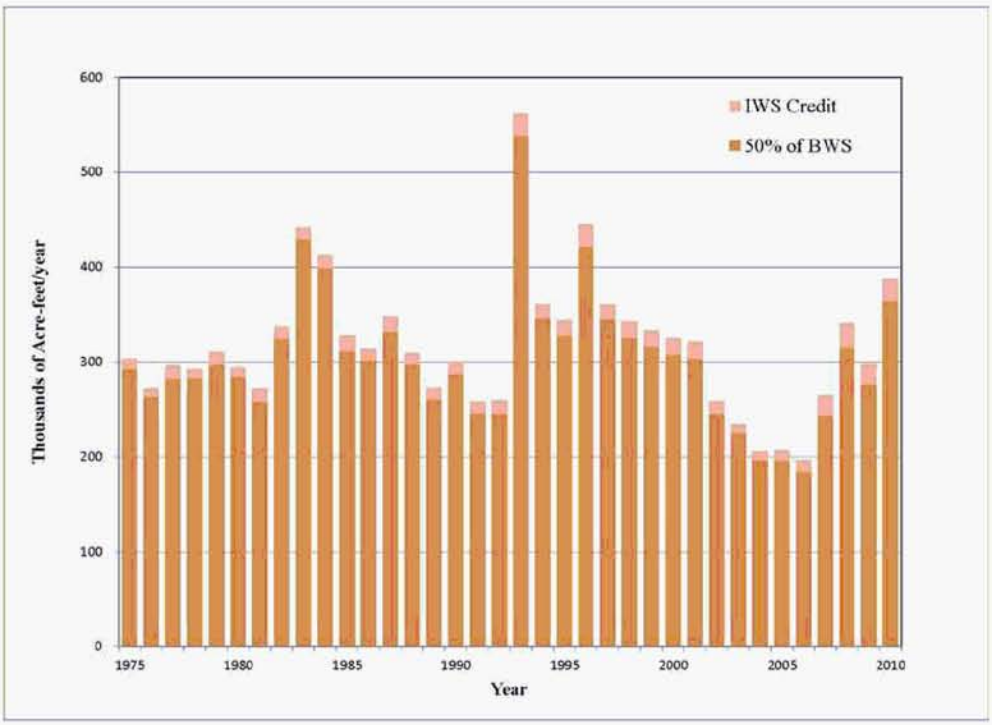

Figure C2. Nebraska's water supply.

Nebraska's historic water use, including the breakdown between surface water CBCU and groundwater CBCU, is shown in Figure C3.

Figure C3. Nebraska's water use.

Nebraska's total water supply and total water use are compared in Figure C4.

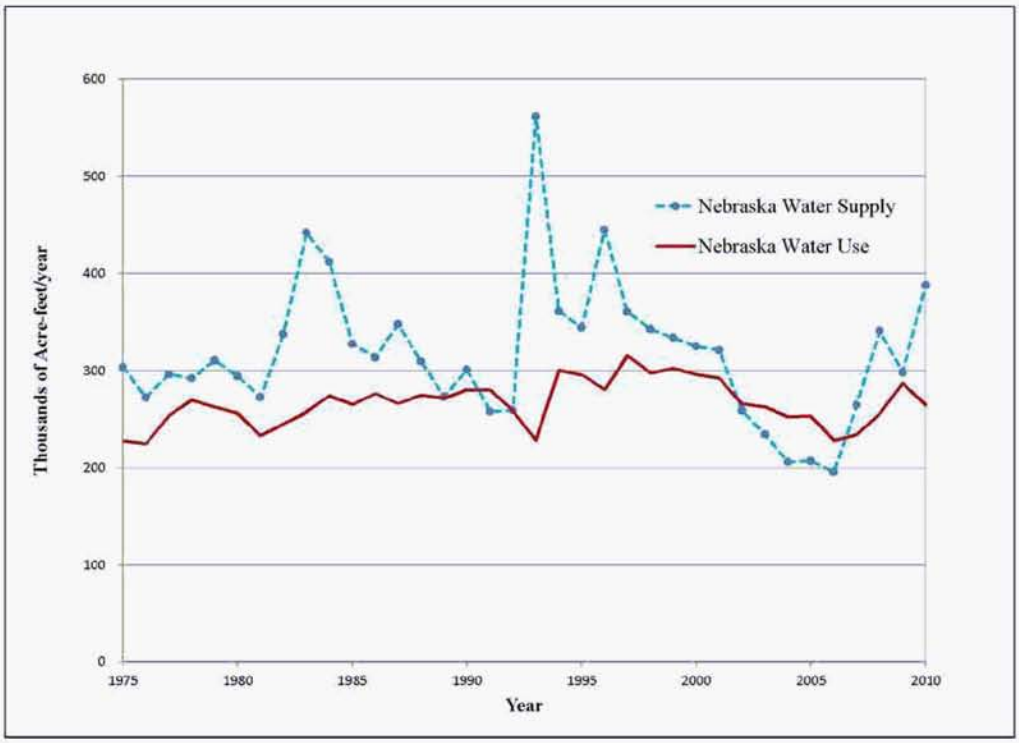

Figure C4. Nebraska's water supply and Nebraska's water use.

Nebraska's annual balance between water supplies and water uses is simply the difference between the two lines in Figure C4. Nebraska's annual balance will be positive when the water supply is greater than water use. Nebraska's annual balance will be negative when the water supply is less than water use. The result of this computation is shown in Figure C5.

Figure C5 also shows the values for Nebraska's annual balance obtained through current Compact Accounting and the CWS. Values for CWS only exist for the period of time beginning in 1995, as this method for Compact Accounting was implemented under the FSS and only applied to years without previously approved Compact Accounting. Prior to 1995, the RRCA approved Compact Accounting results that utilized a significantly different approach and are therefore not directly comparable to later results. The most significant differences include 1) the use of the RRCA Groundwater Model (Model) to compute the groundwater CBCU for each state, and 2) the proper inclusion of an IWS Credit for Nebraska. There is no benefit in matching annual Compact balances from before 1995 with the BWS approach, because that accounting process is no longer applicable. In fact, one advantage of the BWS approach is the ability to approximate Compact

Accounting results from before 1995 that are comparable to results from 1995 forward.

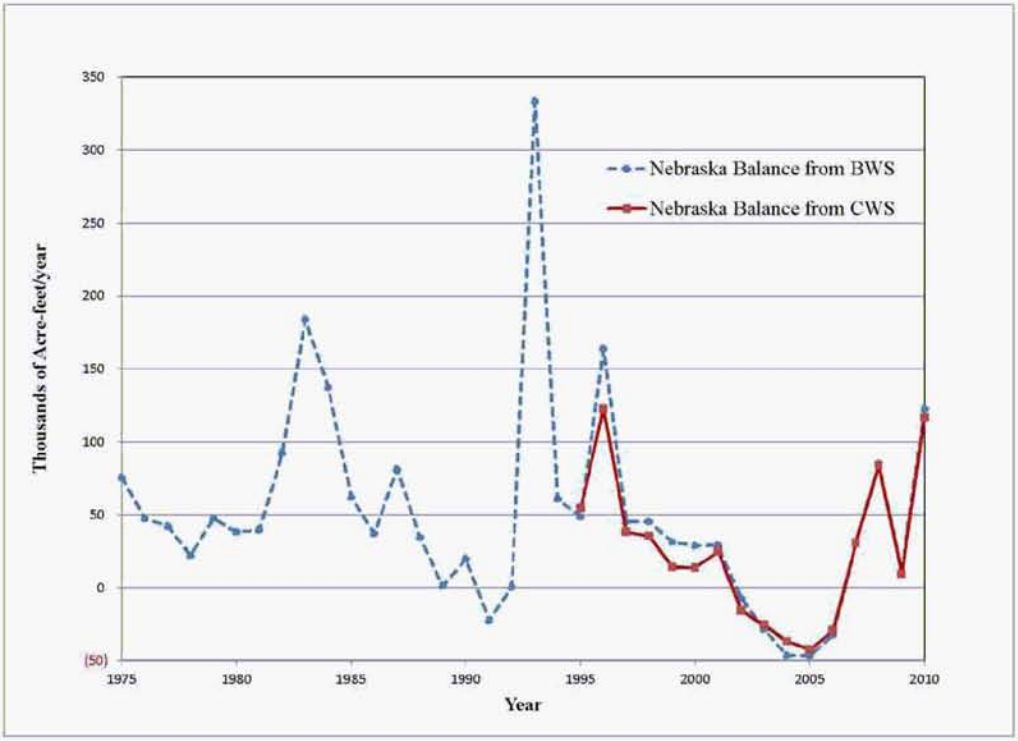

Figure C5. Comparison of Nebraska annual balance as determined using the BWS and the CWS.

The quality of the fit between Nebraska's annual balance derived from the BWS and that derived from the CWS is very good (Figure C5). It is also important to note that, during years when this annual balance is below zero, the BWS approach tends to yield a lower value than the result from the CWS. In other words, the BWS yields a conservative approximation in these critical years. The fit between the two lines can also be shown by a cross-plot of these data (Figure C6). Again, the fit is clearly very good; 97% of the variability in the two data sets is matched.

The BWS approach provides greater simplicity with little to no loss in accuracy of final results. The next step in developing the forecasting mechanism is an approach to predicting the value for the eight major elements that are required for this simplified approach. Recall that the forecast is only intended to accurately predict water supplies and water uses if the upcoming year is very dry. Figures C7 through C10 show the historic values for the groundwater CBCU, as determined by the Model, for Colorado, Kansas and Nebraska, and the IWS Credit.

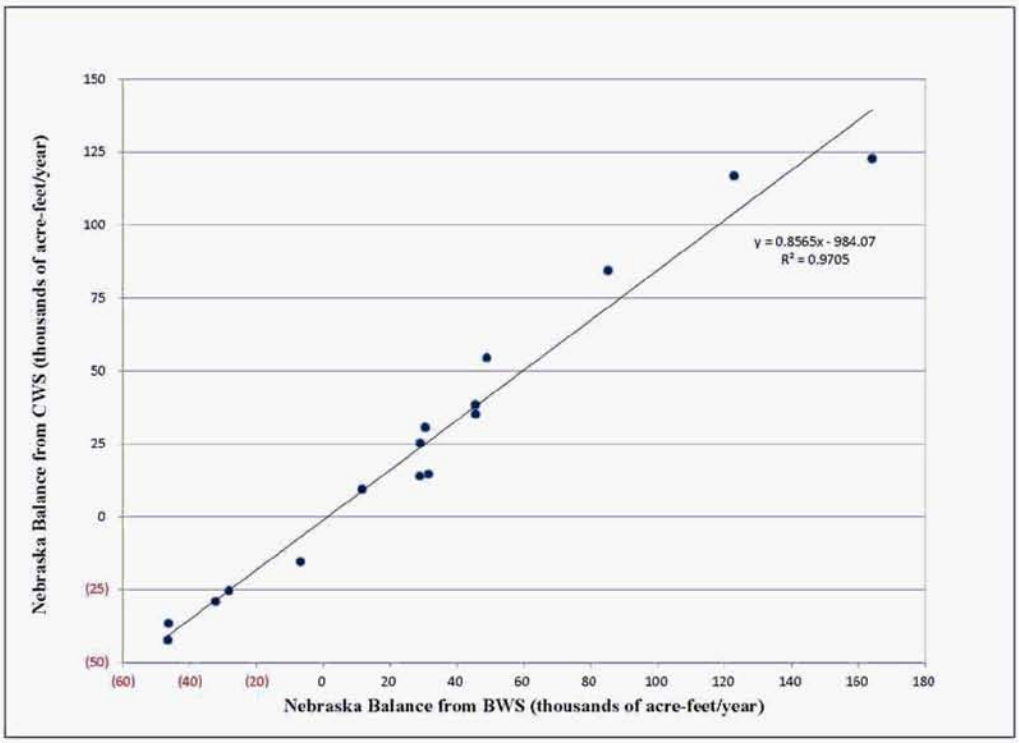

Figure C6. Cross-plot of annual value derived from the CWS versus the annual value derived from the BWS.

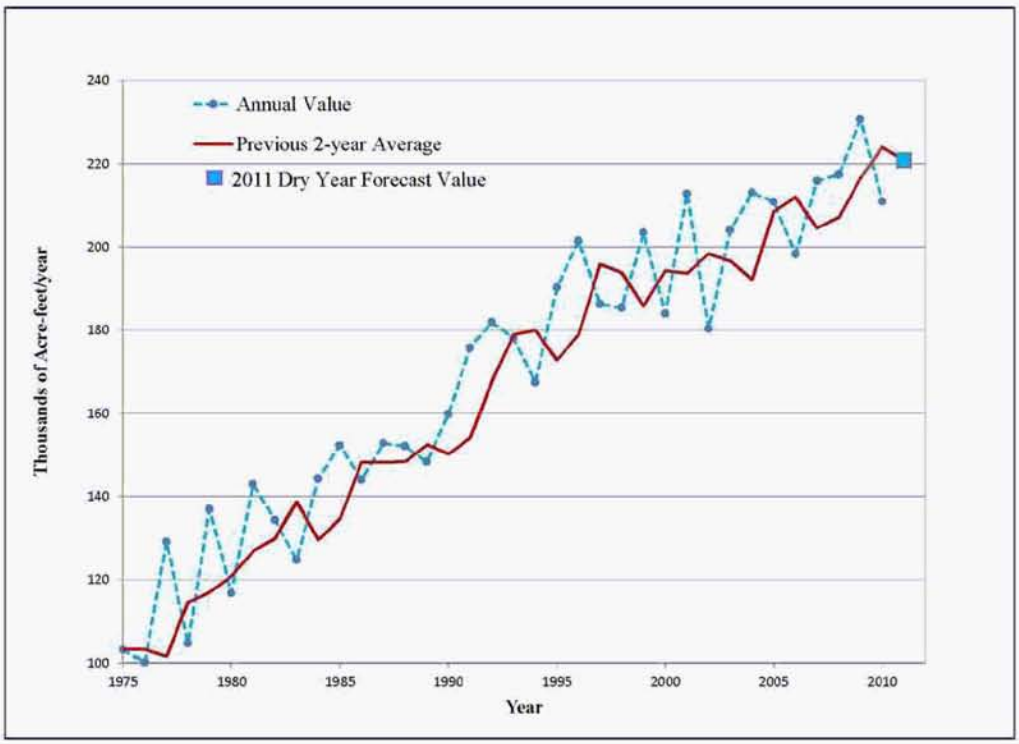

Figure C7. Nebraska groundwater CBCU.

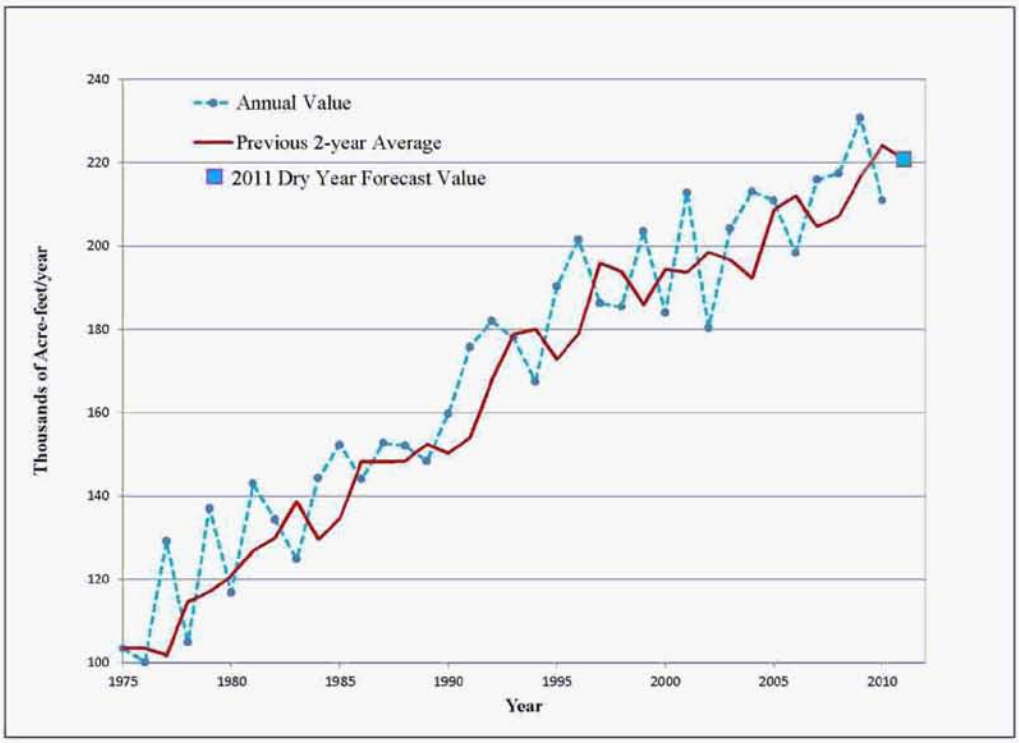

Figure C8. Kansas groundwater CBCU.

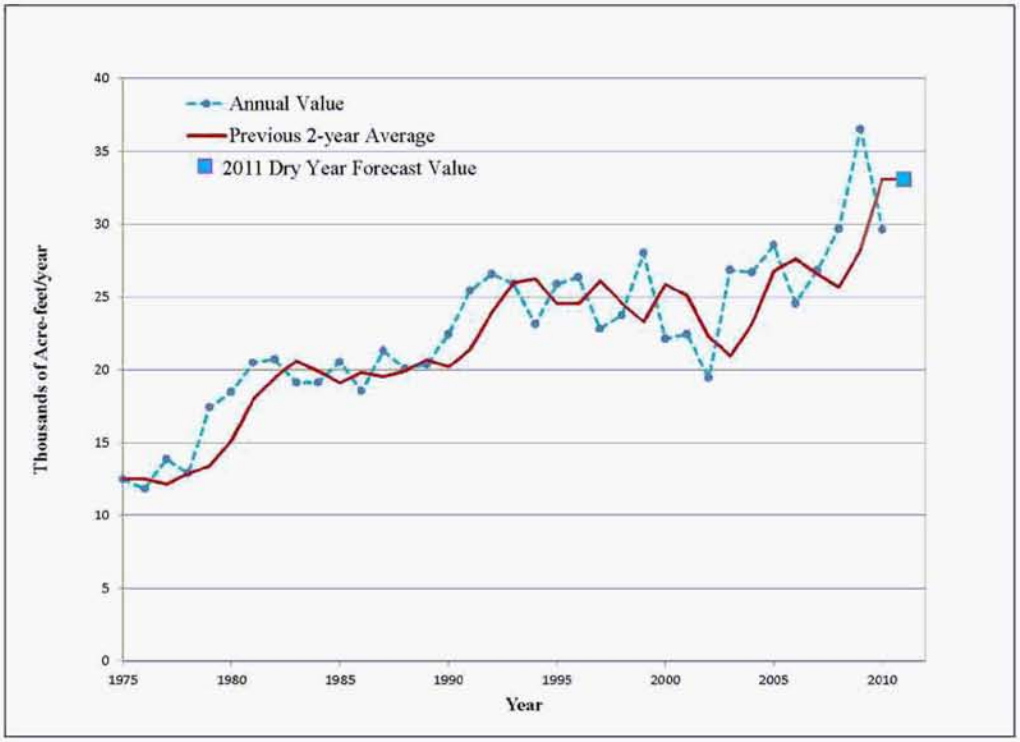

Figure C9. Colorado groundwater CBCU.

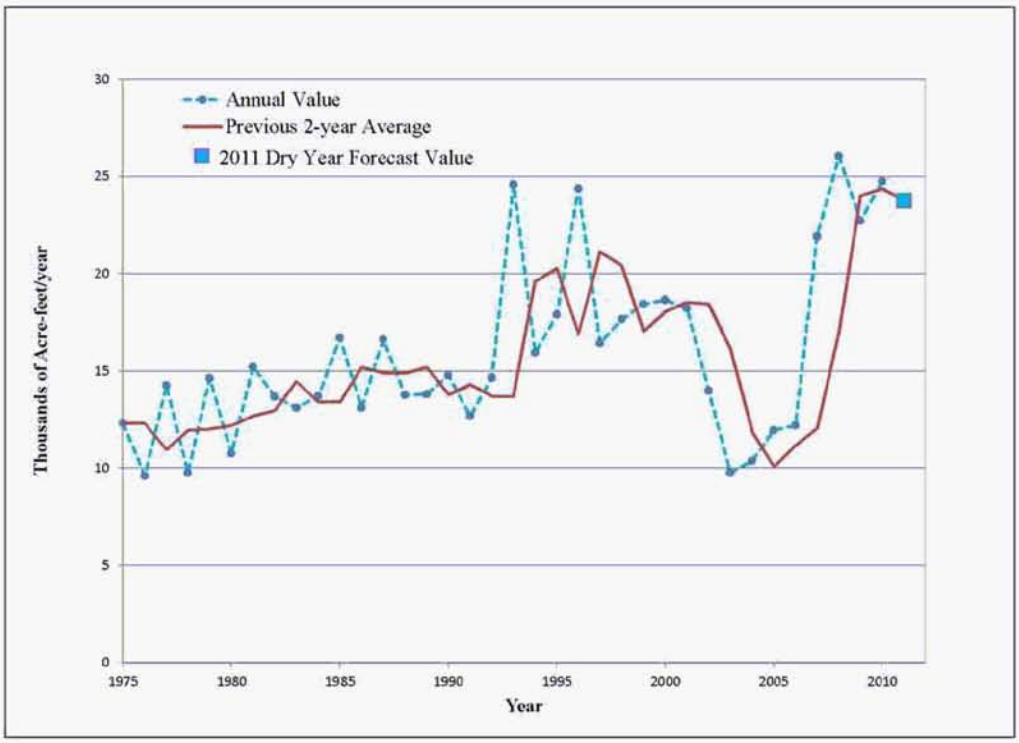

Figure C10. IWS Credit.

These figures show that, while groundwater CBCU and the IWS Credit do exhibit some long-term trends, the recent year's values are a reasonably accurate indicator of an upcoming years value. In other words, actual groundwater use in a given year has only a very small influence on the resulting groundwater CBCU for that year. Some short-term variability also exists, however, so the previous two-year average of the actual groundwater CBCU and the IWS Credit are used as the value for the upcoming year's forecasted value. The character of the surface water CBCU in Colorado is similar (Figure C11); here the previous two-year average is also used.

In contrast to the groundwater CBCU in Kansas and Nebraska, the surface water CBCU in Kansas and Nebraska has little relationship to previous year's values. The primary driving factor behind a year's surface water CBCU in Kansas and Nebraska is the available supply of surface water in storage (i.e., water available for irrigation from the USBR reservoirs in the Basin). When reservoirs are consistently full, surface water CBCU has little relationship with the available supply, but is instead driven somewhat more by the actual need for irrigation water during that growing season. Therefore, the recent period of 1999-2005, generally characterized by dry growing season conditions and/or low amounts of water available for irrigation, were analyzed for a useful predictive relationship between reservoir storage and actual surface water CBCU in that year.

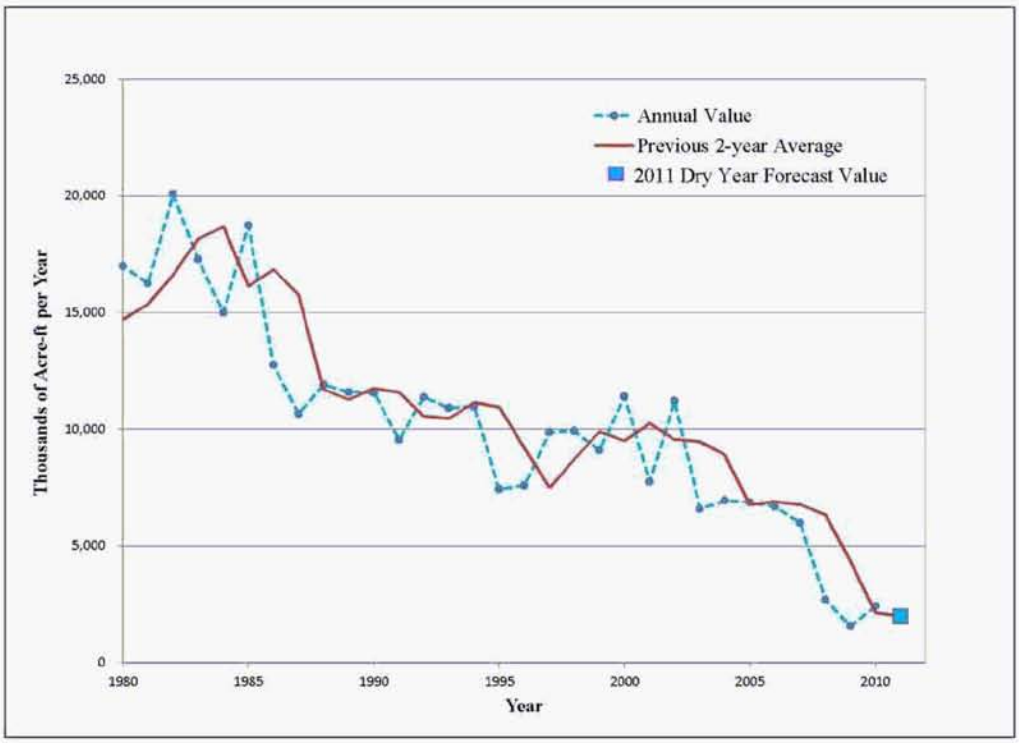

Figure C11. Colorado surface water CBCU.

Nebraska surface water irrigated areas are served by a total of five USBR reservoirs; Swanson Lake and Harlan County Lake on the Mainstem of the Republican River, Enders Reservoir on Frenchman Creek, Hugh Butler Lake on Red Willow Creek, and Harry Strunk Lake on Medicine Creek. Figure C12 shows a cross-plot of the total reservoir storage content in these five reservoirs, on January 1 of a given year, against the actual surface water CBCU in Nebraska during that year. Not surprisingly, the two variables are highly correlated, providing a very useful tool for predicting the surface water CBCU in Nebraska, during an upcoming dry year, based on the surface water in storage at the beginning of that year. This relationship is used in the forecast for the surface water CBCU in Nebraska.

The vast majority of the surface water CBCU in Kansas is associated with Harlan County Lake. Figure C13 shows a cross-plot of the total water content in Harlan County Lake on January 1 of a given year against the actual surface water CBCU in Kansas during that upcoming year. While not as strong as the relationship for surface water CBCU in Nebraska, a good relationship between the two does exist. This relationship is used in the forecast for the surface water CBCU in Kansas.

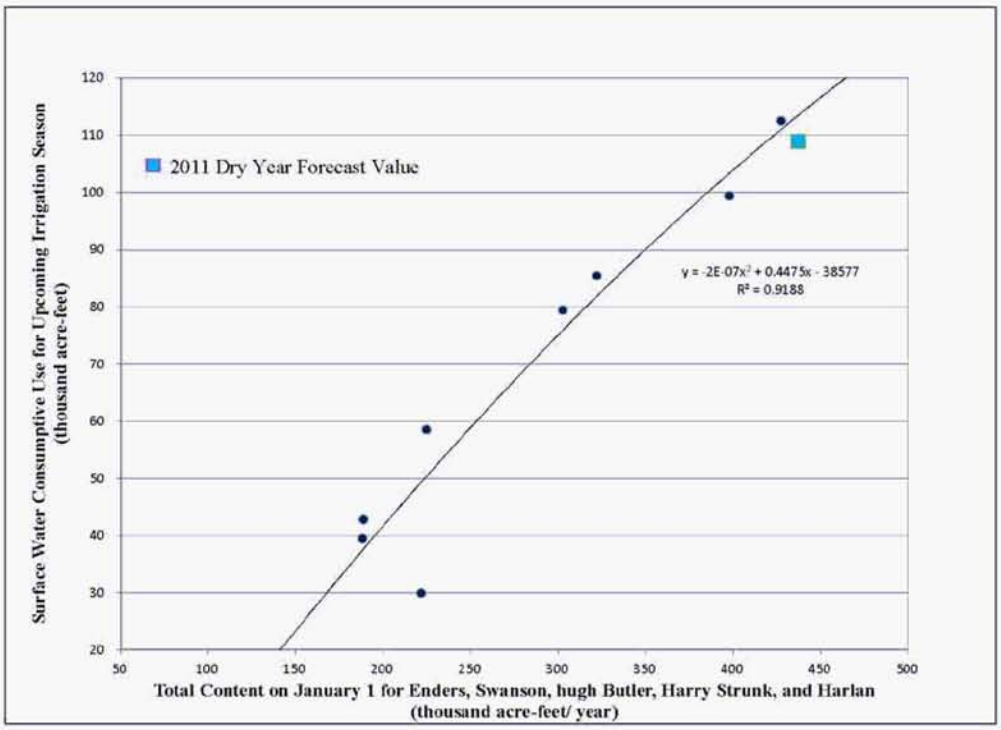

Figure C12. Relationship between reservoir content and Nebraska surface water CBCU.

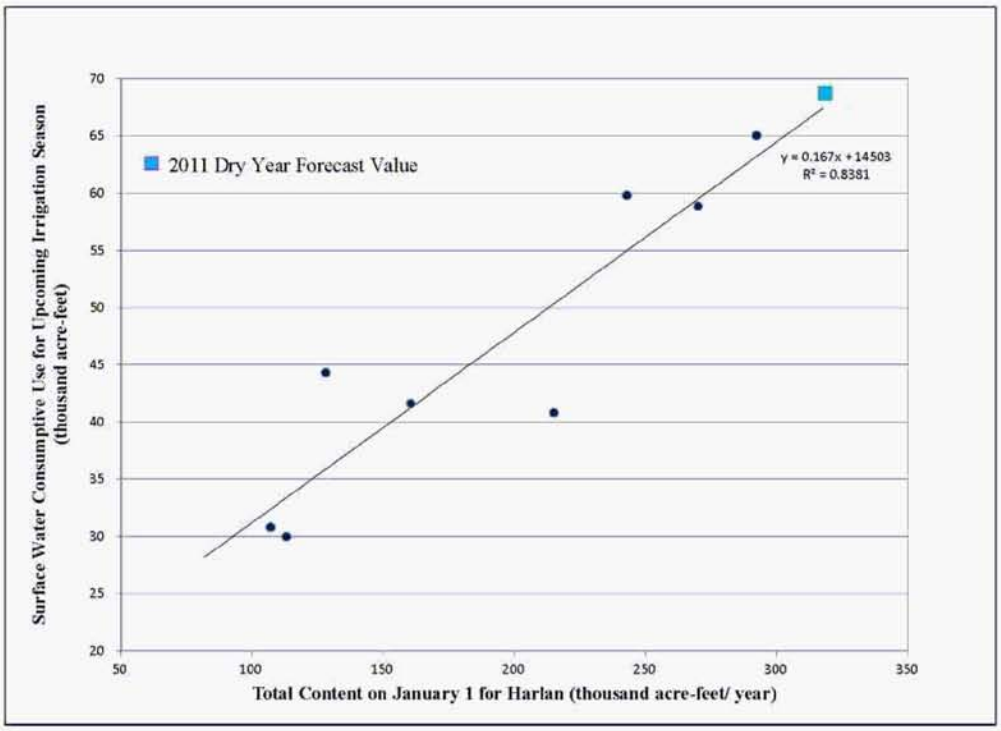

Figure C13. Relationship between Harlan County Lake content and Kansas surface water CBCU.

The final, and probably most critical, piece of the BWS is the streamflow. Hydrologic and operational features of the Republican River would indicate that the streamflow at the Nebraska-Kansas stateline in an upcoming dry year is likely to be well correlated with antecedent conditions, the storage in Harlan County Lake, or both. Antecedent conditions are important as streamflow tends to be driven by baseflow from the aquifer in dry years. The content of Harlan County Lake is important as dry conditions tend to drive demand for irrigation water from the Lake, and return flows from that irrigation are important contributions to streamflows in dry years.

Analysis of these variables during the period 2002-2006 revealed a strong, multi-linear correlation. The equation developed for the dry-year prediction of state line streaflow is:

Streamflow = (0.41 * A) + (0.23 * B) – 27,450

Where: A = the previous 5-year average stateline streamflow

B = the total content of Harlan County Lake on January 1

In other words, the stateline flow in an upcoming dry year is predicted to be 41% of the previous five year average streamflow plus 23% of the content of Harlan County Lake at the beginning of the year, minus 27,450 acre-feet. Figure C14 shows a comparison of the historical values for stateline streamflow with the result of this predicted dry-year streanflow for each year. First note the close match during 2002-2006, the period used to develop this relationship. Next, observe that this prediction underestimates state line streamflow in almost every previous year. The two values are only equal in about six of the driest previous years, and the predicted value is never significantly greater than the measured value. This is clearly a very conservative predictive tool for upcoming dry-year streamflow that is not likely to overestimate this value, but rather very likely to underestimate it.

All of these relationships have been developed for the entire Basin above Hardy, Nebraska. During water short years, the accounting is also completed for the basin above Guide Rock, Nebraska. Instead of redeveloping the BWS for the Basin above Guide Rock, a relationship between Nebraska's annual balance was developed using historical Compact accounting data from 1995-2008 (Figure C15).

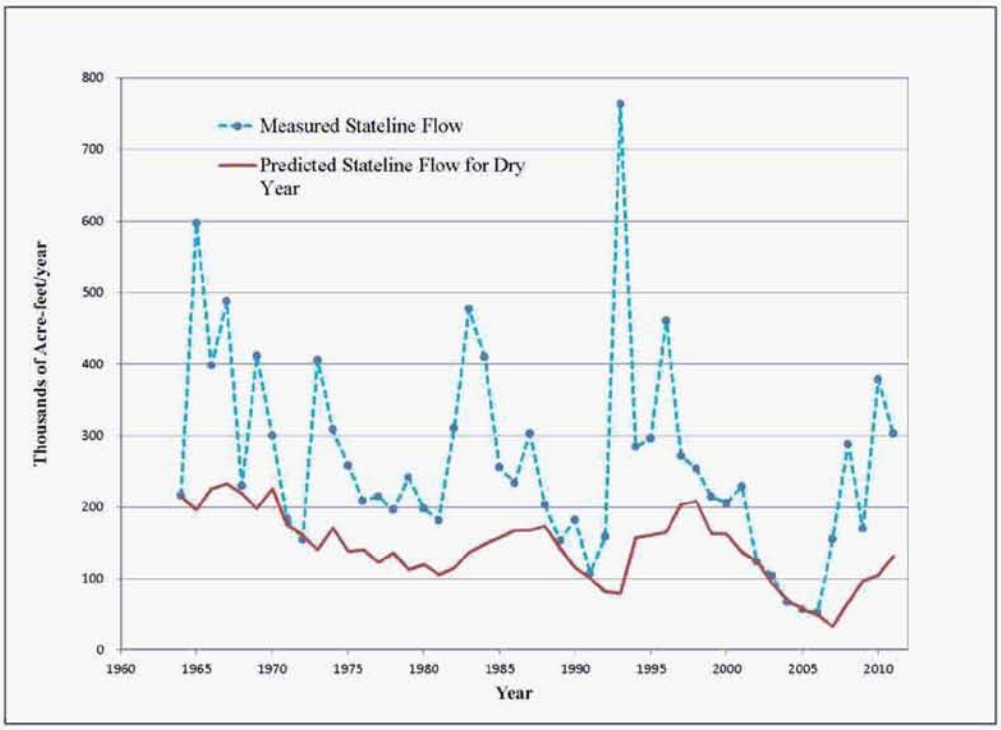

Figure C14. Comparison of measured stateline streamflows and the dry year predicted value.

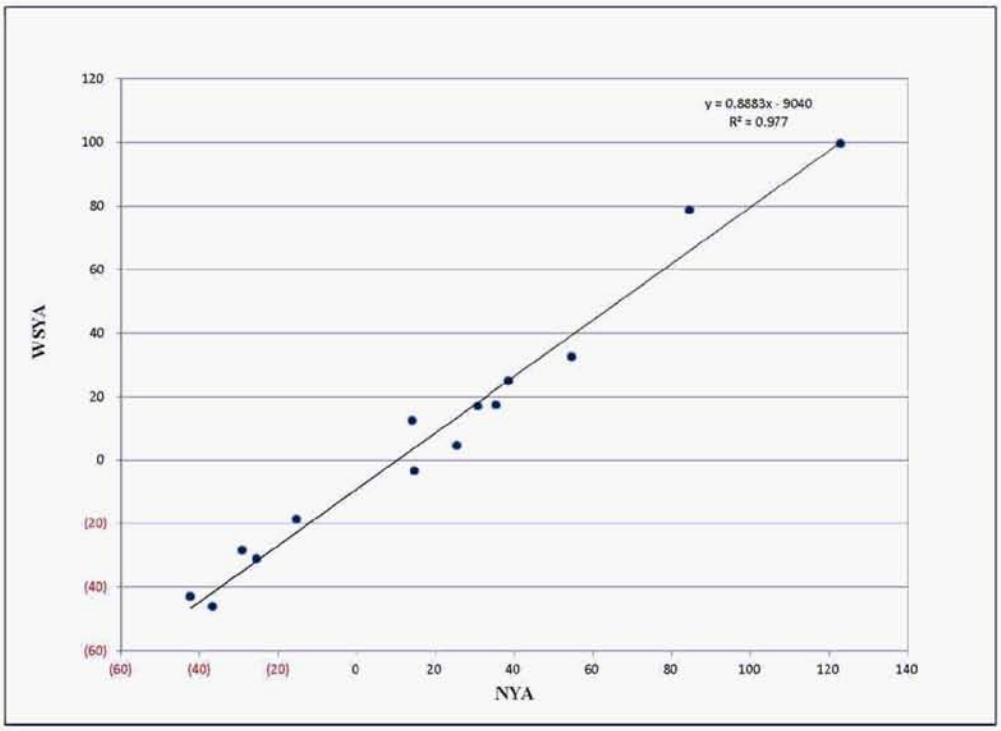

Figure C15. The relationship between Nebraska's annual balance above Hardy and Nebraska's annual balance above Guide Rock.

The relationships and equations above can be used to recreate a historic series of dry-year forecast values for the Basin above Guide Rock (Figure C15). In accordance with Compact Accounting, each annual forecast value then must be incorporated into the appropriate multi-year average. However, the annual forecast value is not averaged with previous years forecast values, as those previous years values would be known, or could be accurately estimated, by then. The annual forecast is combined with previous year's annual accounting balances to compute the relevant average balance. These averages are used to determine the need to implement additional management actions in an upcoming year, as outlined in the next section.

C.5.2 Application of Forecast

Republican River Compact compliance works within a system of running averages. Every year, a five year average is computed, and during Water Short Year Administration, a two year average is computed. This two year average can be changed to a three year average if an Alternative Water Short Year Administration Plan has been approved by the RRCA and implemented by Nebraska. Therefore, in order to determine the potential for non-compliance in an upcoming dry year, the forecast discussed above must be incorporated with the results of Compact Accounting from previous years. Additionally, because the two year average for WSYA includes one year that has already happened, a tool to look ahead for the potential for WSYA in two years is needed. The forecast is combined with the previous accounting and other data to accomplish these needs.

The process of implementing the forecast is summarized in two flow charts that are attached to the IMPs. The Monitoring section of the IMPs also contains a series of Checklists that mirror these flowcharts. The first flowchart deals with potential non-compliance during WSYA (see URNRD, 2010, page 23). The first component of this flowchart is the assessment of the USBR projection of the available water supply for Harlan County Lake on January 1. If this projection indicates an available water supply of less than 119,000 acre-feet, the upcoming year may be subject to WSYA. Final designation of WSYA occurs in July when the assessment of the actual available water supply is completed. In the past, the available water supply has been projected to be less than 119,000 acre-feet on January 1, but the actual water supply determined in July has been greater than 119,000 acre-feet. However, action cannot wait until the final assessment has been completed in July. Therefore, these IMPs include additional evaluation and the potential for immediate action based on that evaluation in January. Also note that historically the available water supply as determined in July has only been less than 119,000 acre-feet if the January prediction indicated the potential for that supply to be less than 119,000 acre-feet. Taking action based on the January prediction may result in restrictions for WSYA compliance even though that year may not ultimately be subject to WSYA. However, when the January prediction

indicates the WSYA would not be in effect, it is appropriate to conclude that additional management actions are not necessary for WSYA compliance.

When the USBR forecast for the water supply available from Harlan County Lake is less than 119,000 acre-feet on January 1, the dry year forecast is utilized in conjunction with the previous year's balance to determine the potential for non-compliance under WSYA. This evaluation utilizes Compact accounting results for the Basin above Guide Rock and also incorporates a cushion of 10,000 acre-feet. Consider the following example. The previous year's annual Compact balance for Nebraska above Guide Rock is 10,000 acre-feet. The forecast procedures predict an upcoming dry year balance of -10,000 acre-feet. Combining these two values would yield a two year average of zero acre-feet. However, when the 10,000 acre-foot cushion is incorporated, the two year average becomes -5,000 acre-feet. A two-year annual balance that is negative would result in non-compliance under WSYA.[34] Therefore, this result would trigger a Compact Call Year. If the result of this evaluation was a positive two-year average (with the 10,000 acre-foot cushion included), it would not trigger a Compact Call Year and Compact compliance under Normal Year Administration would be evaluated. This evaluation is discussed below, but first, the WSYA Early Warning System is demonstrated.

When the USBR forecast for the water supply available from Harlan County Lake is greater than 119,000 acre-feet on January 1, an additional evaluation is completed, which will be termed the WSYA Early Warning System. This process requires that several criteria are met. The first is an evaluation of the amount of water stored in Harlan County Lake. The purpose of this criterion is to determine if there is a possibility that the USBR forecast for the water supply available from Harlan County Lake on January 1 of the following year will be for less than 119,000 acre-feet. In the past, when the water stored in Harlan County Lake has decreased from the beginning to the end of the year, the amount of this decrease is generally 16% of the amount in storage in the beginning of the year. So, for example, if on January 1 the storage in Harlan County Lake is 300,000 acre-feet at the beginning of the year, and dry conditions resulted in less water flowing into the reservoir than was released from the reservoir, the reservoir would most likely contain about 252,000 acre-feet at the end of the year.

The formulas and procedures used by the USBR to compute the irrigation supply available from Harlan County Lake are included as Appendix K to the FSS. This generally involves a process to take into account, among other things, the current (e.g., beginning of the year) amount in storage, the anticipated inflows, and

[34] As noted above, there is the potential for Alternative Water Short Year Administration, which allows for a three-year average, but requires approval by the RRCA and implementation by Nebraska. If such approval and implementation occurs, these procedures would recognize this difference. For simplicity, this discussion focuses on the two year averaging.

evaporative losses. If the reservoir storage at the beginning of the year is 246,000 acre-feet, these formulae will generally yield an available water supply of greater than 119,000 acre-feet. So, the first criteria for the WSYA Early Warning System is to multiply the amount of water in storage in Harlan County Lake on January 1 by 84%. If this value is greater than 246,000 acre-feet, no further evaluation is required and compliance under Normal Year Administration is then considered. However, if the value obtained from this calculation is less than 246,000 acre-feet, additional criteria are evaluated.

The first criteria whether or not the upcoming dry year forecast is greater than zero. If this is greater than zero, this means that even if the next year does trigger WSYA, the first year in the two-year average will be a positive value. Therefore, even a negative annual balance in the next year could still result in Compact compliance. The Early Warning System is therefore considered to be satisfied and the process moves on to the evaluation of Normal Year Administration. However, if the dry year forecast is negative, then the very same criterion that applies when the upcoming year is predicted to be under WSYA also applies, even though WSYA would not be in effect. In other words, the sum of the dry year forecast and the previous year's balance minus 10,000 acre-feet must be greater than zero. If this value is less than zero, a Compact Call Year is in effect. This would require additional management and regulations in the upcoming year, even though there is not a prediction of non-compliance in that year. Nebraska realizes that these additional restrictions, not required by the FSS or the Compact, are necessary to ensure that Compact compliance remains within reach in all years. If all of these criteria are satisfied, the potential for non-compliance under Normal Year Administration is next evaluated.

The flowchart that represents the Normal Year Administration evaluation (see URNRD, 2010, page 24) is conducted in every year that a Compact Call year is not triggered by the WSYA flowchart. This evaluation essentially requires that two criteria are met: 1) the five year average consisting of the upcoming dry year forecast and the four previous years must be positive, and 2) the four year average consisting of the upcoming dry year and the three previous years must be positive. If either of these criteria is not met, a Compact Call Year is triggered. The first criterion is a requirement of the FSS. The second criterion is self-imposed by Nebraska. This second criterion ensures that Nebraska will not have to deal with offsetting a negative average from the previous four years when the next year comes around. For example, consider the following annual balances: -10,000 acre-feet (forecast), 10,000 acre-feet, -20,000 acre-feet, -10,000 acre-feet, 40,000 acre-feet. The five-year average from these values would equal 2,000 acre-feet. However, the four-year average for the most recent four years would be -7,500 acre-feet. This would require the next year to achieve an annual balance for Nebraska of 30,000 acre-feet. While this may certainly be possible, it would be much more practical to take actions in the upcoming year to ensure that the four-

year average is zero acre-feet (i.e., the upcoming year has an annual balance of 20,000 acre-feet instead of -10,000 acre-feet). In this way, if that next year is dry (with a dry year forecast of -10,000 acre-feet), the challenge is only to make up the 10,000 acre-feet, as opposed to 40,000 acre-feet if no action were taken.

The forecast requires management actions in the upcoming year if necessary for compliance in that year. Additionally, the forecast contains key triggers that require immediate management actions beyond those that are strictly necessary for compliance in that year. If it turns out that any of these actions were not required, Nebraska will have foregone Compact entitlements in that year, but will be much better positioned for the future.

When a Compact Call Year is triggered, management and regulatory actions are required. In this situation, there is an imbalance between the projected amount of water that Nebraska is allowed to use under the compact and the projected amount of water that Nebraska would use, absent additional actions. Essentially, the Compact Call requires that Nebraska CBCU be reduced to an amount that offsets that imbalance. Using the example from the WSYA evaluation above, there is a projected two-year average for Nebraska of 5,000 acre-feet, meaning that Nebraska must reduce CBCU (from the projected amount) by 10,000 acre-feet in the upcoming year, to achieve a neutral two-year balance.

The projected overuse by Nebraska of 10,000 acre-feet means that one, two, or all three of the NRDs are projected to exceed their allowable groundwater depletions. The IMPs next outline the computations that are made to apportion this overuse of 10,000 acre-feet (or whatever the value is in any given year) amongst the three NRDs. The IMPs then require that the NRDs take management actions to ensure that these projected overuses of their allowable groundwater depletions do not occur. If no other options are available to the NRDs, this would mean curtailment of groundwater wells in the Rapid Response Region, as described above under the groundwater controls.

The final step in ensuring Compact compliance is to compute the streamflow that must occur at the Kansas-Nebraska state line such that Nebraska uses will not exceed the projected supplies. The forecast predicts a value for this streamflow; if a Compact Call Year is in effect it means that value is not enough. The necessary reductions in Nebraska's CBCU can be translated into required increases in this forecasted streamflow volume. As discussed above under surface water controls, the DNR then administers surface water diversions until this required streamflow volume has been achieved.

APPENDIX D. Historical Agricultural, Technological, and Socioeconomic Information

D.1 Historical Crop Acres

Historical data on crop acreage levels were obtained from the U.S. Department of Agriculture's National Agricultural Statistics Service (NASS) using the Quick Stats 1.0 online database tool.[35] The following counties in Nebraska, which contain at least a portion of area within the Republican River basin, were included: Perkins, Chase, Dundy, Lincoln, Hayes, Hitchcock, Frontier, Red Willow, Gosper, Furnas, Phelps, Harlan, Kearney, Franklin, Webster, and Nuckolls. The following crop types were included (some of these crop types consist of the sum of multiple NASS crop categories, as indicated below):

- Corn – includes corn for grain and corn for silage
- Soybeans
- Wheat – Includes winter wheat
- Edible Beans – Includes dry edible beans and pinto beans
- Sorghum – Includes sorghum for grain and sorghum for silage
- Hay – Includes hay alfalfa (dry) and hay other (dry)
- Sugar Beets
- Small Grains – Includes barley, oats, and rye
- Sunflower – Includes sunflower seed non-oil use and Sunflower seed for oil

Table D1 below shows the harvested acreage levels obtained for these crop types. Figure D1 display this same information graphically.

[35] Quick Stats 1.0 is available at http://www.nass.usda.gov/Data_and_Statistics/Quick_Stats_1.0/index.asp

Table D1. Harvested Acres of Selected Crop Types in Nebraska Republican River Basin Counties (USDA NASS Quick Stats 1.0)

Year	Corn	Soybeans	Wheat	Edible Beans	Sorghum	Hay	Sugar Beets	Small Grains	Sunflowers	Total
1950	1,065,250				97,080					1,162,330
1951	1,117,280				91,520					1,208,800
1952	1,087,190				70,890					1,158,080
1953	1,083,210				132,280					1,215,490
1954	1,053,030				265,370					1,318,400
1955	666,060				293,550					959,610
1956	675,810		960,560		295,810					1,932,180
1957	706,990		868,520		484,400					2,059,910
1958	774,290		1,017,300		376,760					2,168,350
1959	834,410		922,030		401,260			128,520		2,286,220
1960	753,590	440	881,800		513,670	395,160		106,530		2,651,190
1961	599,400	1,840	946,250		404,540	395,170		124,710		2,471,910
1962	543,090	2,030	818,600		486,430	455,770		131,170		2,437,090
1963	546,840	2,180	820,540		540,350	389,290		97,930		2,397,130
1964	450,550	1,920	852,310		538,110	395,100		77,940		2,315,930
1965	405,530	2,910	919,110		515,210	400,060		46,100		2,288,920
1966	473,190	4,460	901,500		505,110	374,770		46,830		2,305,860
1967	547,040	2,900	1,017,400		492,820	394,500		19,020		2,473,680
1968	573,880	5,600	949,700		402,100	355,210		30,300		2,316,790
1969	626,550	7,150	849,000		359,450	375,300		59,570		2,277,020
1970	692,450	9,040	745,600		353,550	368,700		75,510		2,244,850
1971	794,780	2,210	786,700		454,100	367,900		69,320		2,475,010
1972	796,400	3,800	821,000	6,100	368,100	342,200	8,730	22,560		2,368,890
1973	895,800	15,300	893,700	7,300	487,200	367,000	8,700	19,800		2,694,800
1974	947,300	8,800	917,000	8,700	428,800	346,000	7,530	22,200		2,686,330

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1975	990,800	6,400	906,500	12,300	394,000	373,800	11,850	26,200		2,721,850
1976	1,056,300	4,900	917,000	11,000	389,700	358,600	12,320	25,700		2,775,520
1977	1,181,800	9,100	919,000	10,700	372,000	363,500	9,550	21,000		2,886,650
1978	1,189,700	11,600	817,000	12,000	335,700	341,000	10,480	10,400		2,727,880
1979	1,251,700	17,200	733,100	19,400	415,900	344,000	9,590	13,600		2,804,490
1980	1,290,600	19,900	912,900	25,600	410,800	350,000	13,390	9,000		3,032,190
1981	1,237,800	36,800	919,500	42,200	478,800	355,000	11,390	14,800		3,096,290
1982	1,267,800	67,800	961,600	31,400	391,200	348,000	7,320	23,600		3,098,720
1983	888,100	99,500	788,600	12,600	248,300	339,000	6,020	35,500		2,417,620
1984	1,284,400	168,400	748,700	19,600	482,300	391,000	6,830	31,500		3,132,730
1985	1,314,800	182,400	776,700	31,700	454,700	330,600	165	46,600		3,137,665
1986	1,231,500	172,700	704,400	40,900	360,700	371,500	0	48,900		2,930,600
1987	1,152,200	121,800	702,600	41,200	292,800	314,000	0	52,000		2,676,600
1988	1,239,600	125,100	731,200	30,000	322,200	364,400	0	52,900		2,865,400
1989	1,329,400	129,800	698,300	39,300	352,800	379,000	0	16,800		2,945,400
1990	1,381,100	104,000	838,500	52,100	298,100	370,800	0	16,800		3,061,400
1991	1,472,200	106,000	785,700	41,000	297,400	416,200	0	17,900		3,136,400
1992	1,465,100	90,200	744,100	34,600	350,000	338,000	0	13,500	16,200	3,051,700
1993	1,466,500	89,100	897,500	76,000	264,500	348,000	0	4,200	27,100	3,172,900
1994	1,591,500	98,800	867,800	76,100	274,600	346,500	0	6,000	35,900	3,297,200
1995	1,535,900	114,200	851,600	78,000	238,800	310,500	0	5,800	44,800	3,179,600
1996	1,632,000	92,900	863,400	67,600	250,500	311,500	500	5,900	17,600	3,241,900
1997	1,767,300	155,300	744,600	42,700	190,400	300,500	2,900	6,600	15,500	3,225,800
1998	1,784,300	217,800	719,600	52,700	156,500	302,500	3,700	8,700	20,500	3,266,300
1999	1,737,000	323,400	728,600	48,300	133,600	316,900	7,300	9,100	38,100	3,342,300
2000	1,613,000	435,200	672,700	35,200	155,700	294,400	5,800	4,600	21,500	3,238,100
2001	1,540,400	525,300	704,100	39,700	154,000	354,500	3,100	7,000	21,800	3,349,900
2002	1,332,000	461,300	665,700	57,500	132,400	332,700	5,000	6,600	10,600	3,003,800
2003	1,446,000	433,500	775,900	46,500	211,600	350,500	4,500	12,300	18,700	3,299,500
2004	1,517,400	516,400	644,100	34,700	192,600	310,200	5,800	4,800	12,300	3,238,300

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2005	1,644,500	487,300	730,100	69,100	114,400	303,200	4,300	7,600	26,700	3,387,200
2006	1,536,500	564,400	660,400	42,400	106,000	308,400	5,700	6,000	11,300	3,241,100
2007	1,807,800	353,200	768,700	27,300	115,200	279,300	2,800	3,100	9,300	3,366,700
2008	1,762,000	542,200	624,300	23,500	90,400	263,400	1,200	0	0	3,307,000
2009	1,736,000	556,500	596,500	12,200	62,900	274,100	2,300	0	1,700	3,242,200
2010	1,860,800	602,200	608,600	15,900	37,700	272,300	0	0	0	3,397,500

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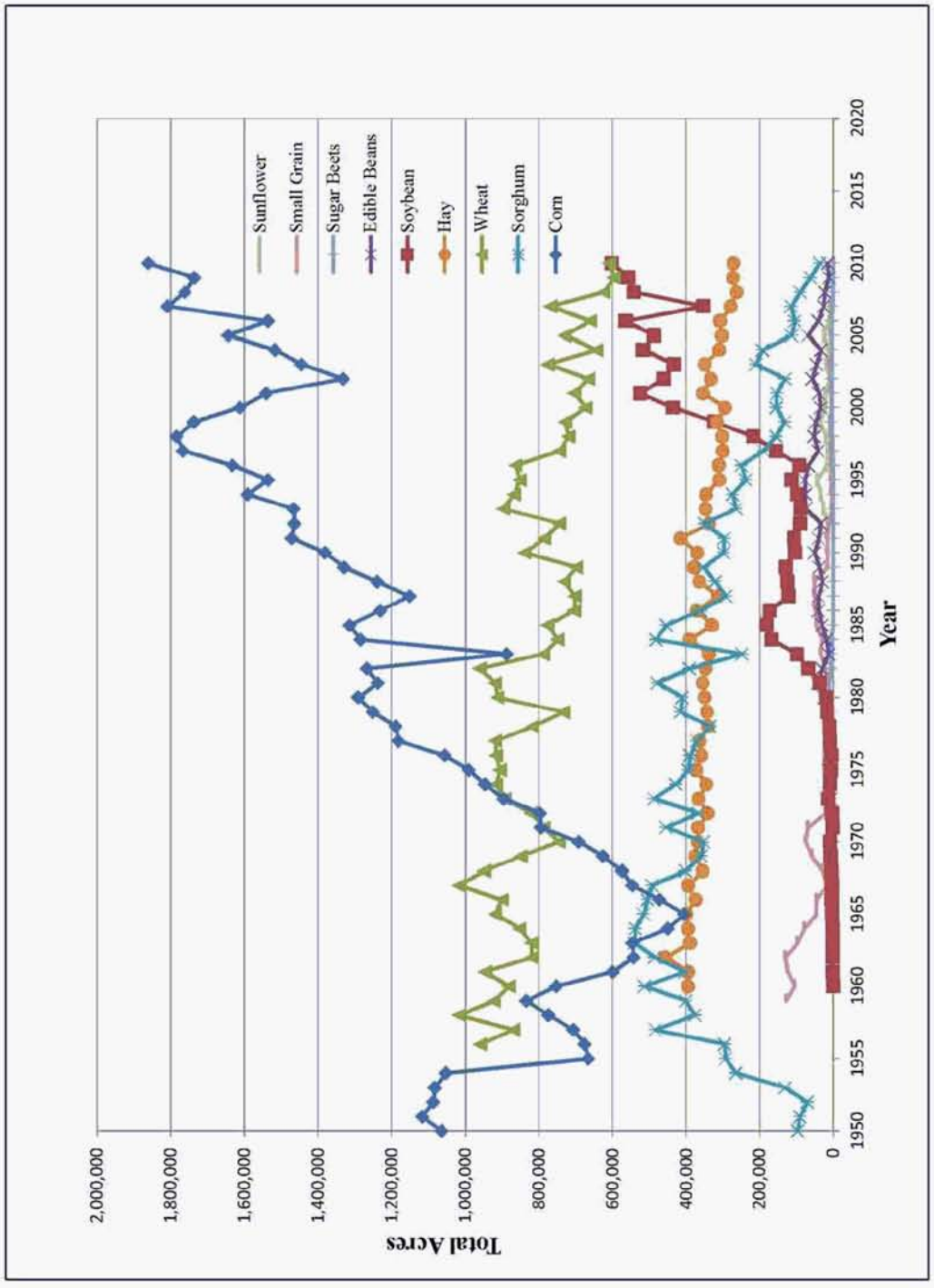

Figure D1. Historical Trends in Cropped Acres by Crop Type for the Basin (data from Table D1).

D.2 Historical Tillage Practices

Historical data on crop tillage practices were obtained from the National Crop Residue Management Survey[36], conducted by the Conservation Technology Information Center (CTIC). The following counties in Nebraska, which contain at least a portion of area within the Republican River basin, were included: Perkins, Chase, Dundy, Lincoln, Hayes, Hitchcock, Frontier, Red Willow, Gosper, Furnas, Phelps, Harlan, Kearney, Franklin, Webster, and Nuckolls. Five different tillage types[37] were included within the surveys, and the results are shown in Figure D2 and Table D2 below.

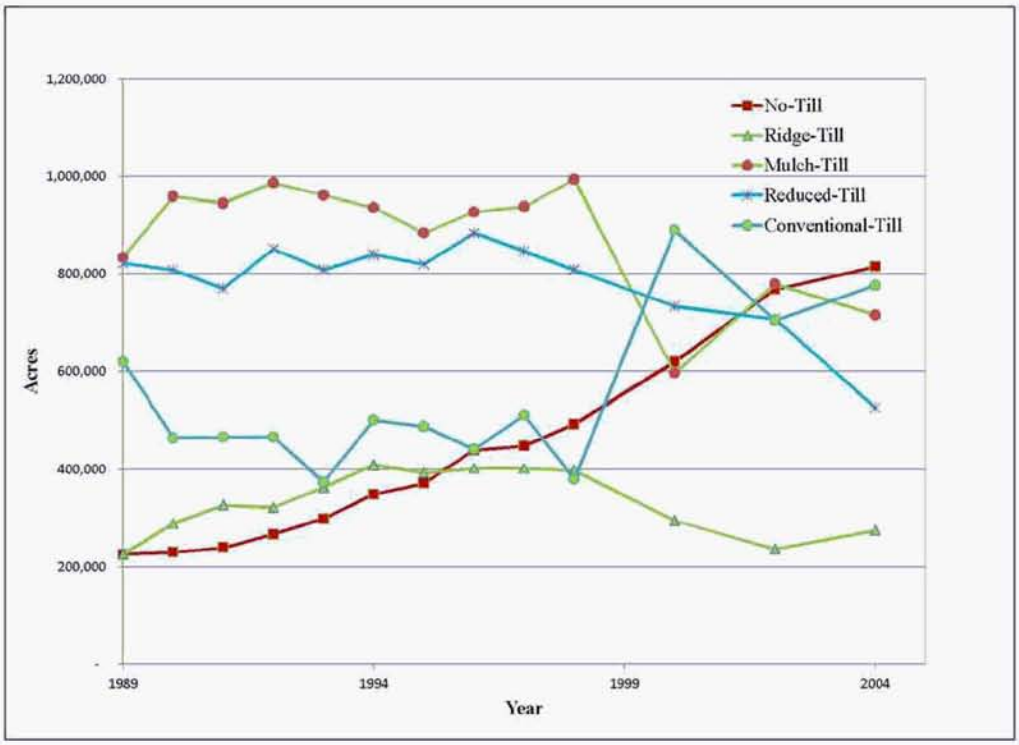

Figure D2. Historical trends in tillage practices (data from Table D2)

[36] Information on the Survey, as well as CTIC, is available at the following location: http://www.ctic.purdue.edu/CRM/

[37] Definitions for the five tillage types are available at the following location: http://www.ctic.purdue.edu/media/pdf/TillageDefinitions.pdf

Table D2. Acres by Tillage Practice in Nebraska's Republican River Counties (National Crop Residue Management Survey, Conservation Technology Information Center).

Year	No-Till	Ridge-Till	Mulch-Till	Reduced-Till	Conventional Till	TOTAL
1989	225,670	226,544	834,208	822,719	619,646	2,728,787
1990	230,477	289,140	959,610	808,309	464,322	2,751,858
1991	239,581	326,650	945,543	770,332	466,347	2,748,453
1992	266,916	321,579	986,991	851,461	466,324	2,893,271
1993	298,813	363,082	961,740	809,060	374,529	2,807,224
1994	349,041	409,290	936,641	840,131	500,884	3,035,987
1995	371,683	393,538	884,787	820,461	487,783	2,958,252
1996	439,240	401,881	928,153	883,866	441,454	3,094,594
1997	448,324	402,071	938,652	846,896	511,267	3,147,210
1998	492,704	398,299	993,695	808,740	380,932	3,074,370
2000	620,041	294,805	596,825	733,574	890,380	3,135,625
2002	767,941	237,011	779,480	707,717	704,993	3,197,142
2004	815,260	275,726	715,617	525,923	776,551	3,109,077

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D.3 Technology Changes

The history of technology changes in agriculture has been documented in numerous sources, but one source of note is in the web-based resource called *Growing a Nation: The Story of American Agriculture*[38], maintained by LetterPressSoftware, Inc., headquartered on the Utah State University Innovation Campus. The web site includes a series of timelines, referred to as *A History of American Agriculture*[39], showing critical events and changes that took place related to agriculture over the last few centuries.

The "Crops and Livestock" section of *A History of American Agriculture* highlights several key developments with crop production that took place between the 1950 and 2010 time period. For instance, by 1960, the use of hybridization had expanded to the extent that about 96 percent of corn acreage was planted with hybrid seed. In 1970, a Nobel Peace Prize was awarded to Norman Borlaug for developing high-yielding wheat varieties. By the 1980s, biotechnology became available for improving crop and livestock yields. More recently, genetic engineering became available for use with both crops and livestock, revolutionizing agricultural methods, while sparking some controversy at the same time. While these particular events are only a small sampling of the many agricultural changes impacting crops and livestock in the period between 1950 and 2010, it is obvious that the technological developments and improved crop yields were considerable.

Farm machinery has also improved in efficiency, size, and speed from 1950 to 2010. In the "Farm Machinery & Technology" section of *A History of American Agriculture,* the authors mention the fact that in 1950 one farmer could supply 15.5 people, while in 1990 a farmer could supply 100 people. One of the reasons for this nearly ten-fold jump in productivity involved the increased mechanization of farm operations. As a result of better machinery, along with other factors, the average size of farms increased while the number of farms decreased. According to the "Farmers & the Land" section of *A History of American Agriculture*, there were 5,388,000 farms nationwide in 1950 with an average size of 216 acres, while in 1990 the number of farms decreased to 2,143,150, with an average size of 461 acres. The farm machinery of 2010 is on average much larger and able to cover significantly greater acres per hour than its 1950 counterparts.

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[38] *Growing a Nation: The Story of American Agriculture* is accessible at http://www.agclassroom.org/gan/index.htm

[39] *A History of American Agriculture* is accessible at http://www.agclassroom.org/gan/timeline/index.htm

Land practices, including planting, fertilizing, and harvesting, also changed over the 1950 to 2010 period, as highlighted in the "Farm Machinery & Technology" section. In the 1970s and 1980s, no-till agriculture practices spread across much of the U.S., largely as a means to control erosion. In the 1990s, precision agriculture arose, using satellites and GPS technology to track and plan farming procedures. With the higher commodity prices and associated farm incomes of recent years, the use of precision ag has been increasingly adopted by farmers as a way to reinvest income into improving efficiencies and reducing input costs. Many of these technologies would have been difficult to even imagine in the early1950s, when computers of any kind were unavailable for everyday use, and the first launch of a U.S. satellite was still in the planning stages.

D.4 Socioeconomics

One of the basic metrics used in socioeconomic analysis is population; historical records were obtained from the U.S. Census Bureau, as described below. Population estimates for the Republican River basin in Nebraska were obtained from the U.S. Census Bureau[40], and were obtained for the following counties, each of which is at least partially contained within the Republican River basin: Perkins, Chase, Dundy, Lincoln, Hayes, Hitchcock, Frontier, Red Willow, Gosper, Furnas, Phelps, Harlan, Kearney, Franklin, Webster, and Nuckolls. The population numbers are shown in Table D3 and Figure D3 below.

Table D3. Populations in Nebraska Republican River Basin Counties (U.S. Census Bureau)

County	1950	1960	1970	1980	1990	2000	2010
Chase	5,176	4,317	4,129	4,758	4,381	4,068	3,966
Dundy	4,354	3,570	2,926	2,861	2,582	2,292	2,008
Franklin	7,096	5,449	4,566	4,377	3,938	3,574	3,225
Frontier	5,282	4,311	3,982	3,647	3,101	3,099	2,756
Furnas	9,385	7,711	6,897	6,486	5,553	5,324	4,959
Gosper	2,734	2,489	2,178	2,140	1,928	2,143	2,044
Harlan	7,189	5,081	4,357	4,292	3,810	3,786	3,423
Hayes	2,404	1,919	1,530	1,356	1,222	1,068	967
Hitchcock	5,867	4,829	4,051	4,079	3,750	3,111	2,908
Kearney	6,409	6,580	6,707	7,053	6,629	6,882	6,489
Lincoln	27,380	28,491	29,538	36,455	32,508	34,632	36,288

[40] 1950 to 1990 data were from the following source: http://www.census.gov/population/cencounts/ne190090.txt 2000 data were from the following source: http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=DEC_00_SF2_PCT001&prodType=table 2010 data were from the following source: http://quickfacts.census.gov/qfd/states/31/31029.html

Nuckolls	9,609	8,217	7,404	6,726	5,786	5,057	4,500
Perkins	4,809	4,189	3,423	3,637	3,367	3,200	2,970
Phelps	9,048	9,800	9,553	9,769	9,715	9,747	9,188
Red Willow	12,977	12,940	12,191	12,615	11,705	11,448	11,055
Webster	7,395	6,224	6,477	4,858	4,279	4,061	3,812
TOTAL	127,114	116,117	109,909	115,109	104,254	103,492	100,558

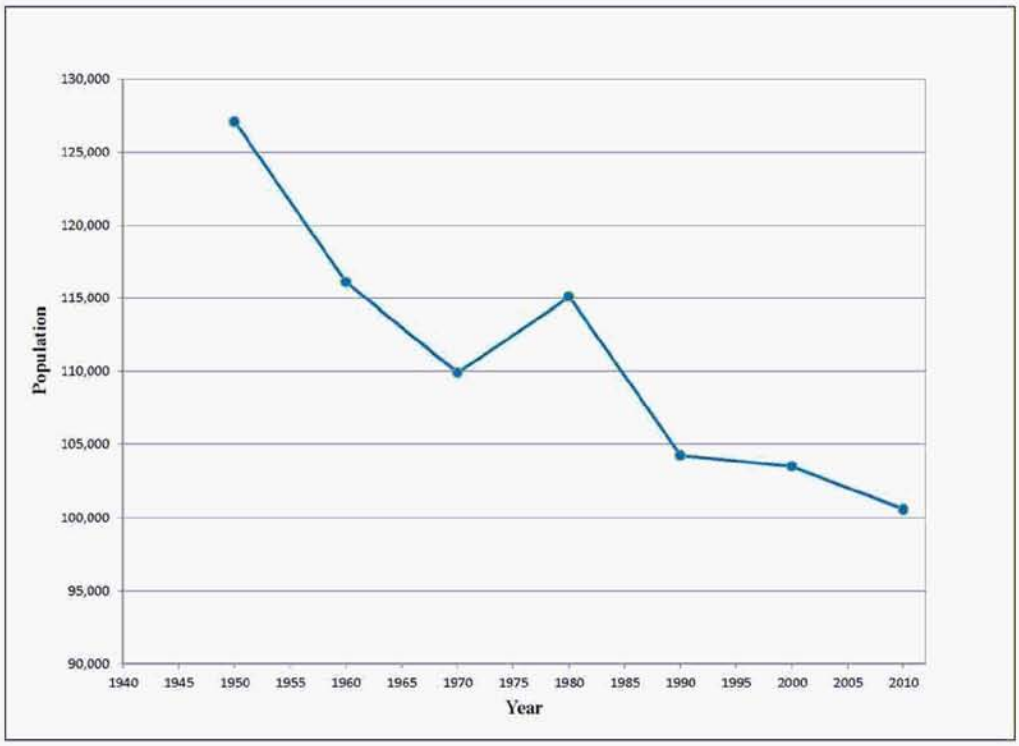

Figure D3. U.S. Census Bureau population for the Republican River Basin (data from Table D3)

Nebraska Responsive Expert Report Concerning Nebraska's Future Compliance

Reference Materials

James C. Schneider, Ph.D

March 15, 2012

Effective
October 1, 2011

Lower Republican NRD

INTEGRATED MANAGEMENT PLAN
Jointly Developed by the
DEPARTMENT OF NATURAL RESOURCES
and the
LOWER REPUBLICAN NATURAL RESOURCES DISTRICT

I. Authority

This Integrated Management Plan (IMP) was prepared by the Board of Directors of the Lower Republican Natural Resources District (LRNRD) and the Nebraska Department of Natural Resources (DNR) in accordance with the Nebraska Ground Water Management and Protection Act, *Neb. Rev. Stat.* § 46-701 et seq., and the Republican River Compact.

II. Background

In 1943 the states of Colorado, Kansas and Nebraska entered into the Republican River Compact (Compact) with the approval of the United States Congress. The Compact provides for the equitable apportionment of the "virgin water supply" of the Republican River Basin. In 1998, following several years of dispute about Nebraska's consumptive use of water within the basin, Kansas filed an original action in the United States Supreme Court (Court) against the states of Nebraska and Colorado, seeking, among other things, to include ground water in the calculation of the virgin water supply and consumptive use. After several rulings by the Court and its Special Master (including a recommendation that the depletions to streamflow from the use of ground water be included in the virgin water supply and be included in the calculations of each state's beneficial consumptive use), and several months of negotiation, the three states entered into a comprehensive Final Settlement Stipulation (FSS). That FSS was approved by the Supreme Court on May 19, 2003, and the Special Master's final report approving the Republican River Compact Administration (RRCA) Ground Water Model (GWM) developed by the three states for use in computing streamflow depletions resulting from ground water use was submitted to the Court on September 17, 2003.

Ground water use within the Republican River Basin is regulated by four natural resources districts: the Lower Republican Natural Resources District (LRNRD), the Upper Republican Natural Resources District (URNRD), the Middle Republican Natural Resources District (MRNRD), and the Tri-Basin Natural Resources District (TBNRD) (collectively referred to below as the NRDs). Both prior and subsequent to the approval of the FSS, the DNR conducted and participated in several meetings with the LRNRD during which it explained that in order for the state of Nebraska to achieve and maintain compliance with the terms of the FSS and the Compact it would be necessary to undertake the following: (1) to continue the moratorium on new surface water appropriations and new ground water wells, (2) to reduce all ground water pumpage from historic levels across the entire basin, and (3) to further reduce ground water pumping to comply with the Compact in water short years. The foregoing steps were to be accomplished to the extent possible through the use of incentive programs to reduce consumptive use of water. Similar discussions were held between the DNR and each of the other NRDs regarding the need (1) to accurately measure actual ground water pumpage and surface water diversions throughout the basin and within each NRD, (2) for the TBNRD to maintain the

Compact Imported Water Supply that Nebraska receives because of discharges from the "ground water mound" at sufficient levels to offset depletions to the Republican River caused by ground water pumping within the Republican River Compact area within TBNRD, and 3) for each of the NRDs other than the TBNRD to reduce their ground water pumping from their "1998-2002 baseline pumping volumes," which the DNR has defined as follows:

URNRD - 531,763 acre-feet

MRNRD - 309,479 acre-feet

LRNRD - 242,289 acre-feet

The DNR, through the use of the Republican River Compact Administration Ground Water Model, determined each NRD's depletions to streamflow for the 1998-2002 period (referred to below as the "1998-2002 baseline depletion") and the related depletion proportion (referred to below as the "1998-2002 baseline depletion proportion"):

URNRD - 74,161 acre-feet (44% of the depletions)

MRNRD - 52,168 acre-feet (30% of the depletions)

LRNRD - 43,954 acre-feet (26% of the depletions)

The percentage of allowable ground water depletions for each NRD was based on the proportion of the average ground water depletions caused by ground water pumping within each NRD that occurred during the baseline period from 1998- 2002 as determined by model runs of the Republican River Compact Administration Ground Water Model, with ground water pumping within each NRD alternated between being turned off and then being turned on. The percentage of allowable ground water depletions may be altered in the future if concurrence on a new methodology can be reached amongst all of the basin NRDs.

On June 24, 2005, the first Integrated Management Plan (2005 IMP) adopted by the LRNRD and the DNR became effective. That 2005 IMP described the ground water Rules and Regulations for the 2005-2007 period. Among other things, that 2005 IMP provided for a base ground water allocation of 12 acre-inches per year (36 acre-inches for the allocation period) for all regulated wells located west of U.S. Highway 183, and a base ground water allocation of 11 acre-inches per year (33 acre-inches for the allocation period) for all regulated wells located east of U.S. Highway 183. The 2005 IMP also allowed the landowners to carry forward unused base allocations.

Since adoption of the 2005 IMP, there have been efforts to implement incentive programs, studies, and research to further our understanding and ability to comply with the Republican River Compact and FSS. The LRNRD and the DNR now seek to adopt and implement a revised IMP for the regulation of water resources within the LRNRD as required by the laws of the state of Nebraska, specifically the Ground Water Management and Protection Act. A subsequent IMP was adopted by LRNRD and DNR in 2008, with additional changes during 2009.

During 2008 Colorado, Kansas, and Nebraska entered into dispute resolution regarding a number of issues, including future compliance. In June 2009 the arbitrator, Karl Dreher, issued a finding that the LRNRD IMP may be adequate during years with average and above-average precipitation, but may not be adequate during dry years. Although the LRNRD's allowable depletions to streamflow are limited to 26% of Nebraska's allowable depletions, there were no details in the plan to describe how this would be accomplished. These additional details have been added to this 2011 version of the IMP.

The LRNRD will meet its responsibility under *Neb. Rev. Stat.* § 46-715 of the Ground Water Management and Protection Act, including meeting the obligations under the FSS, by adopting revised Rules and Regulations to implement the this IMP. The LRNRD understands that the URNRD and the MRNRD have also revised their IMPs, and have chosen to adopt a "compliance standard" whereby they have agreed that their use of ground water shall be within the allocation granted to them as determined by the 1998-2002 baseline pumping volumes, reduced by a certain percentage. They have also agreed that they will be assigned their proportionate share of streamflow depletions as calculated by the 1998-2002 baseline depletion percentages. The failure of any one NRD to adopt, implement or enforce IMPs adequate to meet their proportionate share of the responsibility to achieve and maintain Nebraska's compliance with the Compact and the FSS shall not itself require any additional action by the other NRDs.

III. Limitations for Certain Purposes

To the extent provisions of this IMP relate to and accommodate or provide for water short year regulatory action intended to achieve compliance with this Compact, this IMP applies to portions of the Republican River Basin lying in the Nebraska counties of Furnas, Harlan, Franklin, Webster, and Nuckolls, lying upstream of Guide Rock, Nebraska: those areas within the basin lying west of a line proceeding north from the Nebraska-Kansas state line and following the western edge of Webster County, Township 1, Range 9, Sections 34, 27, 22, 15, 10, and 3 through Webster County, Township 2, Range 9, Sections 34, 27 and 22; then proceeding west along the southern edge of Webster County, Township 2, Range 9, Sections 16, 17 and 18; then proceeding north following the western edge of Webster County, Township 2, Range 9, Sections 18, 7 and 6, through Webster County, Township 3, Range 9, Sections 31, 30, 19, 18, 7, and 6 to its intersection with the northern boundary of Webster County.

IV. Goals and Objectives

The LRNRD and the DNR have adopted the following Goals and Objectives:

A. Goals:

1. Ensure that ground water and surface water users within the LRNRD assume their share of the responsibility to keep Nebraska in compliance with the Republican River Compact.

2. Provide that LRNRD's share of that responsibility be distributed in an equitable manner and to minimize adverse economic, social and environmental consequences to the extent possible.

3. To sustain a balance between water uses and water supplies within the LRNRD so that the economic viability, social and environmental health, safety, and welfare of the LRNRD can be achieved and maintained for both the near and long term.

B. Objectives:

1. With limited exceptions, prevent the initiation of new or expanded uses of water that increase Nebraska's computed beneficial consumptive use of water within the LRNRD, as required for Compact compliance and by Nebraska law.

2. Achieve the required reductions in water use through a combination of regulatory and incentive programs designed to reduce beneficial consumptive use.

3. The DNR shall ensure that administration of surface water appropriations in the basin is in accordance with the Compact and in full compliance with Nebraska law.

4. After taking into account any reduction in beneficial consumptive use achieved through basin-wide incentive and streamflow augmentation programs, make such additional reductions in ground water use in Compact Call Years as are necessary to achieve a reduction in beneficial consumptive use in the LRNRD to 26% of the allowable ground water depletions in such years. Compact Call Years will be determined through the procedures outlined in Section IX of this IMP.

5. The LRNRD and the DNR will continue to investigate and explore augmentation projects that would add to or retime the water supply within the basin. Such augmentation and retiming projects include, but are not necessarily limited to, the following:

a. Leasing or purchasing surface water and/or ground water;
b. Augmentation wells, both within and outside of the Republican River Basin;
c. Exploring trans-basin diversion projects;
d. Conjunctive management of surface water irrigation projects.

6. The LRNRD's net depletions shall not exceed its appropriate allocation (26%) of the state's allowable ground water depletions as determined by the Republican River Compact Administration Ground Water Model

V. Map

Except as noted in Section III above, the area subject to this IMP is the geographic area within the boundaries of the LRNRD (see Map 1). The Rapid Response Region is shown as a sub-area within the boundaries of the LRNRD (see Map 2).

VI. Ground Water Controls

The authority for the ground water component of this IMP is the Nebraska Ground Water Management and Protection Act, *Neb. Rev. Stat.* § 46-701 et seq. The ground water controls in this IMP will be implemented in the LRNRD Ground Water Management Rules and Regulations. The Rules and Regulations may be modified in a manner consistent with this IMP from time to time hereafter by the LRNRD, and shall be sufficient so as to meet the Compliance Standards and controls set forth below.

A. Compliance Standards

1. Purpose

These compliance standards are established by DNR and LRNRD to assess whether the course of action taken by the LRNRD, with the intention of providing their proportionate share of assistance to the state in order for the state to maintain compliance with the FSS and Compact, is sufficient. The action taken by the LRNRD shall be evaluated in connection with the action taken by the other NRDs in the Republican River Basin and any other relevant considerations, including the information and data provided by DNR and past action by the LRNRD.

2. Duration

On an annual basis the DNR and LRNRD shall reexamine the sufficiency and effectiveness of the compliance standards to determine if amendments or revisions to this IMP are necessary to ensure the state's compliance with the FSS and Compact. Nothing contained herein shall prohibit or preclude any amendment or revision at any time by the DNR and LRNRD when such action is necessary. Further, nothing contained in this subsection shall be construed as eliminating the review of the provisions of this IMP as required by *Neb. Rev. Stat.* § 46-715.

3. Standards

The LRNRD shall adopt and implement rules and regulations which shall ensure that the following standards are met. The standards shall be affected through the procedure described in Section IX - Monitoring and Studies. Section IX specifies a forecast and resulting actions needed at the Guide Rock compliance point (during water short years) and at the Hardy compliance point. The procedures for determining whether the compliance standards are met will be based on the Republican River Compact Administration (RRCA) Accounting Procedures, the baseline depletion percentage, and the annual forecast as outlined in Section IX. The standards are:

a. Provide for a minimum twenty percent (20%) reduction in pumping from the 98-02 pumping volume using a combination of regulation and supplemental programs so that the average ground water pumping volume is no greater than 194,000 acre-feet over the

long term. If precipitation is lower than average for any given year, the ground water pumping volume for any single year may be above 194,000 acre-feet.

b. An additional five percent (5%) reduction in 98-02 pumping volumes during the next five-year period shall be accomplished primarily through voluntary incentive programs and other means as determined by the LRNRD. The necessity for continuing this annual reduction shall be reevaluated by DNR and the LRNRD in 2015.

c. The LRNRD's net depletions to streamflow shall average no greater than 26% of the allowable ground water depletions determined in accordance with RRCA Accounting Procedures using the RRCA GWM. The average shall be computed using the annual allowable ground water depletion for the same years as are used to determine the averages for Nebraska's compliance with the FSS.

B. Other Ground Water Controls and Management Activities

The LRNRD and the DNR recognize that the required reductions in water consumption could be accomplished by means other than those adopted in this IMP. The IMP and associated controls may need to be amended in the future to implement any such revisions.

1. During Compact Call Years, the LRNRD will seek to implement management actions (such as surface water leasing, ground water leasing, augmentation, etc.) to ensure compliance with this IMP. These management actions will be implemented through the authorities granted by the Nebraska Ground Water Management and Protection Act, *Neb. Rev. Stat.* §§ 46-701 to 46-753. Details of such management actions will be provided to DNR by January 31st of each year for evaluation. If such management actions are insufficient to ensure compliance with this IMP, the LRNRD will in the alternative to management actions, implement additional ground water controls and regulations to make up for its proportionate share of any expected shortfall as identified in the annual forecast and described in Section IX of this IMP. Such additional control will include, but not be limited to, restriction or curtailment of ground water pumping within the Rapid Response Region of the LRNRD and restrictions on ground water pumping in all other sub areas of the district.

2. When necessary to ensure compliance with this IMP during Compact Call Years, the LRNRD may set a one-year pumping allocation within the district. Such allocation will set the maximum pumping level in that year within any region or sub-region.

3. Maintain requirement for metering of all ground water uses according to LRNRD standards.

4. Provide for transfers according to LRNRD standards

VII. Surface Water Controls - Department of Natural Resources

The authority for the surface water component of this IMP is the Nebraska Ground Water Management and Protection Act, *Neb. Rev. Stat.* § 46-701 et seq. The surface water controls that will be continued and/or begun by the DNR are as follows:

A. DNR shall continue to administer surface water under the prior appropriation system.

B. The DNR shall implement the following additional surface water administration as required by the FSS:

1. To provide for regulation of natural flow between Harlan County Lake (HCL) and Superior-Courtland Diversion Dam, Nebraska will recognize a priority date of February 26, 1948, for Kansas Bostwick Irrigation District, the same priority date as the priority date held by the Nebraska Bostwick Irrigation District's Courtland Canal water right.

2. When water is needed for diversion at Guide Rock and the projected or actual irrigation supply is less than 130,000 acre-feet of storage available for use from Harlan County Lake as determined by the Bureau of Reclamation using the methodology described in the Harlan County Lake Operation Consensus Plan attached as Appendix K to the FSS, Nebraska will close junior, and require compliance with senior, natural flow diversions of surface water between Harlan County Lake and Guide Rock.

3. Nebraska will protect storage water released from Harlan County Lake for delivery at Guide Rock from surface water diversions.

4. Nebraska, in concert with Kansas and in collaboration with the United States, and in the manner described in Appendix L to the FSS, will take actions to minimize the bypass flows at the Superior- Courtland Diversion Dam.

C. Metering of all surface water diversions at the point of diversion from the stream will continue to be required. For surface water canals that are not part of a Bureau of Reclamation project, farm turnouts are required to install and maintain a DNR approved measuring device. All measuring devices shall meet DNR standards for installation, accuracy and maintenance. All appropriators will be monitored to ensure that neither the rate of diversion nor the annual amount diverted exceeds that allowed by the applicable permit or by statute.

D. The DNR's moratorium on the issuance of new surface water permits was made formal by an Order of the Director dated July 14, 2004. Exceptions may be granted by the DNR to the extent permitted by statute or to allow issuance of permits for existing reservoirs that currently do not have such permits. Such reservoirs are limited to those identified through the FSS required inventory of reservoirs with over 15 acre-feet capacity.

E. All proposed transfers of surface water rights shall be subject to the criteria for such transfers as found in *Neb. Rev. Stat.* §§ 46-290 to 46-294.04 and related DNR Rules or the criteria found

in *Neb. Rev. Stat.* §§ 46-2,120 to 46-2,130 and related DNR Rules in effect as of January 1, 2010.

F. The DNR completed the adjudication process within the LRNRD upstream of Guide Rock for the individual appropriators in the Republican River Basin in 2004. The results of that adjudication provided up-to-date records of the number and location of acres irrigated with surface water by such appropriators. Those records will be used by the DNR to monitor use of surface water and to make sure that unauthorized irrigation is not occurring. The DNR shall also be proactive in initiating subsequent adjudications whenever information available to the DNR indicates the need for adjudication as outlined by state statutes.

G. The DNR reserves the right to request, in the future, that this IMP be modified to require any such additional measures. In the event such a request is made, the DNR shall "allow the affected surface water appropriators and surface water project sponsors a reasonable amount of time, not to exceed one hundred eighty (180) days, unless extended by the DNR, to identify the conservation measures to be applied or utilized, to develop a schedule for such application and utilization, and to comment on any other proposed restrictions." *Neb. Rev. Stat.* § 46-716(2).

H. During Compact Call Years, as determined from the procedures and analysis set forth in Section IX below, DNR will regulate and administer surface water in the basin as necessary to ensure Compact compliance. During Compact Call Years, DNR will issue a "Compact Call" on the Republican River at Hardy or Guide Rock to carry out administration for the Compact in a manner consistent with the doctrine of prior appropriation. A "Compact Call" will result in DNR issuing closing notices on all natural flow and storage permits in the basin until such time as DNR, in consultation with the LRNRD and other basin NRDs, determines that yearly administration is no longer needed to ensure Compact compliance, pursuant to Section IX.

VIII. Incentive Programs

The LRNRD and DNR, alone or in cooperation with other parties, intend to establish and implement financial, incentive, and qualified projects as described in *Neb. Rev. Stat.* § 2-3226.04 to reduce beneficial consumptive use of water within the LRNRD. These projects include, but are not limited to, (1) acquisition by purchase or lease of surface water or ground water rights, including storage water rights with respect to a river or any of its tributaries, (2) acquisition by purchase or lease or the administration and management, pursuant to mutual agreement, of canals and other works, including reservoirs, constructed for irrigation from a river or any of its tributaries, (3) vegetation management, including, but not limited to, the removal of invasive species in or near a river or any of its tributaries, and (4) the augmentation of river flows. As a condition for participation in an incentive program, water users or landowners and the LRNRD may be required to enter into and perform such agreements or covenants concerning the use of land or water as are necessary to produce the benefits for which the incentive program is established. Such incentive programs may include any program authorized by state law and/or federal programs such as, but not limited to, the Conservation Reserve Enhancement Program (CREP) and Environmental Quality Incentives Program (EQIP) operated by the U.S. Department of Agriculture.

Any reductions in depletions to streamflow generated through supplemental programs, funded entirely by the state of Nebraska and/or the United States Government, including acreage retirement or other incentive programs undertaken through programs available throughout the Republican River Basin will not accrue to any specific NRD, regardless of the location or other conditions of the acreage included in the program or of the location of the effect of such water savings on the river system. Any reductions in depletions to streamflow resulting from any such basin-wide programs shall be considered, in the calculation of each NRD's compliance with the 98-02 depletion percentages. This calculation is outlined in Section IX.B.2.c of this IMP.

However, should any NRD establish, fund partially or in total, and implement its own such conservation program, available only for acreage within such district, the accounting of credit for the resulting water savings shall be given exclusively to that NRD.

With agreement of the NRDs involved, the benefits from a supplemental program may be allocated to each NRD based upon their share of the cost of the program.

To the extent possible, it is the intent of the LRNRD to provide compensation to water users that are required to forgo water use to allow the LRNRD and the state to comply with the compact. This may be in addition to or as part of any other LRNRD incentive or retirement program developed to facilitate compact compliance.

IX. Monitoring and Studies

The overarching purpose of the Monitoring and Studies Section is to ensure that, in cooperation with the other Republican River Basin NRDs, the DNR and LRNRD maintain compliance with the Republican River Compact as adopted in 1943 and as implemented in accordance with the FSS approved by the United States Supreme Court on May 19, 2003. The objective of the Monitoring and Studies Section of this IMP is to gather and evaluate data, information, and methodologies that could be used to increase understanding of the surface water and hydrologically connected ground water system, to test the validity of the conclusions and information upon which this IMP is based, and to assist decision makers in properly managing the water resources within the LRNRD and the Republican River Basin as a whole.

On an annual basis the results of monitoring and studies will typically be discussed in a basin-wide meeting which will take place prior to October 31st each year. The purpose of the meeting will be to discuss the preliminary accounting for the current year, the forecast of allowable streamflow depletions for the coming year, and potential management actions as necessary. Table 1 outlines important dates and objectives related to section IX.

Table 1. Important Dates and Objectives.

Date	Objective
Prior to February 1	LRNRD will provide DNR with meter reading database and GIS coverage maps to be used for the RRCA annual model update.
Prior to RRCA Annual Meeting	DNR will provide LRNRD with their determination of whether the LRNRD was in compliance with the compliance standards based on each previous year's annual Compact accounting.
September - October	Obtain power records and other estimates to determine pumping for T = 0 ground water model run.
Prior to October 31	Discuss results of monitoring and studies, preliminary accounting for current year, and early forecast of allowable streamflow depletions.
Prior to November 15	DNR will provide correspondence to LRNRD notifying them of potential Compact call determination for the coming year (T + 1).
November 15 – January 1	LRNRD and DNR will discuss potential management alternatives in the situation that the coming year (T + 1) will be a Compact Call Year.
Prior to December 1	Surface water project sponsors may present a plan to DNR to achieve a consumptive use that is less than forecasted consumptive use.
Prior to January 1	Provide final forecast of allowable streamflow depletions and determination of Compact Call Years.
Prior to January 31	LRNRD will provide DNR with details regarding existing management alternatives in lieu of additional ground water regulations or controls to make up for the expected shortfall.

A. Plan to Gather and Evaluate Data, Information and Methodologies

As outlined in *Neb. Rev. Stat.* § 46-715(2)(e), ongoing programs and new studies or other projects may become a source of information that is used to evaluate the effectiveness of controls adopted by the LRNRD and the DNR. The LRNRD and DNR will jointly pursue and/or evaluate studies, contingent upon budget and staff resources, to evaluate their potential effectiveness in achieving the goals and objectives of this IMP.

The following potential studies have been identified by the DNR and the LRNRD: (1) crop rotation, (2) vegetation management, (3) irrigation scheduling, (4) a survey of the type and location of irrigation systems throughout the LRNRD, (5) tillage practices, and (6) conjunctive management.

B. Monitoring

Part One of this Monitoring Section describes the tracking and reporting of water use activities within fully appropriated areas of the district by the LRNRD and the DNR. Part Two of this Monitoring Section describes the analyses that will be utilized to annually forecast the projected depletions in each subsequent year. This accounting and forecast in accordance with

Neb. Rev. Stat. § 46-715(6) will serve to increase the understanding and test the validity of the conclusions and information upon which this plan is based.

Compact accounting and data exchanges among the states shall be done annually in accordance with the FSS, dated December 15, 2002, including the RRCA Accounting Procedures and Reporting Requirements which are contained in Appendix C thereof. An annual report of the RRCA is published each year. The accounting procedures, reporting requirements, and annual report of the RRCA are independent of this monitoring plan, and therefore are not restated within the Monitoring Section of this plan.

1. Part One: Tracking and Reporting of Water Use Activities

The LRNRD and the DNR will make all documents, reports, records, computer runs or other calculations or material necessary to determine compliance with the Compact available to each other, regardless of whether such documents are available under the Nebraska Public Records Act or otherwise, unless such materials are identified as confidential under Nebraska statutes or by a ruling of a court of competent jurisdiction. Specifically, and without limitation, the LRNRD agrees to annually provide GIS coverage maps of all lands irrigated and to meter, record and provide to the DNR its ground water usage records and irrigation system details. The LRNRD shall make copies of district actions taken on variances, offsets, and similar actions available to DNR.

The DNR agrees to make available to the LRNRD all reports and records of the other NRDs necessary to determine their compliance with reductions, as well as all documentation and reports utilized by the DNR to determine the basin's virgin water supplies and Nebraska's compliance with the Compact.

In the event any materials are withheld by either DNR or LRNRD under a claim of statutory confidentiality, the party withholding such materials shall describe the contents of the materials and reasons for the denial in accordance with *Neb. Rev. Stat.* § 84-712.04.

2. Part Two: Forecast Procedures

Each year in compliance with *Neb. Rev. Stat.* § 46-715(6) the DNR in consultation with the Republican River NRDs shall forecast the maximum amount of water that may be available from streamflow for beneficial use in the short term and long term to comply with the Compact. This forecast will be used to assist the DNR and the NRDs in ensuring compliance with the Compact. DNR in conjunction with the NRDs will annually evaluate the forecast procedures and make changes as deemed necessary to reflect management actions being taken in the basin.

In order to complete the forecast, the DNR and LRNRD in conjunction with the other NRDs will review available information and determine if additional controls must be implemented within any district for Compact Call Year compliance. The forecast will be completed prior to January 1st of each year, and will detail the expected shortfall within each district in the event that the coming year is a Compact Call Year. By the following January 31st, if

necessary, the LRNRD will provide DNR with details regarding existing management alternatives (such as execution of existing surface water leases) in lieu of additional ground water regulations or controls to make up for the expected shortfall.

The procedures developed to complete the forecast will be reviewed annually by the DNR to determine if modifications are necessary. The forecast will project the next year's balance (projected Nebraska allocation plus projected Imported Water Supply less the projected Computed Beneficial Consumptive Use, or CBCU), and the projected water short year and normal year accounting balances. These balances will be utilized in conjunction with other information to determine if a Compact Call Year exists.

The DNR's calculation of allowable ground water depletions for the LRNRD and determination of the necessity for additional controls will utilize additional ground water model information, estimated end-of-year information for reservoir volumes, and estimated streamflow to determine on an annual basis whether additional NRD-specific controls must be implemented.

a. Determination of Available Streamflow

The forecast will typically determine the forecast values for both Guide Rock (water short year accounting point) and Hardy (normal year accounting point). The DNR's forecast values for Guide Rock will include: 1) the one-year balance (projected allocation less the projected CBCU plus the imported water supply); two-year average, and three-year average. The DNR's forecast values for Hardy will include: 1) the one-year balance (projected allocation less the projected CBCU plus the imported water supply) and 2) the five-year average. These forecasted values will be used in conjunction with sections IX.B.2.b, IX.B.2.c, IX.B.2.d, and IX.B.2.e to determine when management actions or controls must be implemented. The DNR will calculate forecast values for the next year using the variables in table 2.

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Lower Republican NRD

Table 2. Information Used for Forecast of Allowable Depletions.

Year	Item	Information Source
T – 3		Draft; current Accounting Procedures (v. 2005)
T – 2		Draft; current Accounting Procedures (v. 2005)
T – 1		Draft; current Accounting Procedures (v. 2005)
Provisional Data for T = 0 (Current Year or Immediate Past Irrigation Season)	Pumping	Power records estimate
	Surface Water Use	Estimated from preliminary data and previous years values
	Streamflow	Available provisional records end of year estimated
	Evaporation	T – 1 records
Forecast Year T + 1 (Coming Irrigation Season)	Ground Water Consumptive Use and Imported Water Supply Credit	Average values for T = 0 and T – 1
	Surface Water Consumptive Use	Colorado: Average of T – 1 and T – 2 use Kansas: + (.1858 x HCL content) + 9,575 Nebraska: $-(4\times10^{-7}) \times (\text{NE lake volume})^2$ + (0.52) x (NE lake volume) - 42,000
	Streamflow	+ (5-year average of state line flows) x 0.41 + 0.23 x HCL content - 27,450

In accordance with *Neb. Rev. Stat.* § 46-703(6), DNR, the NRDs, and surface water project sponsors shall meet prior to the final forecast of allowable streamflow depletions and determination of Compact Call Years. At this meeting the involved parties will discuss the forecasted streamflow and surface water consumptive use. From these discussions, surface water project sponsors may present a plan to DNR to achieve a consumptive use that is less than forecasted consumptive use. Such a plan could avoid a potential Compact Call Year. This plan must be completed and provided to the DNR no later than December 1st of the current year (T = 0).

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Lower Republican NRD

The following equations will be utilized to determine the one-year balance for the forecast year.

$$CWS = + SwCBCU_{NE} + SwCBCU_{KS} + SwCBCU_{CO} + GwCBCU_{NE} + GwCBCU_{KS} + GwCBCU_{CO} + \text{State Line Streamflow}$$

Nebraska Allocation = CWS * 0.5

$CBCU_{NE} = SwCBCU_{NE} + GwCBCU_{NE}$

IWS = Imported Water Supply Credit

Hardy One-Year Balance = Nebraska Allocation + IWS – $CBCU_{NE}$

Guide Rock One-Year Balance = Hardy One-Year Balance * 0.89 – 9040

Where:

T – 3 = Three years ago from the current year

T – 2 = Two years ago from the current year

T – 1 = One year ago from the current year

T = 0 = The current year

T + 1 = The upcoming year that is being forecasted

CWS = Computed Water Supply

$GwCBCU_{NE, KS, CO}$ = Ground Water Computed Beneficial Consumptive Use for each respective state

$SwCBCU_{NE, KS, CO}$ = Surface Water Computed Beneficial Consumptive Use for each respective state

Nebraska Allocation = CWS x 0.5: The amount of water the state of Nebraska is allowed to use over one year

Balance = The sum of Nebraska's Allocation, plus the Nebraska Imported Water Supply, less Nebraska's Computed Beneficial Consumptive Use

The one-year balance for normal year accounting (Hardy One-Year Balance) and water short year accounting (Guide Rock One-Year Balance) will be utilized to

project the two-year and three-year average balances above Guide Rock and the five-year average balance above Hardy.

b. Compact Call Year Evaluation

This section of the monitoring plan specifies the process that will be completed by the DNR to determine the Compact Call Years, as detailed in Attachment 1, Republican River Water Supply Evaluation and Required Actions Flowchart. This evaluation takes into account reservoir content and recent balances above Guide Rock and Hardy and the annual forecast as described above in Section IX.B.2.a. This process will be completed and provided to the LRNRD by DNR prior to January 1st of each year.

Checklist A. Water Short Year Test

1) Is the forecast projection for the coming year's irrigation supply less than 119 kAF?
    a. Yes. Proceed to Checklist B.
    b. No. Proceed to Checklist C.

Checklist B. Water Short Year

1) Is the current year's balance (T = 0) above Guide Rock sufficient to offset the dry year forecast for next year's balance above Guide Rock minus 10 kAF[1]?
    a. Yes. Proceed to Checklist D.
    b. No. COMPACT CALL YEAR: The DNR will determine each NRD's share of any potential overuse and propose adjustments in accordance to Section IX.B.2.c. of this IMP.

Note: If it is beneficial to utilize the alternative water short year provisions from the FSS (the previous two years have a greater balance than last year alone), and an alternative water short year plan has been approved by the RRCA, then the two-year balance (for T = 0, the current year, and T – 1, the prior year) will be substituted for the current year's balance in Checklist B.

[1] In the event it is the second consecutive Compact Call Year, this value will be reduced to 5k AF. For any remaining consecutive Compact Call Years, it will be reduced to zero.

Checklist C. Early Warning System for Water Short Year Compliance

1) When Harlan County Lake declines from one year to the next, the December end-of-month (EOM) content is generally about 84% of what it was last year. A December EOM of 246 kAF provides a high level of confidence that the coming year (T + 1) will not be water short. Based on the current year's (T = 0) Harlan County Lake December EOM content, compute a dry-year projection for next year (T + 1) based on this relationship. Is the value greater than 246 kAF?
    a. Yes. Proceed to Checklist D.
    b. No. Advance to question 2.

2) Is the dry year forecast for next year's (T + 1) balance above Guide Rock greater than zero?
    a. Yes. Proceed to Checklist D.
    b. No. Advance to question 3.

3) Is the current year's balance (T = 0) above Guide Rock sufficient to offset the dry year forecast for next year's balance (T + 1) above Guide Rock minus 10 kAF[2]?
    a. Yes. Proceed to Checklist D.
    b. No. COMPACT CALL YEAR: The DNR will determine each NRD's share of any potential overuse and propose adjustments in accordance to Section IX.B.2.c. of this IMP.

Checklist D. Normal Year Administration

1) Will the forecast for next year (T + 1) result in a 5-year average at Hardy that is greater than 10 kAF?
    a. Yes. Analyze long term trends and additional adjustments in accordance to Section IX.B.2.e.
    b. No. Advance to question 2.

2) Will both the forecast for next year result in a 5-year average at Hardy (T – 3, T – 2, T – 1, T = 0, and T + 1) that is greater than zero and the average balance at Hardy of the most recent four years (T – 2, T – 1, T = 0, and T + 1) be greater than zero?
    a. Yes. Analyze long term trends and additional adjustments in accordance to Section IX.B.2.e.
    b. No. COMPACT CALL YEAR: The DNR will determine each NRD's share of any potential overuse and propose adjustments in accordance to Section IX.B.2.c. of this IMP.

[2] In the event it is the second consecutive Compact Call Year, this value will be reduced to 5k AF. For any remaining consecutive Compact Call Years, it will be reduced to zero.

c. Calculation of Allowable Ground Water Depletions for the LRNRD and Determining the Necessity of Additional Controls

This section of the monitoring plan specifies the calculations which will be completed by the DNR to determine the allowable ground water depletions for the LRNRD in any Compact Call Year. These procedures will be utilized to indicate when additional controls must be implemented by the LRNRD and DNR to ensure compliance with this IMP in the event that the DNR's forecast, provided prior to January 1st of each year, indicates a Compact Call Year. These procedures will incorporate information provided by the LRNRD (contracts for water leasing, augmentation, etc.) to the DNR by January 31st of each year following a forecast that indicates a Compact Call Year. The procedures for determining the allowable ground water depletion for the LRNRD are as follows.

The allowable ground water depletion for the LRNRD =

(Nebraska Allocation + IWS – $SwCBCU_{NE}$ – Other NRD CBCU) * 0.26

Where:

Nebraska Allocation = Nebraska available water supply under the Compact

IWS = Imported Water Supply credit

$SwCBCU_{NE}$ = The surface water consumptive use by Nebraska, including net evaporative losses

Other NRD CBCU = The $GwCBCU_{NE}$ calculated for the South Platte NRD, Twin Platte NRD, Tri-Basin NRD, Central Platte NRD, and Little Blue NRD

The DNR will utilize information provided by the LRNRD by January 31st, to evaluate the following.

Step 1.LRNRD Estimated Ground Water Depletions

Ground water depletions for the LRNRD will be based on the previous 2-year average (as described in table 2 above), unless such plan provided by the LRNRD indicates that additional restrictions on ground water pumping will be imposed. If the additional restrictions would cause the pumping to be less than the previous two year average then the lower estimate will be used. In cases where that year's allocation will be less the LRNRD will provide the DNR a map indicating the geographic area subject to the allocation for that year and the maximum allocation available. The DNR will utilize the information provided by the LRNRD and represent such information in the RRCA GWM.

Step 2. Potential yield from LRNRD surface water leases/agreements, augmentation, etc.

The DNR will determine the potential yield from any surface water lease/agreement, augmentation, etc. entered into or provided by the LRNRD. In the event that augmentation is utilized, procedures for determining the project yield must have been approved by the RRCA. This potential yield will be incorporated as NRD management actions in section IX.B.2.d.

If a Compact Call Year is reached as a result of checklist B.1 or C.3 the final step to determine if additional ground water and surface water controls (refer to Section VI.B.1. and VII.H of this IMP) must be implemented is as follows.

Allowable ground water depletions for LRNRD (as determined above) - Forecasted LRNRD's portion of GwCBCU $_{NE}$ (Step 1) + Potential yield from LRNRD surface water leases/agreements, augmentation, etc. (Step 2) + Current Year's Balance (T = 0) – 3333[3].

If the resulting balance is greater than or equal to negative one-hundred (-100) acre-feet, no additional ground water and surface water controls will be implemented.

If the resulting balance is less than negative one-hundred (-100) acre-feet, the additional ground water and surface water controls (refer to Section VI.B.1. and VII.H of this IMP) must be implemented. This potential yield will be incorporated as NRD management actions in section IX.B.2.d.

Note: If it is beneficial to utilize the alternative water short year provisions from the FSS (the previous two years have a greater balance than last year alone), and an alternative water short year plan has been approved by the RRCA, then the two-year balance (for T = 0, the current year, and the prior year, T – 1) will be substituted for the current year's balance in Checklist B.

If a Compact Call Year is reached as a result of checklist D.2 the final step to determine if additional ground water and surface water controls (refer to Section VI.B.1. and VII.H of this IMP) must be implemented is as follows.

Allowable ground water depletions for LRNRD (as determined above) - Forecasted LRNRD's portion of GwCBCU $_{NE}$ (Step 1) + Potential yield from LRNRD surface water leases/agreements, augmentation, etc. (Step 2) + Previous Years Balances (T = -3, T = -2, T = -1, T = 0 or if applicable + T = -2, T = -1, T = 0)

If the resulting balance is greater than or equal to negative one-hundred (-100) acre-feet, no additional ground water and surface water controls will be implemented.

[3] In the event it is the second consecutive Compact Call Year, this value will be reduced to 1667. For any remaining consecutive Compact Call Years, it will be reduced to zero.

If the resulting balance is less than negative one-hundred (-100) acre-feet, the additional ground water and surface water controls (refer to Section VI.B.1. and VII.H of this IMP) must be implemented. This potential yield will be incorporated as NRD management actions in section IX.B.2.d.

d. Calculation of Compact Call Streamflow Volume

This section of the monitoring plan specifies the calculation which will be completed by the DNR to determine the streamflow volume necessary to ensure Compact compliance in any Compact Call Year. If DNR's forecast, provided prior to January 1st of each year, indicates a Compact Call Year, then these calculations will be made incorporating information provided by the LRNRD (contracts for water leasing, augmentation, etc.) to the DNR by January 31st of each year following a forecast that indicates a Compact Call Year. The result of these calculations will be utilized to indicate when additional controls must be implemented by the LRNRD and DNR to ensure compliance with this IMP. When such a Compact Call Year is indicated, the DNR will implement additional surface water controls (refer to Section VII.H of this IMP). Criteria that will be used to determine when administration for the "Compact Call" is no longer necessary will be based on ensuring sufficient streamflow volumes have been achieved at the compliance point. Determination of sufficient streamflow volumes to ensure Compact compliance will be determined through the following procedures.

Compact Call Streamflow Volume = Forecasted Streamflow + NRD Management Actions + Surface Water Curtailment Benefit

Where:

Forecasted Streamflow = Streamflow for T + 1; (5-year average of state line flows) x 0.41 + 0.23 x HCL content – 27,450.

NRD Management Actions = Actions taken by the LRNRD and/or other basin NRDs to enhance streamflow. These actions may include surface water or ground water leases, augmentation, or curtailment.

Surface Water Curtailment Benefit = Actions taken by DNR to ensure Compact compliance in the event that basin NRD Management Actions are not sufficient to overcome the projected negative balance.

e. Additional Adjustments Related to Long-Term Trends

The DNR and LRNRD in conjunction with the other basin NRDs will annually meet to consult to determine if additional reductions from the 98-02 pumping volumes may be warranted. Through this consultation, the DNR and LRNRD will review expected long term (5 to 20 year) increases in depletions to streamflow and discuss potential mitigation measures that may be necessary.

f. Harlan County Lake Operations

In the event that operations of Harlan County Lake are not in accordance with Appendix K of the Final Settlement Stipulation, the DNR will work in consultation with the NRDs to modify Sections VI, VII, and IX of this IMP until normal operations resume.

X. Modifications to the Integrated Management Plan

Except as provided herein, modifications to this Integrated Management Plan including the Rules and Regulations contained within this IMP shall require mutual agreement by both the LRNRD and the DNR as to the proposed changes and shall be effective when signed by both LRNRD and DNR after all legally required hearing procedures and publication requirements have been satisfied. After the proposed changes have been agreed to, a joint hearing on those changes will be required. Following the joint hearing, the LRNRD and the DNR shall issue an order reflecting the decision made.

XI. Information Considered

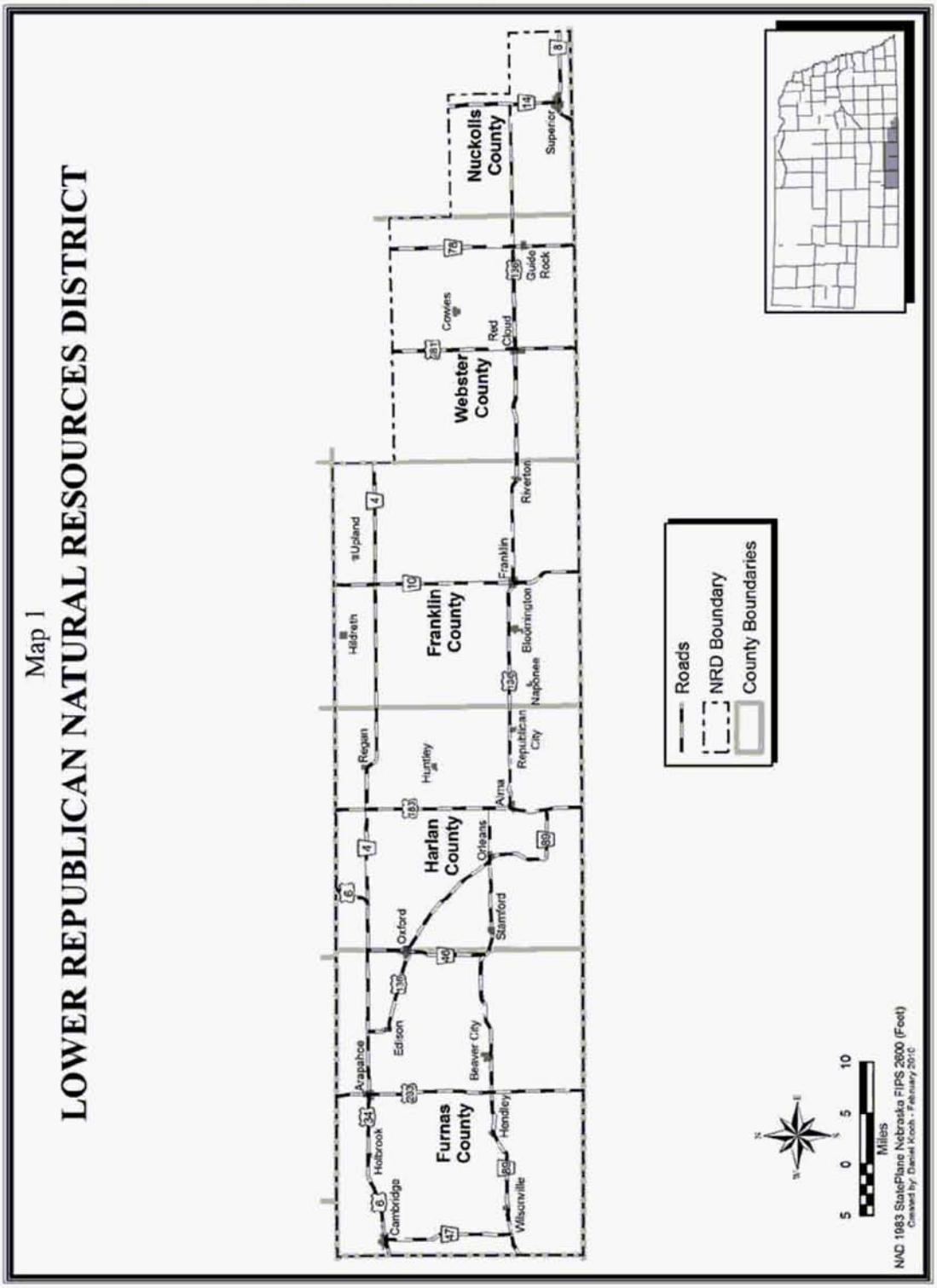
Information used in the preparation and to be used in the implementation of this IMP can be found in:

- The simulation runs of the Republican River Compact Administration Ground Water Model,
- The data tables of the FSS for the Republican River Compact,
- Chapters 3, 6 and 7 of the 1994 Lower Republican NRD Ground Water Management Plan,
- *Arbitrator's Final Decision*, Karl Dreher, June 30, 2009, and
- Additional data on file with the LRNRD and the DNR.

Effective
October 1, 2011

Lower Republican NRD

Map 1. Lower Republican Natural Resources District.



Effective
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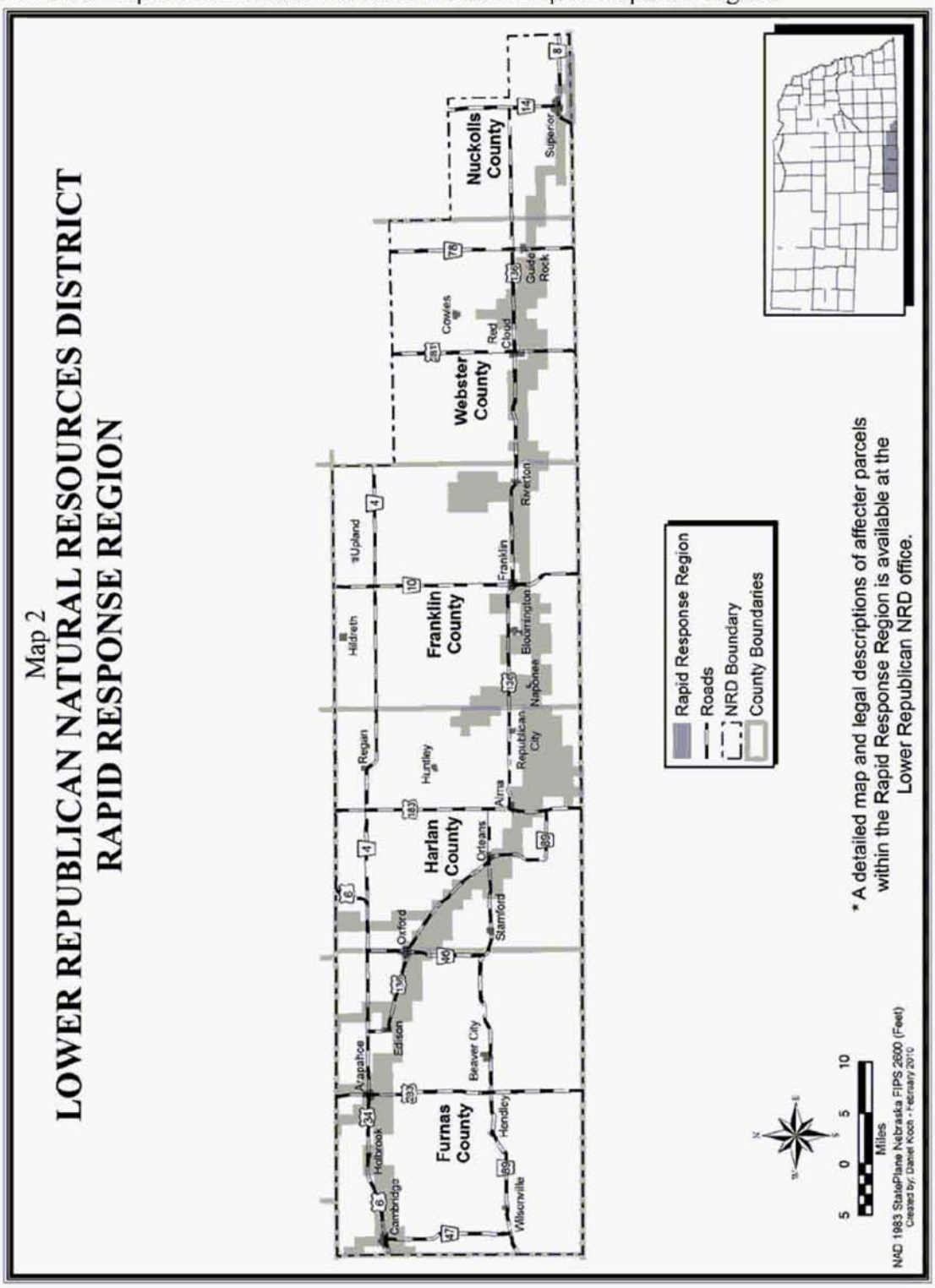
Lower Republican NRD

Map 2. Lower Republican Natural Resources District Rapid Response Region.



Effective
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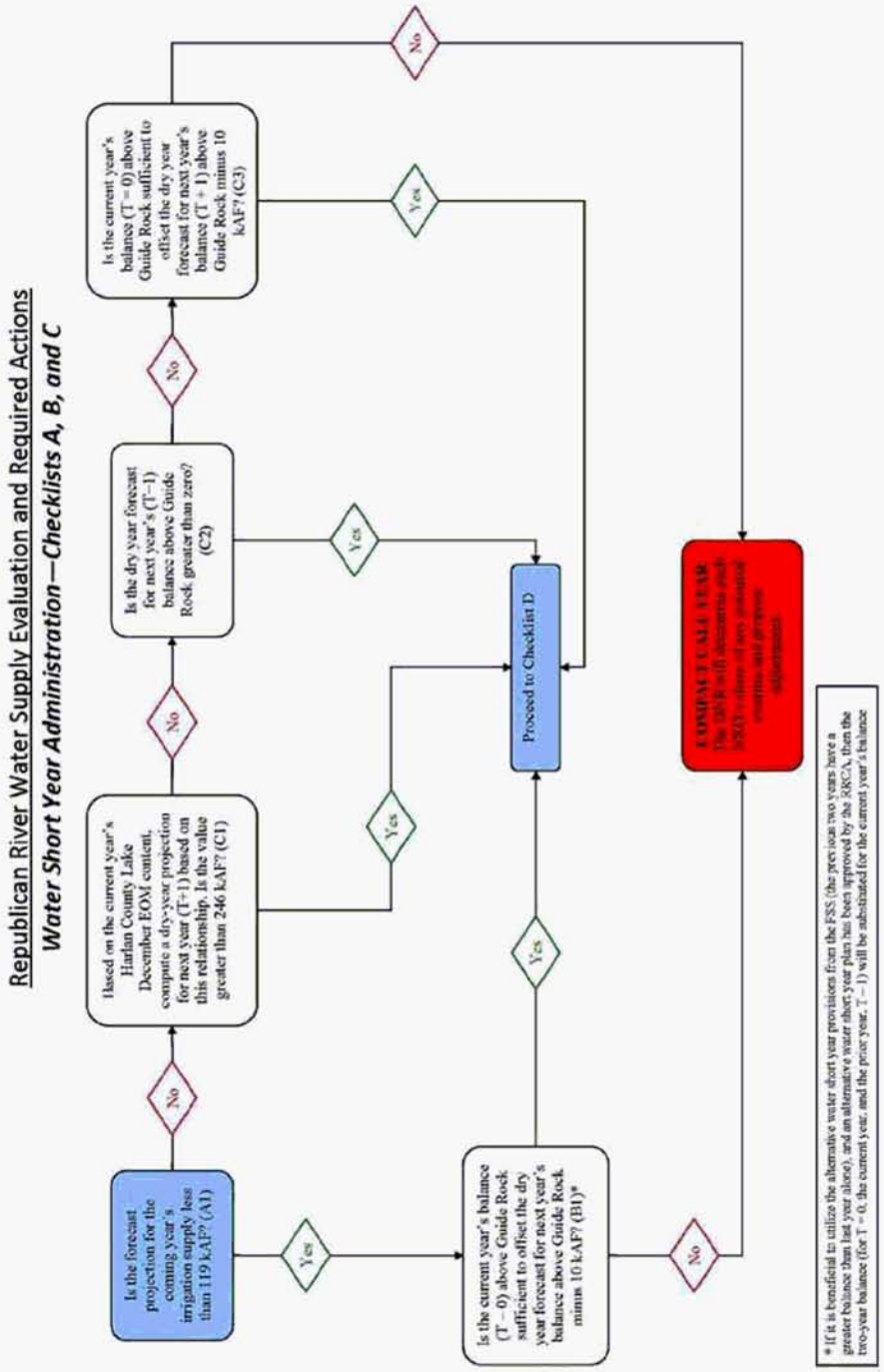
Lower Republican NRD

Attachment 1. Republican River Water Supply Evaluation and Required Actions Flowchart.



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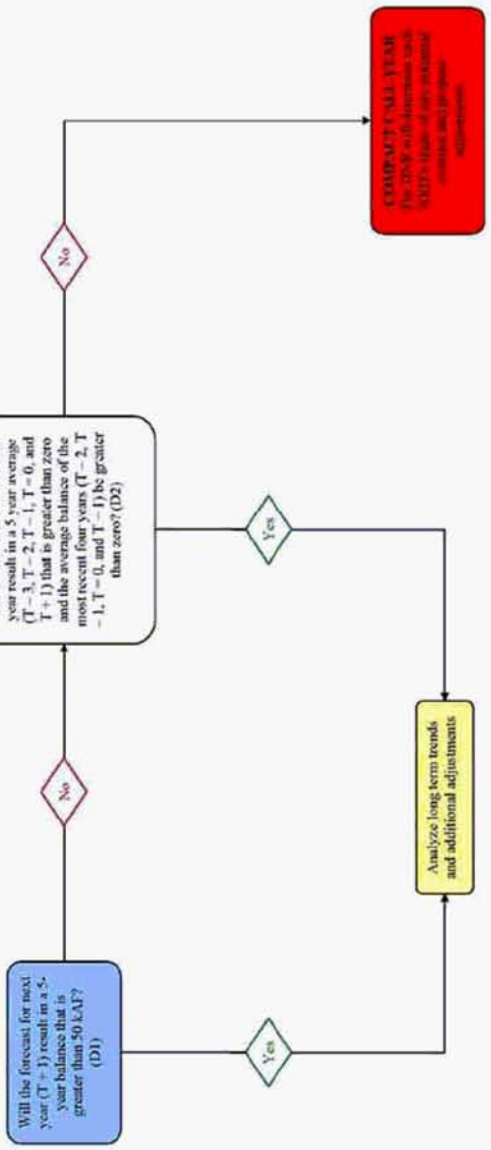
October 1, 2011

Lower Republican NRD

Republican River Water Supply Evaluation and Required Actions

Normal Year Administration—Checklist D



Effective
November 1, 2010

Middle Republican NRD

INTEGRATED MANAGEMENT PLAN
Jointly Developed by the
DEPARTMENT OF NATURAL RESOURCES
and the
MIDDLE REPUBLICAN NATURAL RESOURCES DISTRICT

I. Authority

This integrated management plan (IMP) was prepared by the Board of Directors of the Middle Republican Natural Resources District (MRNRD) and the Nebraska Department of Natural Resources (DNR) in accordance with the Nebraska Ground Water Management and Protection Act, *Neb. Rev. Stat.* §§ 46-701 to 46-753 (Reissue 2004).

II. Background

In 1943 the States of Colorado, Kansas and Nebraska entered into the Republican River Compact (Compact) with the approval of Congress. The Compact provides for the equitable apportionment of the "virgin water supply" of the Republican River Basin. Following several years of dispute about Nebraska's consumptive use of water within the basin, Kansas filed an original action in the United States Supreme Court (Court) against the states of Nebraska and Colorado in 1998. After several rulings by the Court and its Special Master and several months of negotiation, all three states entered into a comprehensive agreement known as the Final Settlement Stipulation (FSS). The FSS was approved by the Court on May 19, 2003, and the Special Master's final report approving the Joint Ground Water Model developed by all three states for use in computing stream flow depletions resulting from ground water use and for computing the imported mound credit was submitted to the Court on September 17, 2003.

In July, 1996, the MRNRD and the other three natural resources districts (NRDs) in the Republican River Basin, pursuant to then Section 46-656.28 of the Nebraska statutes, initiated a joint action planning process with the Department of Water Resources (DWR), the predecessor agency to DNR. In accordance with that process, DWR first made a preliminary determination in 1996 that "there was reason to believe that the use of hydrologically connected ground water and surface water resources is contributing to or is in the reasonably foreseeable future likely to contribute to disputes over the Republican River Compact." When the studies required by Section 46-656.28 had been completed, DNR issued its conclusions on May 20, 2003, in the form of a report entitled: "Republican River Basin, Report of Preliminary Findings." Those conclusions included the following determination:

> Pursuant to Section 46-656.28 and the preliminary findings in this report, the Department determined that present and future Compact disputes arising out of the use of hydrologically connected ground water and surface water

resources in the Republican River Basin could be eliminated or reduced through the adoption of a joint action plan.

Following four hearings on that report, DNR made final the preliminary conclusions in the report and the four basin NRDs were so informed. The MRNRD and the other three NRDs each then adopted orders to proceed with developing a joint action plan for integrated management of hydrologically connected surface water and ground water resources in the Basin; preparation of a joint action plan for the MRNRD began soon thereafter.

The Nebraska Legislature adopted LB962 in April of 2004 and it was signed by Governor Johanns on April 15, 2004, and became operative on July 16, 2004. That bill repealed Section 46-656.28 and replaced it with legislation providing for a revised process for addressing hydrologically connected surface water and ground water resources. In order to avoid the need to begin anew the integrated management planning processes that had been commenced but not completed under Section 46-656.28, LB962 provided for the transition of those ongoing planning processes into the newly enacted process now codified as Sections 46-713 to 46-719. The MRNRD and DNR agreed that preparation of a joint action plan had not been completed prior to July 16, 2004; therefore, subsection (3) of what is codified as Section 46-720, governs that transition. Completion of this plan proceeded under the new process and this plan was adopted in accordance with Section 46-718.

The MRNRD and the DNR adopted an IMP effective January 1, 2005, that contained ground water rules and regulations for the 2005-2007 period. That IMP established an average ground water allocation of thirteen (13) inches per certified acre, certified all uses and included several other controls. A goal of the 2005 IMP was to reduce water use by five percent (5%) from the 1998-2002 baseline. The IMP was updated and revised for 2008 – 2012, with a goal of reducing water use by twenty percent (20%) from the 1998-2002 baseline.

Although the MRNRD's allowable depletions to stream flow are limited to 30% of Nebraska's allowable depletions, there were no details in the plan to describe how this would be accomplished. In 2008 Colorado, Kansas, and Nebraska entered into dispute resolution regarding a number of issues, including future compliance. In June 2009 the arbitrator issued a finding that the MRNRD IMP may be adequate during years with average and above-average precipitation, but since water-short year measures were not specifically identified, the plan may not be adequate during multiple dry years, an issue addressed in this IMP

Since that time, efforts have been taken to implement or conduct incentive programs, studies, and research to further our understanding and ability to comply with the Republican River Compact and the FSS.

III. Agreements

The MRNRD and the DNR wish to adopt and implement a revised IMP for the regulation of water resources within the district as required by the laws of the State of Nebraska. The MRNRD and the DNR agree that the IMP for the district shall keep the district's average net depletions to an amount within thirty percent (30%) of the State's average allowable ground water depletions. Based upon its calculations the DNR believes that at the time this IMP became effective, a twenty percent (20%) reduction from the 98-02 pumping volume would be sufficient, without additional stream flow augmentation, to keep the district's average net depletions within the MRNRD's thirty percent (30%) share of the State's allowable ground water depletions. As described in sections below, during periods of low water supply additional reductions from the 98-02 pumping volume may be necessary.

The DNR has determined pumping volumes, depletion volumes, and depletion percentages for the period 1998-2002 defined as "1998-2002 Baselines". The pumping volumes are used throughout this IMP and are referenced as the "98-02 pumping volume". DNR, through the use of the Republican River Compact Administration Ground Water Model, has also determined each District's impact on stream flow for the baseline period and those impacts are defined as "98-02 depletion volume". Those depletion volumes have resulted in depletion percentages used throughout this IMP and defined as "98-02 depletion percentages."

The failure of any District to adopt, implement, or enforce an IMP adequate to meet their proportionate share of the responsibility to achieve and maintain Nebraska's compliance with the Compact shall not by itself require any additional action by the other Districts. Neither the MRNRD nor DNR will require the IMP to be amended solely for the purpose of changing the responsibility of water users within the MRNRD based on the failure of the other Basin NRDs to implement or enforce an IMP to meet their share of the responsibility to keep Nebraska in compliance with the Republican River Compact.

IV. Definitions

A. 1998-2002 Baselines - The depletions to stream flow, in the Nebraska portion of the Republican River Basin, as a result of ground water uses in the years 1998-2002 inclusive.

98-02 Pumping Volume:
URNRD-531,763 AF, MRNRD-309,479 AF, LRNRD-242,289 AF
98-02 Depletion Volume:
URNRD-74,161 AF, MRNRD-52,168 AF, LRNRD-43,954 AF
98-02 Depletion Percentage:
URNRD-44%, MRNRD-30%, LRNRD-26%

B. **Allowable Stream flow Depletions** - the maximum amount of stream flow depletion in the Republican River Basin that can occur in a given year without Nebraska exceeding its allocation. Allowable stream flow depletions are the sum of the allowable ground water depletions and the allowable surface water depletions.

C. **Allowable Ground Water Depletions** - the maximum level of depletions to stream flow that may occur as a result of ground water pumping of wells within the Republican River Basin that can occur in a given year without Nebraska exceeding its allocation.

D. **Allowable Ground Water Depletion for the MRNRD** - the annual mean depletions to stream flow resulting from the impact of ground water pumping in the MRNRD. These depletions shall average no greater than 30% of the allowable ground water depletion. The average shall be computed using the allowable annual ground water depletion for the same years as are used to determine the averages for Nebraska's compliance with the FSS.

E. **Supplemental Programs** – as used in this plan, refers to, but is not limited to; surface water or ground water augmentation projects, river flow enhancement projects, incentive programs, riparian management projects and other projects that may reduce the District's net depletions to stream flow.

F. **Compliance Standard** - the criteria that will be used to determine whether the controls of this IMP and the MRNRD's rules, regulations, and other programs are sufficient to meet the goals and objectives of this IMP pertaining to pumping volumes and depletions

G. **Net Depletion** – the actual ground water depletion for the MRNRD less any reduction in stream flow depletions or increase in accretions to the stream resulting from supplemental projects as determined by the RRCA ground water model and in accordance with the RRCA Accounting Procedures.

H. **Compact Call Year** –A year in which the Department's forecast procedures outlined in Section X.B.2.b of this IMP indicate the potential for non-compliance if sufficient surface water and ground water controls and/or management actions are not taken. Compact Call Year streamflow administration will be conducted by the Department in a manner consistent with Section X.B.2.d of this IMP. Pursuant to Article VI of the Republican River Compact, diversions into the Courtland Canal for beneficial use in the State of Kansas will not be subject to the Compact Call.

V. Goals and Objectives

Pursuant to *Neb. Rev. Stat.* § 46-715 (Reissue 2004), the goals and objectives of this IMP must have a purpose of "sustaining a balance between water uses and water supplies so that the economic viability, social and environmental health, safety, and welfare of the river basin... can be achieved and maintained for both the near term and the long term." The MRNRD will meet its responsibility under Neb. Rev. Stat. § 46-715, including meeting the obligations under the FSS, by adopting revised rules to implement the IMP with regulations and other supplemental programs.

The following goals and objectives are adopted by the MRNRD and the DNR to achieve the purpose stated above:

A. Goals:

1. In cooperation with the other basin NRDs and the Nebraska Department of Natural Resources, maintain compliance with the Compact as adopted in 1943 and as implemented in accordance with the FSS approved by the United States Supreme Court on May 19, 2003.

2. Ensure that ground water and surface water users within the MRNRD assume their share, but only their share, of the responsibility to keep Nebraska in compliance with the Compact.

3. Provide that MRNRD's share of compliance responsibility and impacts to stream flow be apportioned within the MRNRD in an equitable manner and by minimizing, to the extent possible, adverse economic, social, and environmental consequences.

4. Reserve and protect any increases to stream flow available from regulation or supplemental programs, enacted or implemented to maintain Compact compliance, from any use that would negate the benefit of such regulation or programs, to the extent allowed by statute and the surface water controls of this IMP.

5. Protect ground water users whose water wells are dependent on recharge from the river or stream and the surface water appropriators on such river or stream from stream flow depletions caused by surface water uses and ground water uses begun after the date the river basin was designated as fully appropriated.

B. Objectives:

1. With limited exceptions, prevent the initiation of new or expanded uses of water that increase Nebraska's computed beneficial consumptive use of water within the MRNRD.

2. Ensure that administration of surface water appropriations in the basin is in accordance with the Compact and in full compliance with Nebraska law and the surface water controls of this IMP.

3. Achieve, on average, a twenty percent (20%) reduction in 98-02 pumping volume under average precipitation conditions.

4. Maintain, on average, the MRNRD net depletions at or below thirty percent (30%) of the allowable ground water depletion.

5. After taking into account any reduction in beneficial consumptive use achieved through district or basin-wide supplemental projects and other projects developed at the basin or district level with the expressed purpose or result of reducing consumptive use or increasing stream flow, make such additional reductions in ground water use in Compact Call Years as are necessary to achieve a reduction in beneficial consumptive use in the MRNRD to 30% of Nebraska's allowable ground water depletions to stream flow in such years. Compact Call Years will be determined through the procedures outlined in Section X of this IMP.

6. Achieve the required reductions in water use through a combination of regulatory and supplemental programs designed to reduce beneficial consumptive use. To the extent funds are available, incentive programs will be made available to as many MRNRD water users as possible.

7. The MRNRD and the DNR will investigate or explore methods to manage the impact of vegetative growth on stream flow.

8. Develop a procedure to provide offsets for new consumptive uses of water so that economic development in the MRNRD may continue without producing an overall increase in ground water depletions as a result of new uses.

VI. Map

The area subject to this IMP is the geographic area within the boundaries of the MRNRD (see Map 1). The Rapid Response Region is shown as a sub-area within the boundaries of the MRNRD, (see Map 2). The Quick Response region is shown as a sub-area within the boundaries of the MRNRD, (see map 3).

VII. Ground Water Controls

In accordance with *Neb. Rev. Stat.* § 46-715, one or more of the ground water controls authorized by *Neb. Rev. Stat.* § 46-739 and *Neb. Rev. Stat.* § 46-740 shall be adopted for the purpose of implementing this plan. Other authorities, provided for in the Ground Water Management and Protection Act, may be used to supplement

these controls. These controls, along with any applicable supplemental programs, shall be consistent with the goals and objectives of this plan and be sufficient to meet the compliance standards set forth below, ensure that the state will remain in compliance with the Compact, and protect the ground water users whose water wells are dependent on recharge from the river or stream and the surface water appropriators on such river or stream from stream flow depletion caused by surface and ground water uses begun after July 16, 2004, the date the river basin was designated as fully appropriated, in accordance with *Neb. Rev. Stat.* §§ 46-720 and 46-713-46-715,

The Rules and Regulations – Ground Water Management Area in the Middle Republican Natural Resources District contains the rules for implementation of controls required by the FSS and other controls needed for the effective administration of a ground water management subarea for integrated management. The actions proposed by the FSS were rules and regulations for transfers, meters, and certification of acres. In addition, a well drilling moratorium and a ban on the increase of irrigated acres were also implemented. The compliance standard and management activities listed below will be or have been implemented to achieve and maintain Compact compliance.

Amendments to the MRNRD rules and regulations dealing with the requirements of *Neb. Rev. Stat.* §46-715(4)(b), and §46-715(4)(c) shall have the concurrence of DNR. The MRNRD may otherwise amend those regulations without the approval of the DNR so long as the compliance standards listed below are met.

The Determination of whether the MRNRD is in compliance with the compliance standards shall be made prior to the regular annual meeting of the RRCA and shall be based on each year's annual Compact accounting.

A. Compliance Standards

1. Purpose

   These Compliance Standards are established by DNR and MRNRD to assess whether the course of action taken by the MRNRD, with the intention of providing a proportionate share of assistance to the State, is sufficient for the State to maintain compliance with the FSS and the Compact. The action taken by the MRNRD shall be evaluated in connection with the action taken by the other NRDs in the Republican River Basin and any other relevant considerations, including the information and data provided by DNR and past action by the district.

2. Duration

   On an annual basis the DNR and MRNRD shall examine the sufficiency and effectiveness of the Compliance Standards to determine if amendments or

revisions to this IMP are necessary to ensure the State's compliance with the FSS and the Compact. Nothing contained herein shall prohibit or preclude any amendment or revision, at anytime, by the DNR and MRNRD, when such action is necessary. Further, nothing contained in this subsection shall be construed as eliminating the review of the provisions of this IMP as allowed by *Neb. Rev. Stat.* §46-715.

3. Standards

The MRNRD shall adopt and implement rules and regulations which shall ensure that the following standards are met. The standards shall be affected through the procedure described in Section X - Monitoring and Studies. Section X specifies a forecast and resulting actions needed at the Guide Rock compliance point (during water short years) and at the Hardy compliance point. The procedures for determining whether the compliance standards are met will be based on the RRCA Accounting Procedures, the baseline ground water depletion percentage, and the annual forecast as outlined in Section X. The standards are

a. A minimum of twenty percent (20%) reduction in pumping from the 98-02 pumping volume using a combination of regulation and supplemental programs so that the average ground water pumping volume is no greater than 247,580 acre-feet over the long term. The ground water pumping volume for any single year may be above 247,580 acre-feet.

b. An additional reduction in 98-02 pumping volumes of five percent (5%) during the next five year period shall be accomplished primarily through voluntary incentive programs and other means as determined by the MRNRD. The necessity for continuing this annual reduction shall be reevaluated by DNR and the MRNRD in 2015.

c. The district's net depletions to stream flow shall average no greater than thirty percent (30%) of the State of Nebraska's allowable ground water depletions as computed using the RRCAGWM. The average shall be computed using the annual allowable ground water depletion for the same years as are used to determine the averages for Nebraska's compliance with the FSS.

B. Other Controls and Management Activities

The MRNRD and the DNR recognize that the required reductions in water consumption could be accomplished by means other than those adopted in this IMP. The IMP and associated controls may need to be amended in the future to implement any such revisions.

1. During Compact Call Years, the MRNRD will seek to implement management actions (such as surface water leasing, ground water leasing, augmentation, etc.) to ensure compliance with this IMP. These management actions will be implemented through the authorities granted by the Nebraska Ground Water Management and Protection Act, *Neb. Rev. Stat.* §§ 46-701 to 46-753. Details of such management actions will be provided to DNR by January 31 of each year for evaluation. If such management actions are insufficient to ensure compliance with this IMP, the MRNRD will in the alternative to management actions, implement additional ground water controls and regulations to make up for its proportionate share of any expected shortfall as identified in the annual forecast and described in Section X of this IMP. Such additional control will include but not be limited to, restriction or curtailment of ground water pumping within the Rapid Response Region of the MRNRD and restrictions on ground water pumping in all other sub areas of the district.

2. When necessary to ensure compliance with this IMP during Compact Call Years, the MRNRD may set a one year pumping allocation within the district. Such allocation will set the maximum pumping level in that year within any region or sub-region.

3. Maintain a moratorium on new uses with the exceptions noted in the FSS.

4. Limit or prevent the expansion of irrigation uses.

5. Maintain requirement for metering of all ground water uses according to MRNRD standards.

6. Provide for transfers according to NRD standards.

7. The MRNRD shall make available to DNR copies of NRD actions taken on variances and consult with DNR to minimize or eliminate any impact, relating to Compact compliance, that may arise as a result of a variance granted by the district.

8. DNR will consult with the MRNRD when considering applications for permits under the Municipal and Rural Domestic Ground Water Transfers Permit Act, the Industrial Ground Water Regulatory Act or other such permitting actions by the DNR that will have an impact on water supplies of the Republican River Basin.

9. The MRNRD will work with DNR to achieve the maximum amount of benefit in the accounting of leased or purchased water, augmentation projects or in similar projects.

Effective
November 1, 2010

Middle Republican NRD

VIII Surface Water Controls - Department of Natural Resources

The authority for the surface water component of this IMP is *Neb. Rev. Stat.* §46-715 and §46-716. The surface water controls that will be continued and/or begun by the DNR are as follows:

A. DNR will do the following additional surface water administration as required by the FSS:

1. To provide for regulation of natural flow between Harlan County Lake and Superior-Courtland Diversion Dam, Nebraska will recognize a priority date of February 26, 1948, for Kansas Bostwick Irrigation District, the same priority date as the priority date held by the Nebraska Bostwick Irrigation District's Courtland Canal water right.

2. When water is needed for diversion at Guide Rock and the projected or actual irrigation supply is less than 130,000 acre-feet of storage available for use from Harlan County Lake as determined by the Bureau of Reclamation using the methodology described in Harlan County Lake Operation Consensus Plan attached as Appendix K to the FSS, Nebraska will close junior, and require compliance with senior, natural flow diversions of surface water between Harlan County Lake and Guide Rock.

3. Nebraska will protect storage water released from Harlan County Lake for delivery at Guide Rock from surface water diversions.

4. Nebraska will take actions to minimize the bypass flows at Superior-Courtland Diversion Dam in concert with Kansas and in collaboration with the United States, and in the manner described in Appendix L to the FSS.

B. Metering of all surface water diversions at the point of diversion from the stream will continue to be required. For surface water canals that are not part of a Bureau of Reclamation project, farm turnouts also will be required to be metered. All meters shall have a totalizer and shall meet DNR standards for installation, accuracy and maintenance. All appropriators will be monitored closely to ensure that neither the rate of diversion nor the annual amount diverted exceeds that allowed by the applicable permit or by statute.

C. The DNR's moratorium on the issuance of new surface water permits was made formal by Order of the Director dated July 14, 2004, and will be continued. Exceptions may be granted to the extent permitted by statute or to allow issuance of permits for existing reservoirs that currently do not now have such permits. Such reservoirs are limited to those identified through the FSS required inventory of over fifteen (15) acre-feet capacity reservoirs.

D. All proposed transfers of surface water rights shall be subject to the criteria for such transfers as found in *Neb. Rev. Stat.* §§46-290 to 46-294.04 and related DNR rules or the criteria found in *Neb. Rev. Stat.* §§46-2,120 to 46-2,130 and related DNR rules.

E. The DNR completed the adjudication process for individual appropriators in the Republican River Basin upstream of Guide Rock in 2004. The results of that adjudication provided up-to-date records of the number and location of acres irrigated with surface water by such appropriators. Those records will be used by the DNR to monitor use of surface water and to make sure that unauthorized irrigation is not occurring. The DNR also will be proactive in initiating subsequent adjudications whenever information available to the DNR indicates the need for adjudication as outlined by state statutes.

F. During Compact Call Years, as determined from the procedures and analysis set forth in Section X below, DNR will regulate and administer surface water in the basin as necessary to ensure Compact compliance. During Compact Call Years, DNR will issue a "Compact Call" on the Republican River at Hardy or Guide Rock to carry out administration for the Compact in a manner consistent with the doctrine of prior appropriation. A "Compact Call" will result in DNR issuing closing notices on all natural flow and storage permits in the basin until such time as DNR in consultation with the MRNRD and other basin NRDs, determines that yearly administration is no longer needed to ensure Compact compliance, pursuant to Section X.

IX. Augmentation and Incentive Programs

The MRNRD and DNR, alone or in cooperation with other parties, intend to establish and implement financial, incentive, and qualified projects as described in *Neb. Rev. Stat.* §§ 2-3226.04 to reduce beneficial consumptive use of water within the MRNRD. These projects include, but are not limited to (1) acquisition by purchase or lease of surface water or ground water rights, including storage water rights with respect to a river or any of its tributaries, (2) acquisition by purchase or lease or the administration and management, pursuant to mutual agreement, of canals and other works, including reservoirs, constructed for irrigation from a river or any of its tributaries, (3) vegetation management, including, but not limited to, the removal of invasive species in or near a river or any of its tributaries, and (4) the augmentation of river flows. As a condition for participation in an incentive program, water users or landowners may be required to enter into and perform such agreements or covenants concerning the use of land or water as are necessary to produce the benefits for which the incentive program is established.

Such incentive programs may include any program authorized by state law and/or federal programs such as the Conservation Reserve Enhancement Program (CREP) and Environmental Quality Incentives Program (EQIP) operated by the U.S. Department of Agriculture.

Projects that have a net effect of reducing consumptive use or increasing stream flow can originate from many sources. The MRNRD will initiate these types of projects when possible and participate in projects sponsored by other groups within their capabilities.

The MRNRD, through the Republican River Basin Coalition, intends to establish and implement river flow enhancement projects.

The MRNRD, alone, and/or through the Republican River Basin Coalition, may use any or all available funding authorities to establish and implement river flow enhancement projects or any other projects that result in an increase to streamflow or a decrease in ground water depletions.

Any reductions in depletions to stream flow generated through supplemental programs, funded entirely by the State of Nebraska and / or the United States Government, including acreage retirement or other incentive programs undertaken through programs available throughout the Republican River Basin will not accrue to any specific NRD, regardless of the location or other conditions of the acreage included in the program or of the location of the effect of such water savings on the river system. Any reductions in depletions to stream flow resulting from any such basin-wide programs shall be considered, in the calculation of each NRD's compliance with the 98-02 depletion percentages. This calculation is outlined in Section X.B.2.c of this IMP.

However, should any NRD establish, fund partially or in total, and implement its own such conservation program, available only for acreage within such district, the accounting of credit for the resulting water savings shall be given exclusively to that NRD.

With agreement of the NRDs involved, the benefits from a supplemental program may be allocated to each NRD based upon their share of the cost of the program.

To the extent possible, it is the intent of the MRNRD to provide compensation to water users that are required to forgo water use to allow the MRNRD and the State to comply with the compact. This may be in addition to or as part of any other MRNRD incentive or retirement program developed to facilitate compact compliance.

X. Monitoring and Studies

The overarching purpose of the Monitoring and Studies Section is to ensure that, in cooperation with the other Republican River Basin NRDs, the DNR and MRNRD maintain compliance with the Republican River Compact as adopted in 1943 and as implemented in accordance with the FSS approved by the United States Supreme Court on May 19, 2003. The objective of the Monitoring and Studies Section of this IMP is to gather and evaluate data, information, and methodologies that could be used to increase understanding of the surface water and hydrologically connected

ground water system; to test the validity of the conclusions and information upon which this IMP is based; and to assist decision makers in properly managing the water resources within the MRNRD and the Republican River Basin as a whole.

On an annual basis the results of monitoring and studies will typically be discussed in a basin-wide meeting which will take place prior to October 31 each year. The purpose of the meeting will be to discuss the preliminary accounting for the current year, the forecast of allowable stream flow depletions for the coming year, and potential management actions as necessary. Table 1 outlines important dates and objectives related to section X.

Table 1. Important Dates and Objectives

Date	Objective
Prior to February 1	MRNRD will provide DNR with meter reading database and GIS coverage maps to be used for the RRCA annual model update.
Prior to RRCA Annual Meeting	DNR will provide MRNRD with their determination of whether the MRNRD was in compliance with the compliance standards based on each previous year's annual Compact accounting.
September - October	Obtain power records and other estimates to determine pumping for T=0 ground water model run
Prior to October 31	Discuss results of monitoring and studies, preliminary accounting for current year, and early forecast of allowable stream flow depletions
Prior to November 15	DNR will provide correspondence to MRNRD notifying them of potential Compact call determination for the coming year (T+1).
November 15 – January 1	MRNRD and DNR will discuss potential management alternatives in the situation that the coming year (T+1) will be a Compact Call Year.
Prior to December 1	Surface water project sponsors may present a plan to DNR to achieve a consumptive use that is less than forecasted consumptive use.
Prior to January 1	Provide final forecast of allowable stream flow depletions and determination of Compact Call Years.
Prior to January 31	MRNRD will provide DNR with details regarding existing management alternatives in lieu of additional ground water regulations or controls to make up for the expected shortfall.

A. Plan to Gather and Evaluate Data, Information and Methodologies

As outlined in *Neb. Rev. Stat.* §§ 46-715(2)(e) ongoing programs and new studies or other projects may become a source of information that is used to evaluate the effectiveness of controls adopted by the by the MRNRD and the DNR. The DNR and the MRNRD will jointly pursue and/or evaluate studies, contingent upon budget and

staff resources, to evaluate their potential effectiveness in achieving the goals and objectives of this IMP.

The following potential studies have been identified by the DNR and the MRNRD: (1) crop rotation; (2) vegetation management; (3) irrigation scheduling; (4) a survey of the type and location of irrigation systems throughout the MRNRD; (5) tillage practices; and (6) conjunctive management.

B. Monitoring

Part One of the Monitoring Section describes the tracking and reporting of water use activities within fully appropriated areas of the district by the MRNRD and the DNR. Part Two of the Monitoring Section describes the analyses that will be utilized to annually forecast the projected depletions in each subsequent year. This accounting and the forecast in accordance with *Neb. Rev. Stat.* § 46-715(6) will serve to increase the understanding and test the validity of the conclusions and information upon which this plan is based.

Compact accounting and data exchanges among the states shall be done annually in accordance with the FSS, dated December 15, 2002, including the Republican River Compact Administration (RRCA) Accounting Procedures and Reporting Requirements which are contained in Appendix C thereof. An annual report of the RRCA is published each year. The accounting procedures, reporting requirements, and annual report of the RRCA are independent of this monitoring plan, and therefore not restated within the Monitoring Section of this plan.

1. Part One: Tracking and Reporting of Water Use Activities

The MRNRD and the DNR will make all documents, reports, records, computer runs or other calculations or material necessary to determine compliance with the Compact available to each other, regardless of whether such documents are available under the Nebraska Public Records Act or otherwise, unless such materials are identified as confidential under Nebraska statutes or by a ruling of a court of competent jurisdiction. Specifically, and without limitation, the MRNRD agrees to annually provide GIS coverage maps of all lands irrigated and to meter, record and provide to the DNR its ground water usage records and irrigation system details. The MRNRD shall make copies of district actions taken on variances, offsets, and similar actions available to DNR.

The DNR agrees to make available to the MRNRD all reports and records of the other NRDs necessary to determine their compliance with reductions, as well as all documentation and reports utilized by the DNR to determine the basin's virgin water supplies and Nebraska's compliance with the Compact.

In the event any materials are withheld by either DNR or MRNRD under a claim of statutory confidentiality, the party withholding such materials shall describe the contents of the materials and reasons for the denial in accordance with *Neb. Rev. Stat.* § 84-712.04.

2. Part Two: Forecast Procedures

Each year in compliance with *Neb. Rev. Stat.* § 46-715(6) the DNR in consultation with the Republican River NRDs shall forecast the maximum amount of water that may be available from stream flow for beneficial use in the short term and long term to comply with the Compact. This forecast will be used to assist the DNR and the NRDs in ensuring compliance with the Compact. DNR in conjunction with the NRDs will annually evaluate the forecast procedures and make changes as deemed necessary to reflect management actions being taken in the basin.

In order to complete the forecast, the DNR and MRNRD in conjunction with the other NRDs will review available information and determine if additional controls must be implemented within any district for Compact Call Year compliance. The forecast will be completed prior to January 1 of each year, and will detail the expected shortfall within each district in the event that the coming year is a Compact Call Year. By the following January 31, if necessary, the MRNRD will provide DNR with details regarding existing management alternatives (such as execution of existing surface water leases) in lieu of additional ground water regulations or controls to make up for the expected shortfall.

The procedures developed to complete the forecast will be reviewed annually by the DNR to determine if modifications are necessary. The forecast will project the next year's balance (projected Nebraska allocation plus projected Imported Water Supply less the projected Computed Beneficial Consumptive Use, or CBCU), and the projected water short year and normal year accounting balances. These balances will be utilized in conjunction with other information to determine if a Compact Call Year exists.

The DNR's calculation of allowable ground water depletions for the MRNRD and determination of the necessity for additional controls will utilize additional ground water model information, estimated end-of-year information for reservoir volumes, and estimated stream flow to determine on an annual basis whether additional NRD-specific controls must be implemented.

a. Determination of Available Stream flow

The forecast will typically determine the forecast values for both Guide Rock (water short year accounting point) and Hardy (normal year accounting point). The DNR's forecast values for Guide Rock will include: 1) the one-year balance (projected allocation less the projected CBCU plus the imported water supply); two-year average, and three-year average. The DNR's forecast

values for Hardy will include: 1) the one-year balance (projected allocation less the projected CBCU plus the imported water supply); and 2) the five-year average. These forecasted values will be used in conjunction with sections X.B.2.b, X.B.2.c, X.B.2.d and X.B.2.e to determine when management actions or controls must be implemented. The DNR will calculate forecast values for the next year using the variables in table 2:

Table 2. Information Used for 2010 Forecast of Allowable Depletions.

Year	Item	Information Source
T – 3		Draft; current Accounting Procedures (v. 2005)
T – 2		Draft; current Accounting Procedures (v. 2005)
T – 1		Draft; current Accounting Procedures (v. 2005)
Provisional Data for T = 0 (Current Year or Immediate Past Irrigation Season)	Pumping	Power records estimate
	Surface Water Use	Estimated from preliminary data and previous years values
	Stream flow	Available provisional records end of year estimated
	Evaporation	T – 1 records
Forecast Year T + 1 (Coming Irrigation Season)	Ground water Consumptive Use and Imported Water Supply Credit	Average values for T = 0 and T - 1
	Surface Water Consumptive Use	Colorado: Average of T – 1 and T – 2 use Kansas: + (.1858 x HCL content) + 9,575 Nebraska: - $(4x10^{-7})$ x (NE lake volume)^2 + (0.52) x (NE lake volume) - 42,000
	Stream flow	+ (5-year average of state line flows) x 0.41 + 0.23 x HCL content - 27,450

In accordance with *Neb. Rev. Stat.* § 46-703(6), DNR, NRDs, and surface water project sponsors shall meet prior to the final forecast of allowable stream flow depletions and determination of Compact Call Years. At this meeting the involved parties will discuss the forecasted streamflow and surface water consumptive use. From these discussions, surface water project sponsors may present a plan to

DNR to achieve a consumptive use that is less than forecasted consumptive use. Such a plan could avoid a potential Compact Call Year. This plan must be completed and provided to the Department no later than December 1 of the current year (T=0)

The following equations will be utilized to determine the one year balance for the forecast year.

$$\begin{aligned} CWS = & + SwCBCU_{NE} + SwCBCU_{KS} + SwCBCU_{CO} \\ & + GwCBCU_{NE} + GwCBCU_{KS} + GwCBCU_{CO} \\ & + \text{Stateline Stream flow} \end{aligned}$$

Nebraska Allocation = CWS * 0.5

$CBCU_{NE} = SwCBCU_{NE} + GwCBCU_{NE}$

IWS = Imported Water Supply Credit

Hardy One Year Balance = Nebraska Allocation + IWS – $CBCU_{NE}$

Guide Rock One Year Balance = Hardy One Year Balance * 0.89 – 9040

Where:

T-3 = Three years ago from the current year

T-2 = Two years ago from the current year

T-1 = One year ago from the current year

T=0 = The current year

T+1 = The upcoming year that is being forecasted

CWS = Computed Water Supply

GW $CBCU_{NE, KS, CO}$ = Ground Water Computed Beneficial Consumptive Use for each respective state

SW $CBCU_{NE, KS, CO}$ = Surface Water Computed Beneficial Consumptive Use for each respective state

Nebraska Allocation = CWS x 0.5: The amount of water the State of Nebraska is allowed to use over one year

Balance = The sum of Nebraska's Allocation, plus the Nebraska Imported Water Supply, less Nebraska's Computed Beneficial Consumptive Use

The one year balance for normal year accounting (Hardy One Year Balance) and water short year accounting (Guide Rock One Year Balance) will be utilized to project the two-year and three-year average balances above Guide Rock and the five-year average balance above Hardy.

b. Compact Call Year Evaluation

This section of the monitoring plan specifies the process that will be completed by the DNR to determine the Compact Call Years, as detailed in Attachment 1, Republican River Water Supply Evaluation and Required Actions Flowchart. This evaluation takes into account reservoir content and recent balances above Guide Rock and Hardy and the annual forecast as described above in Section X.B.2.a. This process will be completed and provided to the MRNRD by DNR prior to January 1 of each year.

Checklist A. Water short year Test

1) Is the forecast projection for the coming year's irrigation supply less than 119 kAF?
    a. Yes. Proceed to Checklist B.
    b. No. Proceed to Checklist C.

Checklist B. Water short year

1) Is the current year's balance (T = 0) above Guide Rock sufficient to offset the dry year forecast for next year's balance above Guide Rock minus 10 kAF[1]?
    a. Yes. Proceed to Checklist D.
    b. No. COMPACT CALL YEAR: The DNR will determine each NRD's share of any potential overuse and propose adjustments in accordance to Section X.B.2.c. of this IMP.

Note: If it is beneficial to utilize the alternative water short year provisions from the FSS (the previous two years have a greater balance than last year alone), and An alternative water short year plan has been approved by the RRCA, then the two-year balance (for T = 0, the current year, and the prior year, T – 1) will be substituted for the current year's balance in Checklist B.

[1] In the event it is the second consecutive Compact Call Year, this value will be reduced to 5kAF. For any remaining consecutive Compact Call Years, it will be reduced to zero.

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Checklist C. Early Warning System for Water short year Compliance

1) When Harlan County Lake declines from one year to the next, the December end-of-month (EOM) content is generally about 84% of what it was last year. A December EOM of 246 kAF provides a high level of confidence that the coming year (T+1) will not be water short. Based on the current year's (T=0) Harlan County Lake December EOM content, compute a dry-year projection for next year (T+1) based on this relationship. Is the value greater than 246 kAF?
    a. Yes. Proceed to Checklist D.
    b. No. Advance to question 2.

2) Is the dry year forecast for next year's (T+1) balance above Guide Rock greater than zero?
    a. Yes. Proceed to Checklist D.
    b. No. Advance to question 3.

3) Is the current year's balance (T = 0) above Guide Rock sufficient to offset the dry year forecast for next year's balance (T + 1) above Guide Rock minus 10 kAF[2]?
    a. Yes. Proceed to Checklist D.
    b. No. COMPACT CALL YEAR: The DNR will determine each NRD's share of any potential overuse and propose adjustments in accordance to Section X.B.2.c. of this IMP.

Checklist D. Normal Year Administration

1) Will the forecast for next year (T + 1) result in a 5-year average at Hardy that is greater than 10 kAF?
    a. Yes. Analyze long term trends and additional adjustments in accordance to Section X.B.2.e.
    b. No. Advance to question 2.

2) Will both the forecast for next year result in a 5 year average at Hardy (T – 3, T – 2, T – 1, T = 0, and T + 1) that is greater than zero and the average balance at Hardy of the most recent four years (T – 2, T – 1, T = 0, and T + 1) be greater than zero?
    a. Yes. Analyze long term trends and additional adjustments in accordance to Section X.B.2.e.
    b. No. COMPACT CALL YEAR: The DNR will determine each NRD's share of any potential overuse and propose adjustments in accordance to Section X.B.2.c. of this IMP.

[2] In the event it is the second consecutive Compact Call Year, this value will be reduced to 5kAF. For any remaining consecutive Compact Call Years, it will be reduced to zero.

c. Calculation of Allowable Ground water Depletions for the MRNRD and Determining the necessity of Additional Controls

This section of the monitoring plan specifies the calculations which will be completed by the DNR to determine the allowable ground water depletions for the MRNRD in any Compact Call Year. These procedures will be utilized to indicate when additional controls must be implemented by the MRNRD and DNR to ensure compliance with this IMP in the event that the DNR's forecast, provided prior to January 1 of each year, indicates a Compact Call Year. These procedures will incorporate information provided by the MRNRD (contracts for water leasing, augmentation, etc.) to the DNR by January 31 of each year following a forecast that indicates a Compact Call Year. The procedures for determining the allowable ground water depletion for the MRNRD are as follows.

The Allowable ground water depletion for the MRNRD =
(Nebraska Allocation + IWS – $SWCBCU_{NE}$ – Other NRD CBCU) * 0.30

Where:

Nebraska Allocation = Nebraska available water supply under the Compact

IWS = Imported Water Supply credit

$SWCBCU_{NE}$ = The surface water consumptive use by Nebraska, includes net evaporative losses

Other NRD CBCU = The $GWCBCU_{NE}$ calculated for the South Platte NRD, Twin Platte NRD, Tri-Basin NRD, Central Platte NRD, and Little Blue NRD

The DNR will utilize information provided by the MRNRD by January 31, to evaluate the following.

Step 1.MRNRD Estimated Ground water Depletions

Ground water depletions for the MRNRD will be based on the previous 2-year average (as described in table 2 above), unless such plan provided by the MRNRD indicates that additional restrictions on groundwater pumping will be imposed. If the additional restrictions would cause the pumping to be less than the previous two year average then the lower estimate will be used. In cases where that year's allocation will be less the MRNRD will provide the DNR a map indicating the geographic area subject to the allocation for that year and the maximum allocation available. The DNR will utilize the information provided by the MRNRD and represent such information in the RRCA GWM.

Step 2. Potential yield from MRNRD surface water leases/agreements, augmentation, etc.

The DNR will determine the potential yield from any surface water lease/agreement, augmentation, etc. entered into or provided by the MRNRD. In the event that augmentation is utilized, procedures for determining the project yield must have been approved by the RRCA. This potential yield will be incorporated as NRD management actions in section X.B.2.d.

If a Compact Call Year is reached as a result of checklist B1 or C3 the final step to determine if additional ground water and surface water controls (refer to Section VII.B.1. and VIII.F of this IMP) must be implemented is as follows.

Allowable ground water depletions for MRNRD (as determined above) - Forecasted MRNRD's portion of GWCBCU $_{NE}$ (Step 1) + Potential yield from MRNRD surface water leases/agreements, augmentation, etc. (Step 2) + Current Year's Balance (T = 0) – 3333[3].

If the resulting balance is greater than or equal to negative one hundred (-100) ac-ft, no additional ground water and surface water controls will be implemented.

If the resulting balance is less than negative one hundred (-100) ac-ft, the additional ground water and surface water controls (refer to Section VII.B.1. and VIII.F of this IMP) must be implemented. This potential yield will be incorporated as NRD management actions in section X.B.2.d.

Note: If it is beneficial to utilize the alternative water short year provisions from the FSS (the previous two years have a greater balance than last year alone), and an alternative water short year plan has been approved by the RRCA, then the two-year balance (for T = 0, the current year, and the prior year, T – 1) will be substituted for the current year's balance in Checklist B.

If a Compact Call Year is reached as a result of checklist D2 the final step to determine if additional ground water and surface water controls (refer to Section VII.B.1. and VIII.F of this IMP) must be implemented is as follows.

Allowable ground water depletions for MRNRD (as determined above) - Forecasted MRNRD's portion of GWCBCU $_{NE}$ (Step 1) + Potential yield from MRNRD surface water leases/agreements, augmentation, etc. (Step 2) + Previous Years Balances (T = -3, T = -2, T = -1, T = 0 or if applicable + T = -2, T = -1, T = 0)

[3] In the event it is the second consecutive Compact Call Year, this value will be reduced to 1667. For any remaining consecutive Compact Call Years, it will be reduced to zero.

If the resulting balance is greater than or equal to negative one hundred (-100) ac-ft, no additional ground water and surface water controls will be implemented.

If the resulting balance is negative, the additional ground water and surface water controls (refer to Section VII.B.1. and VIII.F of this IMP) must be implemented. This potential yield will be incorporated as NRD management actions in section X.B.2.d.

d. Calculation of Compact Call Stream flow Volume

This section of the monitoring plan specifies the calculation which will be completed by the DNR to determine the stream flow volume necessary to ensure Compact compliance in any Compact Call Year. If DNR's forecast, provided prior to January 1 of each year, indicates a Compact Call Year, then these calculations will be made incorporating information provided by the MRNRD (contracts for water leasing, augmentation, etc.) to the DNR by January 31 of each year following a forecast that indicates a Compact Call Year. The result of these calculations will be utilized to indicate when additional controls must be implemented by the MRNRD and DNR to ensure compliance with this IMP. When such Compact Call Year is indicated, the DNR will implement additional surface water controls (Section VIII.F of this IMP). Criteria that will be used to determine when administration for the "Compact Call" is no longer necessary will be based on ensuring sufficient stream flow volumes have been achieved at the compliance point. Determination of sufficient stream flow volumes to ensure Compact compliance will be determined through the following procedures.

Compact Call Stream flow Volume = Forecasted Stream flow + NRD Management Actions + Surface Water Curtailment Benefit

Where:

Forecasted Stream flow = Stream flow for T+1; (5-year average of state line flows) x 0.41 + 0.23 x HCL content – 27,450

NRD Management Actions = Actions taken by the MRNRD and/or other basin NRDs to enhance stream flow. These actions may include surface water or ground water leases, augmentation, or curtailment.

Surface Water Curtailment Benefit = Actions taken by DNR to ensure compact compliance in the event that Basin NRD Management Actions are not sufficient to overcome the projected negative balance.

e. Additional adjustments related to long-term trends

The DNR and MRNRD in conjunction with the other basin NRDs will annually meet to consult to determine if additional reductions from the 98-02 pumping volumes may be warranted. Through this consultation, the DNR and MRNRD will review expected long term (5-20 years) increases in depletions to stream flow and discuss potential mitigation measures that may be necessary.

f. Harlan County Lake Operations

In the event that operations of Harlan County Lake are not in accordance with Appendix K of the Final Settlement Stipulation, the DNR will work in consultation with the NRDs to modify Sections VII, VIII, and X of this IMP until normal operations resume.

XI. Information Considered

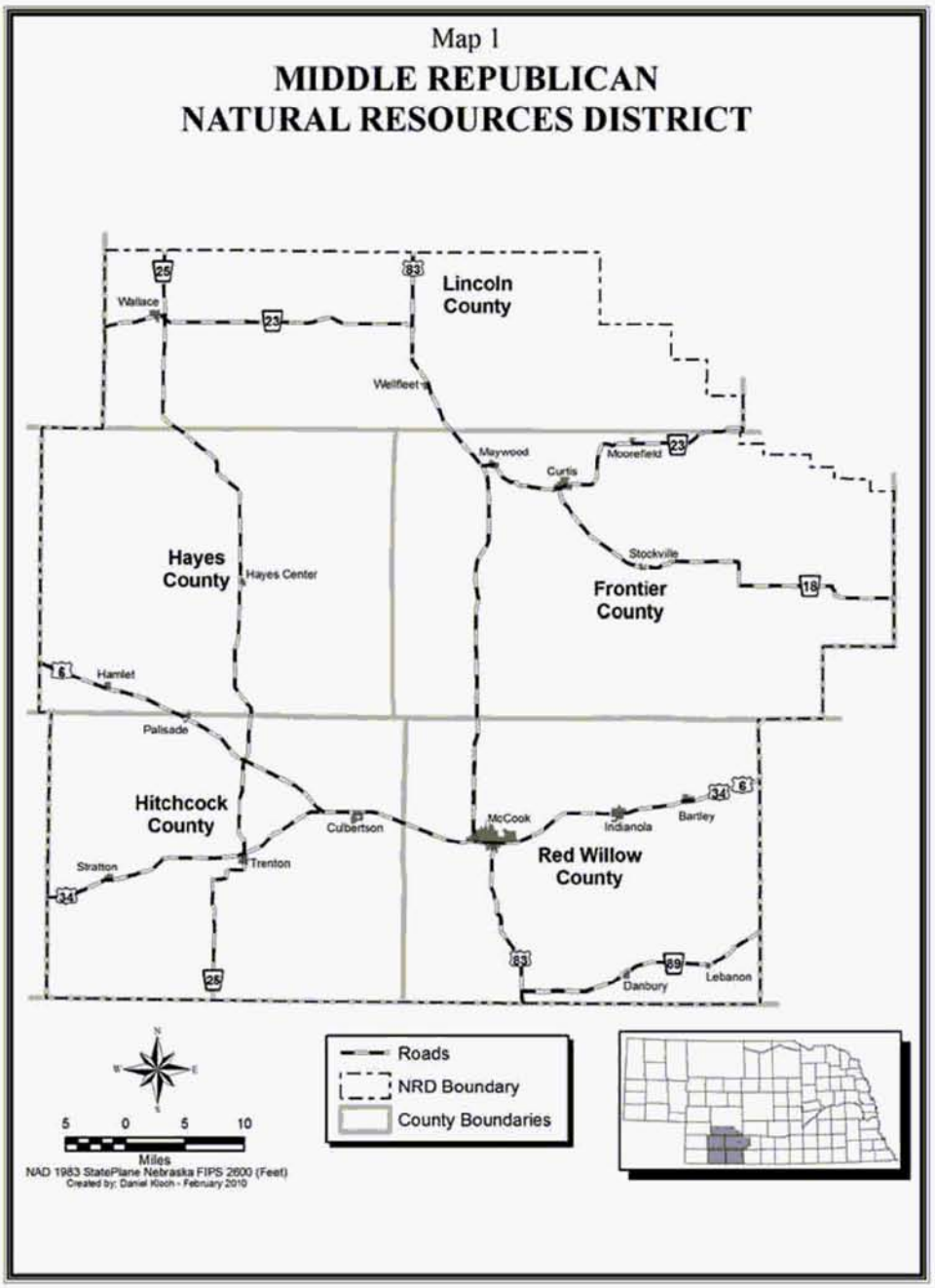
Information used in the preparation and to be used in the implementation of this IMP can be found in:

- Simulation runs of the Republican River Compact Administration Ground Water Model,
- Data tables of the Final Settlement Stipulation for the Republican River Compact,
- Chapters 2 and 3 of the 1994 Middle Republican NRD Ground Water Management Plan,
- Arbitrator's Final Decision, Karl Dreher, June 30, 2009, and
- Additional data on file with the MRNRD and the DNR.

Effective
November 1, 2010

Middle Republican NRD

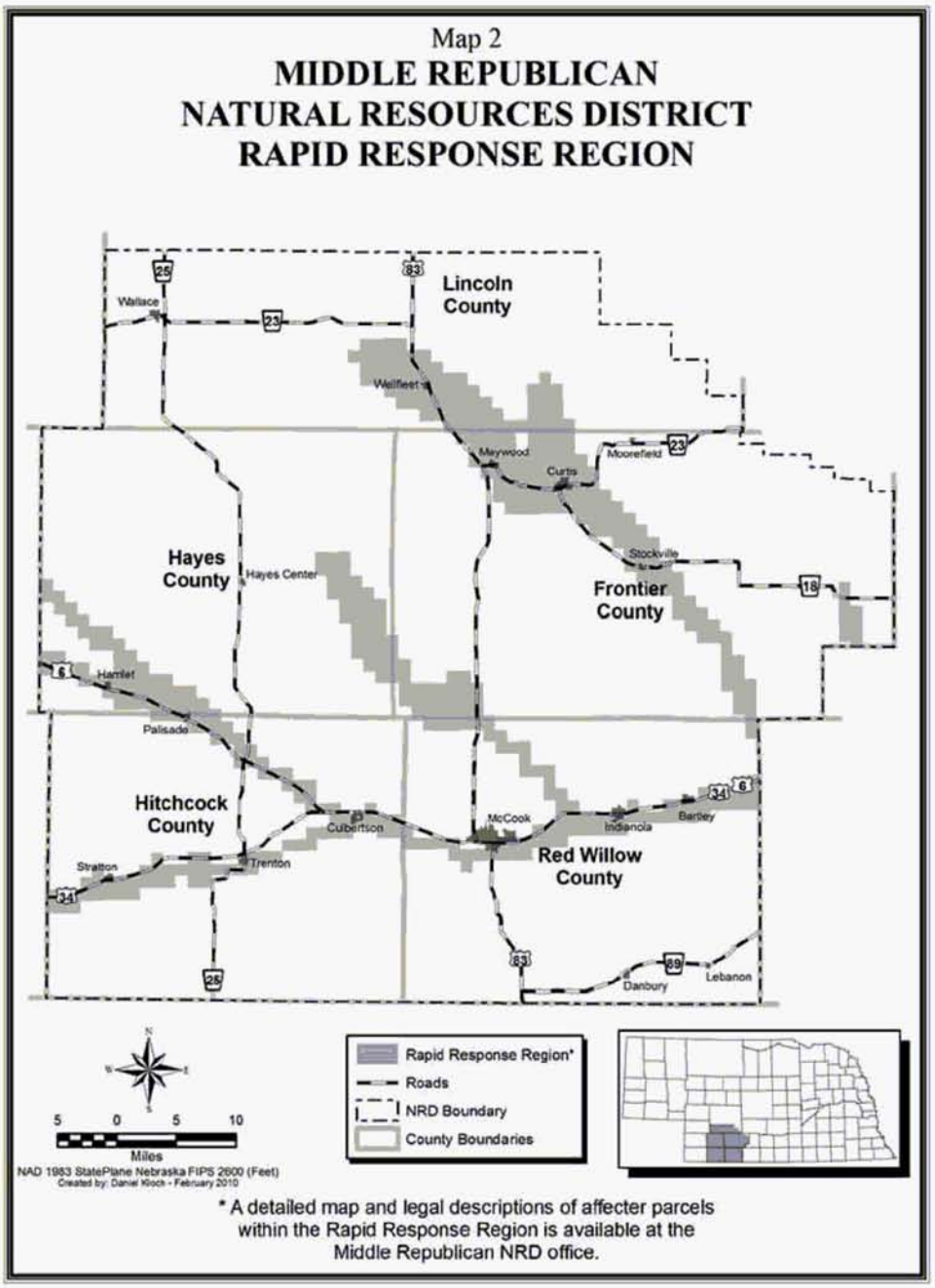
MAP 1. Middle Republican Natural Resource District



Effective
November 1, 2010

Middle Republican NRD

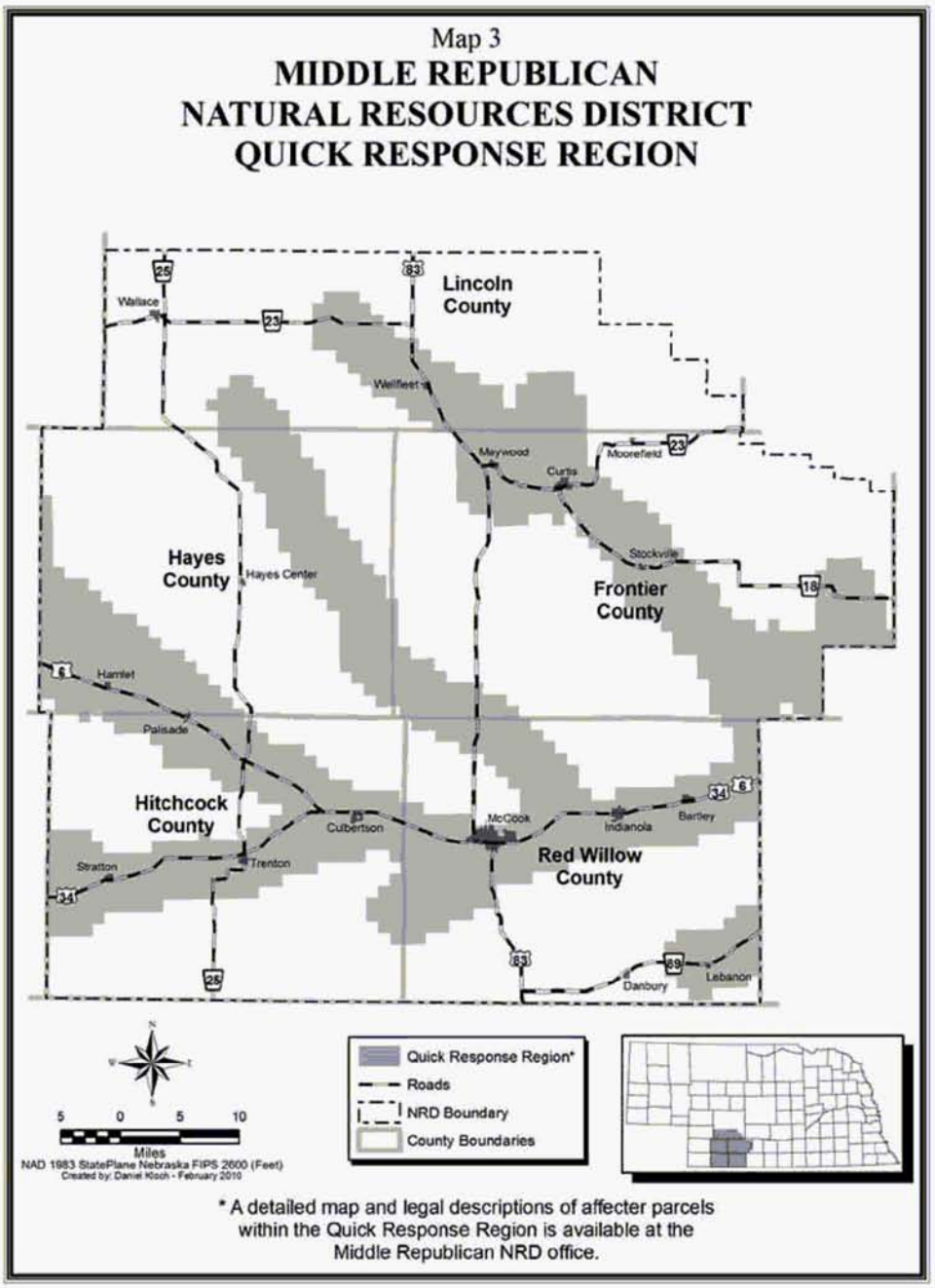
MAP 2. Middle Republican Natural Resource District Rapid Response Region



Effective
November 1, 2010

Middle Republican NRD

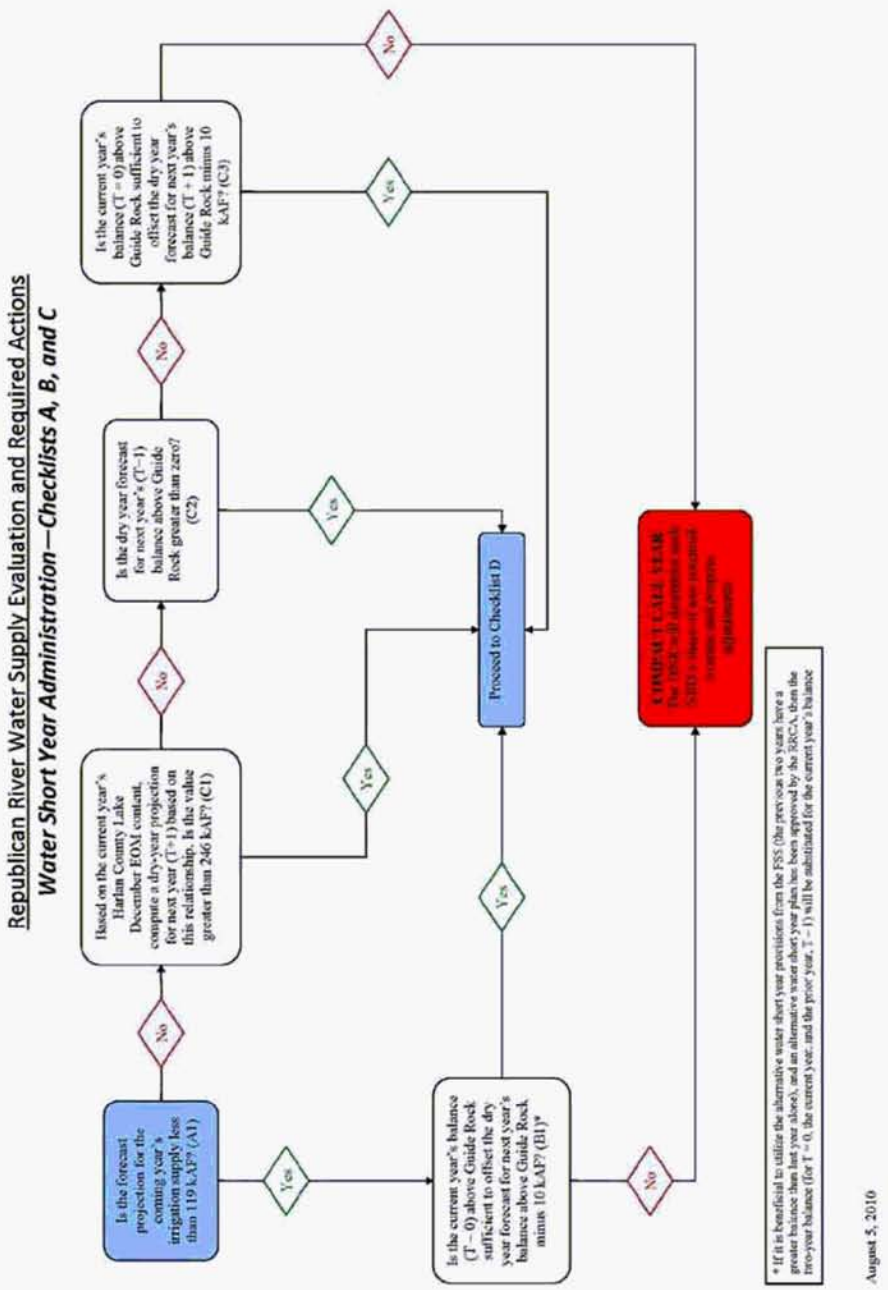
MAP 3. Middle Republican Natural Resource District Quick Response Region



Effective
November 1, 2010

Middle Republican NRD

ATTACHMENT 1. Republican River Water Supply Evaluation and Required Actions

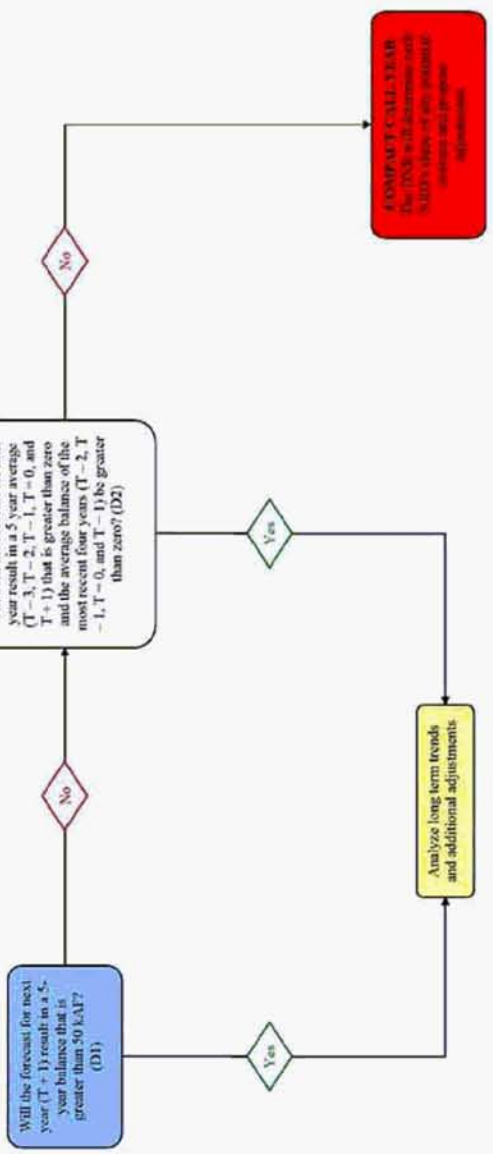


Effective
November 1, 2010

Middle Republican NRD

Republican River Water Supply Evaluation and Required Actions

Normal Year Administration—Checklist D



August 5, 2010

Effective
November 1, 2010

Upper Republican NRD

INTEGRATED MANAGEMENT PLAN
Jointly Developed by the
DEPARTMENT OF NATURAL RESOURCES
and the
UPPER REPUBLICAN NATURAL RESOURCES DISTRICT

I. Authority

This Integrated Management Plan (IMP) was prepared by the Board of Directors for the Upper Republican Natural Resources District (URNRD) and the Nebraska Department of Natural Resources (DNR) in accordance with the Nebraska Ground water Management and Protection Act, *Neb. Rev. Stat.* §§ 46-701 to 46-754 (Cum. Supp. 2008).

II. Background

Commencing in 1978, the URNRD has adopted and enforced rules and regulations for the purpose of managing the ground water resources within the URNRD. On April 11, 2003, effective May 8, 2003, the URNRD, pursuant to applicable statutory rulemaking procedures and *Neb. Rev. Stat.* § 46-739 (Cum. Supp. 2008), adopted the *State of Nebraska Upper Republican Natural Resources District Amendments to Rules and Regulations for Ground water Control – Order No. 26* and the *Upper Republican Natural Resources District Technical Manual of Policies and Procedures TM-26* (the "URNRD rules" or "the rules"). In the regular meeting, on July 6, 2004, the URNRD voted to extend Order No. 26 until September 1, 2005. Rule 9A of the Rules provides for a basic allocation of ground water to certified irrigated acres within the URNRD of 72.5 acre-inches for the five (5) year period between January 1, 2003 and December 31, 2007, an annualized allocation of 14.5 acre-inches. Since their adoption, the Rules have prohibited additional allocations for ground water use and additional well permits, except under limited circumstances. In addition, among other things, the rules continued and recodified the URNRD's practice of allowing ground water users to carryforward the unused portion of their allocation, together with any remaining unused portions of allocations from previous years, into succeeding allocation periods and permitted the URNRD to approve pooling contracts, both in accordance with the URNRD rules.

In 1943 the States of Colorado, Kansas and Nebraska entered into the Republican River Compact (the "Compact") with the approval of the United States Congress. The Compact provides for the allocation of the "virgin water supply" of the Republican River Basin (the "basin") between the three states. Following several years of dispute about Nebraska's consumptive use of water within the basin, Kansas filed an original action in the United States Supreme Court against the States of Nebraska and Colorado in 1998, seeking, among other things, to include ground water in the calculation of the virgin water supply and consumptive use. The United States Supreme Court appointed a Special Master who recommended that the depletions to stream flow from the use of ground water must be included in the virgin water supply and be part of the calculation of each state's beneficial consumptive use. The United States Supreme Court adopted the Special Master's recommendation. Subsequent to this determination, the states entered into a Settlement

Agreement resolving the remaining issues in the case. The Settlement Agreement was approved by the United States Supreme Court on May 19, 2003.

Both prior and subsequent to the approval of the Settlement Agreement, the DNR conducted and participated in several meetings with the URNRD, including several public meetings. During the course of those meetings the DNR explained, in order for the State of Nebraska to achieve and maintain compliance with the terms of the Settlement Agreement, it would be necessary to (1) continue the moratorium on new surface water appropriations and new ground water wells, (2) reduce all ground water pumpage from historic levels across the entire basin and (3) further reduce ground water pumping needed to comply with the Compact in water short years, to be accomplished to the extent possible through the use of incentive programs to reduce consumptive use of water. Ground water within the basin is regulated by four Natural Resource Districts: the URNRD, the Middle Republican Natural Resources District (MRNRD) and the Lower Republican Natural Resources District (LRNRD) and the Tri-Basin Natural Resources District (TBNRD) (collectively hereinafter the NRDs). Similar discussions were held between the DNR and each of the NRDs regarding the need (1) to accurately measure actual ground water pumpage and surface water diversions throughout the basin and within each NRD, (2) for the TBNRD to maintain, at sufficient levels to offset depletions to the Republican River caused by ground water pumping within the Republican River Compact area within the TBNRD, the Compact Imported Water Supply that Nebraska receives because of discharges from the "ground water mound"; and, 3) for each of the NRDs other than the TBNRD to reduce its ground water pumping from their 1998-2002 baseline pumping volumes, as defined below.

Since 1978, with adoption of its Order #1, the URNRD has required the metering, data collection and reporting of ground water use, resulting in actual pumping and use data, and has imposed allocations and regulation on ground water users within the URNRD, while the use of wells in the MRNRD and LRNRD were neither reported nor regulated during the same period. In order to estimate pumping in the MRNRD and LRNRD, other methods based on hours of operation using electrical power information and individual pumping rates were used. The DNR has determined the following pumping volumes for the period 1998-2002: 531,763 acre-feet for the URNRD, 309,479 acre-feet for the MRNRD and 242,289 acre-feet for the LRNRD. These pumping volumes are used throughout this IMP and are referenced as the "1998-2002 baseline pumping volumes." DNR, through the use of the Republican River Compact Administration Ground water Model, has also determined each NRD's depletions to stream flow for the period 1998-2002 ("1998-2002 baseline depletion"): 74,161 acre-feet for the URNRD, 52,168 acre-feet for the MRNRD and 43,954 acre-feet for the LRNRD. Those depletion numbers have resulted in the following depletion proportions: 44% for the URNRD, 30% for the MRNRD and 26% for the LRNRD. These depletion proportions are used throughout this IMP and are referenced as the "1998-2002 baseline depletion proportions." The percentage of allowable ground water depletions for each Republican River NRD were based on the proportion of the average ground water depletions caused by ground water pumping within each district that occurred during the base-line period from 1998-2002 as determined by model runs of the Republican River Compact Administration Groundwater Model with ground water pumping in each district alternated, turned off and then turned on.

Effective
November 1, 2010

Upper Republican NRD

The URNRD and the DNR adopted an IMP on May 3rd, 2005, that contained ground water rules and regulations for the 2005-2007 period. The IMP provided for a ground water allocation of 13.5 inches per certified acre, continued the pooling of allocations, and the carryforward of unused allocations, among other things. The goal of the 2005 IMP was to reduce water use by 5% from the 1998-2002 baseline. The IMP was updated and revised for 2007 – 2012, with a goal of reducing water use by twenty percent (20%) from the 1998-2002 baseline.

Since that time, efforts have been taken to implement or conduct incentive programs, studies, and research to further our understanding and ability to comply with the Republican River Compact and Settlement. Although the URNRD's allowable depletions to stream flow are limited to 44% of Nebraska's allowable depletions, there were no details in the plan to describe how this would be accomplished. In 2008 Colorado, Kansas, and Nebraska entered into dispute resolution regarding a number of issues, including future compliance. In June 2009 the arbitrator issued a finding that the URNRD IMP may be adequate during years with average and above-average precipitation, but since water-short year measures were not specifically identified, the plan may not be adequate during multiple dry years, an issue addressed in this IMP

The URNRD and the DNR wish to adopt and implement a revised IMP for the regulation of water resources within the district as required by the laws of the State of Nebraska.

The URNRD has agreed to meet its responsibility under *Neb. Rev. Stat.* §46-715, including meeting the obligations under the Settlement Agreement, by adopting revised rules to implement the IMP with regulations and other augmentation programs sufficient to reduce the URNRD's depletions to stream flow to meet the district's proportional share of the requirements of the Republican River Settlement Agreement. To ensure each NRD within the Republican River Basin will be treated equitably, the DNR has agreed not to approve any plan, unless the plan would restrict the use of water by each NRD to within the allocation granted to it as determined by the 1998-2002 baseline pumping volumes and that each NRD shall be assigned its proportionate share of stream flow depletion as calculated by the 1998-2002 baseline depletion percentages.

The URNRD and the DNR agree that the IMP for the District shall keep the NRD's depletions including credits for stream flow augmentation, as determined by the Republican River Compact Administration (RRCA) ground water model (GWM) and in accordance with the RRCA Accounting Procedures to an amount within 44% of the allowable ground water depletions. Based upon its calculations, the DNR believes that at the time this IMP became effective, a 20% reduction in pumping from the 98-02 baseline would be sufficient without additional stream flow augmentation to keep the District's net depletions within the URNRD's 44% share of the allowable ground water depletions during periods of average precipitation throughout the basin. As described in sections below, during periods of low water supply additional reductions from the 98-02 pumping volume may be necessary.

III. Definitions

A. Allowable Ground water Depletions - the maximum level of depletions to stream flow from ground water pumping within the Nebraska portion of the Republican River Compact area that can be allowed without exceeding the Compact allocation, in any one year.

B. Allowable Ground water Depletions for the URNRD - the depletions to stream flow from ground water pumping in the URNRD that are no greater than 44% of the total allowable ground water depletions.

C. Allowable Stream flow Depletions – the maximum amount of stream flow depletion in the Republican River Basin that can be allowed without violating the Compact.

D. Baseline Depletion Percentages – the annual mean depletions to stream flow in the Republican River Basin caused by surface water and ground water use in the years 1998-2002 inclusive. The baseline depletions are 74,161 acre feet for the URNRD, 52,168 acre feet for the MRNRD, and 43,954 acre feet for the LRNRD. The percentage depletions assigned to the NRDs are: URNRD, 44%; MRNRD, 30%; and LRNRD, 26%.

E. Baseline Pumping Volumes – the annual mean ground water pumping from the period 1998 to 2002. The baseline pumping volumes are 531,763 acre-feet for the URNRD, 309,479 acre-feet for the MRNRD and 242,289 acre-feet for the LRNRD.

F. Compliance Standard – the criteria and controls that will be used to determine whether URNRD's rules, regulations, and other programs are sufficient to meet the goals and objectives of this IMP pertaining to pumping volumes and depletions.

G. Net Depletions – an NRD's ground water depletions less any reduction in stream flow depletions or increase in allocation resulting from stream flow augmentation projects, including surface water leases as determined by the RRCA ground water model and in accordance with the RRCA Accounting Procedures.

H. Compact Call Year – A year in which the Department's forecast procedures outlined in Section X.B.2.b of this IMP indicate the potential for non-compliance if sufficient surface water and ground water controls and/or management actions are not taken. Compact Call Year streamflow administration will be conducted by the Department in a manner consistent with Section X.B.2.d of this IMP. Pursuant to Article VI of the Republican River Compact, diversions into the Courtland Canal for beneficial use in the State of Kansas will not be subject to the Compact Call.

IV. Goals and Objectives

Pursuant to *Neb. Rev. Stat.* § 46-715 (Cum. Supp. 2008) the goals and objectives of this IMP must have as a purpose "sustaining a balance between water uses and water supplies so that the economic viability, social and environmental health, safety, and welfare of the river basin ... can be achieved and maintained for both the near term and the long term." The following goals and objectives are also adopted by the URNRD and the DNR to meet the additional requirements of *Neb. Rev. Stat.* §46-715.

A. Goals:

1. In cooperation with the State of Nebraska and the other NRDs, maintain compliance with the Compact as adopted in 1943 and as implemented in accordance with the Settlement Agreement approved by the United States Supreme Court on May 19, 2003;

2. Ensure that water users within the URNRD assume their share, but only their share, of the responsibility to maintain compliance with the Compact;

3. Provide the URNRD's share of compliance responsibility and impact be apportioned within the URNRD in an equitable manner and to the extent possible, minimize the adverse economic, social and environmental consequences arising from compliance activities;

4. Protect ground water users whose water wells are dependent on recharge from the river or stream and the surface water appropriators on such river or stream from stream flow depletions caused by surface water uses and ground water uses begun after the date the river basin was designated as fully appropriated; and

5. Reserve any stream flow available from regulation, incentive programs, and purchased or leased surface water and ground water required to maintain Compact compliance from any use that would negate the benefit of such regulations or programs, to the extent allowed by statute and the surface water controls of this IMP.

B. Objectives:

1. Prevent the initiation of new or expanded uses of water, with limited exceptions, that increase Nebraska's computed beneficial consumptive use of water within the URNRD, as required for Compact compliance and by Nebraska law;

2. Ensure administration of surface water appropriations in the Basin is in accordance with the Compact and Nebraska law and the surface water controls of this IMP;

3. Reduce existing ground water use within the URNRD by 20% from the 1998-2002 baseline pumping volumes under average precipitation conditions so that, when combined with stream flow augmentation and incentive programs, the URNRD's ground water depletions are maintained within 44% of Nebraska's allowable ground water depletions as computed through use of the Republican River Compact Administration Ground water Model;

4. Make such additional reductions in ground water use in Compact Call Years as are necessary, after taking into account any reduction in beneficial consumptive use achieved through basin-wide incentive and stream flow augmentation programs, to achieve a reduction in beneficial consumptive use in the URNRD to 44% of Nebraska's the allowable ground water depletions to stream flow above Guide Rock . Compact Call Years will be determined through the procedures outlined in Section IX of this IMP;

5. Cause the reductions in water use required for Compact compliance to be achieved through a combination of regulatory, incentive, and augmentation programs designed to reduce consumptive use. To the extent funds are available, incentive programs will be made available through targeted incentive programs;

6. Cooperate with the DNR to investigate and explore methods to manage the impact of vegetative growth on stream flow: and

7. Develop a program to provide offsets for new consumptive uses of water so that economic development in the district may continue without producing an overall increase in ground water depletions as a result of new uses.

V. Map

The area subject to this IMP is the geographic area within the boundaries of the URNRD, (see Map 1). The Rapid Response Region is shown as a sub-area within the boundaries of the URNRD, (see Map 2).

VI. Ground water Controls

The URNRD will utilize the ground water controls as provided by *NEB.REV.STAT.* §§ 46-715, 46-739 and 46-740 to form the Ground water Controls component of this IMP. The controls that the DNR and URNRD agree are necessary and shall be continued are: 1) ground water allocations and 2) a moratorium on new water wells and irrigated acres as are required by the Final Settlement Stipulation (FSS). In order to provide the URNRD flexibility in addressing compliance, the URNRD may implement a reduction in irrigated acres and incentive programs targeting acres with a higher stream flow depletion factor as alternatives to URNRD-wide reductions in allocation or irrigated acres. The rules shall be set forth in detail and implemented through the URNRD's Rules and Regulations and the provisions of the URNRD's Rules and Regulations shall be sufficient so as to meet the Compliance Standards and Controls set forth below.

In addition to satisfying the compliance standards, the rules and regulations adopted by the URNRD shall contain provisions that adequately ensure that no new ground water uses initiated after July 14, 2004, will adversely impact surface water appropriators or ground water users whose water wells are dependent upon recharge from the stream or river. If the Compliance Standards are met, the URNRD may amend or modify its rules and regulations without the approval of DNR, except for the rules and regulations

pertaining to the satisfaction of the requirements of *NEB.REV.STAT.* §46-715(4)(b) and 46-715(4)(c).

A. Compliance Standards

1. Purpose.

These Compliance Standards are established by DNR and URNRD to assess whether the course of action taken by the URNRD, with the intention of providing their proportionate share of assistance to the State in order for the State to maintain compliance with the FSS and Compact, are sufficient. The action taken by the URNRD shall be evaluated in connection with the action taken by the other NRDs in the Republican River Basin and any other relevant considerations, including the information and data provided by DNR and past action by the NRD.

2. Duration

These Compliance Standards shall be used to assess the action taken by the URNRD. On an annual basis the DNR and URNRD shall reexamine the sufficiency and effectiveness of the Compliance Standards to determine if amendments or modifications are necessary to ensure the State's compliance with the FSS and Compact. Nothing contained herein shall prohibit or preclude any amendment or revision, at anytime, by the DNR and URNRD, when such action is necessary. Further, nothing contained in this subsection shall be construed as eliminating the review of the provisions of this IMP as required by *NEB.REV.STAT.* §46-715.

3. Standards

The URNRD shall adopt and implement rules and regulations which shall ensure that the following standards are met. The standards shall be effected through the procedure described in Section IX - Monitoring and Studies. Section IX specifies a forecast and resulting actions needed at the Guide Rock compliance point (during Water short years) and at the Hardy compliance point. The procedures for determining whether the compliance standards are met will be based on the RRCA Accounting Procedures, the baseline ground water pumping volumes, and the annual forecast as outlined in Section IX. The standards are:

a. Provide for a minimum of twenty percent (20%) reduction in pumping from the 98-02 pumping volume using a combination of regulation and supplemental programs so that the average ground water pumping volume is no greater than 425,000 acre-feet over the long term. If precipitation is lower than average for any given year, the ground water pumping volume for that year may be above 425,000 acre-feet.

b. An additional reduction in 98-02 pumping volumes of five percent (5%) during the next five year period shall be accomplished primarily through voluntary incentive programs and other means as determined by the URNRD. The necessity for continuing this annual reduction shall be reevaluated by DNR and the URNRD in 2015.

c. The URNRD's net depletions to stream flow shall be no greater than 44% of the allowable ground water depletions determined in accordance with RRCA Accounting Procedures using the RRCA GWM. The average shall be computed using the annual allowable ground water depletion for the same years as are used to determine the averages for Nebraska's compliance with the FSS.

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B. Other Controls and Management Activities

The URNRD and the DNR recognize that the required reductions in water consumption could be accomplished by means other than those adopted in this IMP. The IMP and associated controls may need to be amended in the future to implement any such revisions.

1. During Compact Call Years, the URNRD will seek to implement management actions, including but not limited to, surface water leasing, ground water leasing, augmentation, etc., to ensure compliance with this IMP. These management actions will be implemented through the authorities granted by the Nebraska Ground water Management and Protection Act, *Neb. Rev. Stat.* §§ 46-701 to 46-753. Details of such management actions will be provided to DNR by January 31 of each year for evaluation. If such management actions are insufficient to ensure compliance with this IMP, the URNRD will implement additional ground water controls and regulations to make up for any expected shortfall as identified in the annual forecast and described in Section IX of this IMP. Such additional control will include curtailment of ground water pumping within the Rapid Response Region of the URNRD.

2. When necessary to ensure Compact compliance or during Compact Call Years, the URNRD may set a one year pumping allocation within the District. Such allocation will set the maximum pumping level in that year within any region or sub region.

3. Maintain requirement for metering of all ground water uses according to URNRD standards.

4. Provide for transfers according to URNRD and statutory standards.

VII. Surface Water Controls - Department of Natural Resources

The authority for the surface water component of this IMP is *Neb. Rev. Stat.* §§ 46-715 and 46-716 (Reissue 2004). The surface water controls that will be continued and/or begun by the DNR are as follows:

A. The DNR will do the following additional surface water administration as required by the Settlement Agreement:

1. To provide for regulation of natural flow between Harlan County Lake and Superior-Courtland Diversion Dam, Nebraska will recognize a priority date of February 26, 1948 for Kansas Bostwick Irrigation District, the same priority date as the priority date held by the Nebraska Bostwick Irrigation District's Courtland Canal water right.

2. When water is needed for diversion at Guide Rock and the projected or actual irrigation supply is less than 130,000 acre-feet of storage available for use from Harlan County Lake as determined by the Bureau of Reclamation using the methodology described in Harlan County Lake Operation Consensus Plan attached as Appendix K to the Settlement Agreement, Nebraska will close junior, and require compliance with senior, natural flow diversions of surface water between Harlan County Lake and Guide Rock.

3. Nebraska will protect storage water released from Harlan County Lake for delivery at Guide Rock from surface water diversions.

4. Nebraska, in concert with Kansas and in collaboration with the United States, and in the manner described in Appendix L to the Settlement Agreement, will take actions to minimize the bypass flows at Superior-Courtland Diversion Dam.

B. Metering of all surface water diversions at the point of diversion from the stream will continue to be required. For surface water canals that are not part of a Bureau of Reclamation project, farm turnouts are required to install and maintain a DNR approved measuring device by the start of the 2005 irrigation season. All measuring devices shall meet the DNR standards for installation, accuracy and maintenance. All appropriators will be monitored to ensure that neither the rate of diversion nor the annual amount diverted exceeds that allowed by the applicable permit or by statute.

C. The DNR's moratorium on the issuance of new surface water permits was made formal by Order of the Director dated July 14, 2004. Exceptions may be granted by the DNR to the extent permitted by *Neb. Rev. Stat.* § 46-714(3) (Reissue 2004) or to allow issuance of permits for existing reservoirs that currently do not now have such permits. Such reservoirs are limited to those identified through the Settlement Agreement required inventory of reservoirs with over 15 acre-feet capacity.

D. All proposed transfers of surface water rights shall be subject to the criteria for such transfers as found in *Neb. Rev. Stat.* §§ 46-290 to 46-294.04 (Reissue 2004) and related DNR rules or the criteria found in *Neb. Rev. Stat.* §§ 46-2,120 to 46-2,130 (Reissue 2004) and related DNR rules.

E. The DNR completed adjudication of individual appropriators in the Republican River Basin upstream of Guide Rock in 2004. The results of that adjudication provided up-to-date records of the number and location of acres irrigated with surface water by such appropriators. Those records shall be used by the DNR to monitor use of surface water and to make sure that unauthorized irrigation is not occurring. The DNR will also be proactive in initiating subsequent

adjudications whenever information available to the DNR indicates the need for adjudication as outlined by state statutes.

F. During Compact Call Years, as determined from the procedures and analysis set forth in Section IX below, DNR will regulate and administer surface water in the basin as necessary to ensure Compact compliance. During Compact Call Years, DNR will issue a "Compact Call" on the Republican River at Hardy or Guide Rock to carry out administration for the Compact in a manner consistent with the doctrine of prior appropriation. A "Compact Call" will result in DNR issuing closing notices on all natural flow and storage permits in the basin until such time as DNR, in consultation with the URNRD and other basin NRDs, determines that yearly administration is no longer needed to ensure Compact compliance, pursuant to Section IX.

VIII. Augmentation and Incentive Programs

The URNRD and the DNR intend to establish and implement financial, incentive, and qualified projects as described in *Neb. Rev. Stat.* §§ 2-3226.04, LB 862 (2010), *Neb. Rev. Stat.* §§ 2-3252 or other incentive programs to reduce beneficial consumptive use of water within the URNRD. These projects include, but are not limited to (1) acquisition by purchase or lease of surface water or ground water rights, including storage water rights with respect to a river or any of its tributaries, (2) acquisition by purchase or lease or the administration and management, pursuant to mutual agreement, of canals and other works, including reservoirs, constructed for irrigation from a river or any of its tributaries, (3) vegetation management, including, but not limited to, the removal of invasive species in or near a river or any of its tributaries, and (4) the augmentation of river flows. As a condition for participation in an incentive program, water users, landowners or the URNRD may be required to enter into and perform such agreements or covenants concerning the use of land or water as are necessary to produce the benefits for which the incentive program is established. Such incentive programs may include, but shall not be limited to, any program authorized by state law and/or federal programs operated by the United States Department of Agriculture.

Any water savings generated through conservation programs, including acreage retirement or other conservation incentive programs undertaken through programs available throughout the Republican River Basin with the use of funds distributed by the State of Nebraska or the United States Government will not accrue to any specific NRD, regardless of the location or other conditions of the acreage included in the program or of the location of the effect of such water savings on the river system. Any water savings resulting from any such basin-wide programs shall be considered in the calculation of each NRD's depletions allocated to each of the NRDs based upon the 1998-2002 baseline depletion proportions.

However, should any NRD establish, fund, and implement its own such conservation program within its NRD's boundaries, the accounting of credit for the resulting water savings shall be given exclusively to that NRD. Any credit resulting from an inter-district conservation program shall be credited as agreed to by the NRDs involved. Also, if multiple NRDs cooperate in a stream flow augmentation project, the benefits shall be provided to each NRD based upon their share of the cost of the program.

To the extent possible, it is the intent of the URNRD to provide compensation to water users that are required to forgo water use to allow the URNRD and the State to comply with the compact. This may be in addition to or as part of any other URNRD incentive or retirement program developed to facilitate compact compliance.

IX. Monitoring and Studies

The overarching purpose of the Monitoring and Studies Section is to ensure that, in cooperation with the other Republican River Basin NRDs, the DNR and URNRD maintain compliance with the Republican River Compact as adopted in 1943 and as implemented in accordance with the FSS approved by the United States Supreme Court on May 19, 2003. The objective of the Monitoring and Studies Section of this IMP is to gather and evaluate data, information, and methodologies that could be used to increase understanding of the surface water and hydrologically connected ground water system; to test the validity of the conclusions and information upon which this IMP is based; and to assist decision makers in properly managing the water resources within the URNRD and the Republican River Basin as a whole.

On an annual basis the results of monitoring and studies will typically be discussed in a basin-wide meeting which will take place prior to October 31 each year. The purpose of the meeting will be to discuss the preliminary accounting for the current year, the forecast of allowable stream flow depletions for the coming year, and potential management actions as necessary. Table 1 outlines important dates and objectives related to section IX.

Table 1. Important Dates and Objectives

Date	Objective
Prior to February 1	URNRD will provide DNR with meter reading database and GIS coverage maps to be used for the RRCA annual model update.
Prior to RRCA Annual Meeting	DNR will provide URNRD with their determination of whether the URNRD was in compliance with the compliance standards based on each previous year's annual Compact accounting.
September - October	Obtain power records and other estimates to determine pumping for T=0 ground water model run.
Prior to October 31	Discuss results of monitoring and studies, preliminary accounting for current year, and early forecast of allowable stream flow depletions.
Prior to November 15	DNR will provide correspondence to URNRD notifying them of potential Compact Call Year determination for the coming year (T+1).
November 15 – January 1	URNRD and DNR will discuss potential management alternatives in the situation that the coming year (T+1) will be a Compact Call Year.
Prior to January 1	Provide final forecast of allowable stream flow depletions and determination of Compact Call Years.
Prior to January 31	URNRD will provide DNR with details regarding existing management alternatives in lieu of additional ground water regulations or controls to make up for the expected shortfall.

A. Plan to Gather and Evaluate Data, Information and Methodologies

As outlined in *Neb. Rev. Stat.* §§ 46-715(2)(e) ongoing programs and new studies or other projects may become a source of information that is used to evaluate the effectiveness of controls

adopted by the by the URNRD and the DNR. The DNR and the URNRD will jointly pursue and/or evaluate studies, contingent upon budget and staff resources, to evaluate their potential effectiveness in achieving the goals and objectives of this IMP.

The following potential studies have been identified by the DNR and the URNRD: (1) crop rotation; (2) vegetation management; (3) irrigation scheduling; (4) a survey of the type and location of irrigation systems throughout the URNRD; (5) tillage practices; and (6) conjunctive management.

B. Monitoring

Part One of the Monitoring Section describes the tracking and reporting of water use activities within fully appropriated areas of the district by the URNRD and the DNR. Part Two of the Monitoring Section describes the analyses that will be utilized to annually forecast the projected depletions in each subsequent year. This accounting and the forecast in accordance with *Neb. Rev. Stat.* § 46-715(6) will serve to increase the understanding and test the validity of the conclusions and information upon which this plan is based.

Compact accounting and data exchanges among the states shall be done annually in accordance with the FSS, dated December 15, 2002, including the Republican River Compact Administration (RRCA) Accounting Procedures and Reporting Requirements which are contained in Appendix C thereof. An annual report of the RRCA is published each year. The accounting procedures, reporting requirements, and annual report of the RRCA are independent of this monitoring plan, and therefore not restated within the Monitoring Section of this plan.

1. Part One: Tracking and Reporting of Water Use Activities

The URNRD and the DNR will make all documents, reports, records, computer runs or other calculations or material necessary to determine compliance with the Compact available to each other, regardless of whether such documents are available under the Nebraska Public Records Act or otherwise, unless such materials are identified as confidential under Nebraska statutes or by a ruling of a court of competent jurisdiction. Specifically, and without limitation, the URNRD agrees to annually provide GIS coverage maps of all lands irrigated and to meter, record and provide to the DNR its ground water usage records and irrigation system details. The URNRD shall make copies of district actions taken on variances, offsets, and similar actions available to DNR.

The DNR agrees to make available to the URNRD all reports and records of the other NRDs necessary to determine their compliance with reductions, as well as all documentation and reports utilized by the DNR to determine the basin's virgin water supplies and Nebraska's compliance with the Compact.

In the event any materials are withheld by either DNR or URNRD under a claim of statutory confidentiality, the party withholding such materials shall describe the contents of the materials and reasons for the denial in accordance with *Neb. Rev. Stat.* § 84-712.04.

2. Part Two: Forecast Procedures

Each year in compliance with *Neb. Rev. Stat.* § 46-715(6) the DNR in consultation with the Republican River NRDs shall forecast the maximum amount of water that may be available from stream flow for beneficial use in the short term and long term to comply with the Compact. This forecast will be used to assist the DNR and the NRDs in ensuring compliance with the Compact. DNR in conjunction with the NRDs will annually evaluate the forecast procedures and make changes as deemed necessary to reflect management actions being taken in the basin.

In order to complete the forecast, the DNR and URNRD in conjunction with the other NRDs will review available information and determine if additional controls must be implemented within any district for Compact Call Year compliance. The forecast will be completed prior to January 1 of each year, and will detail the expected shortfall within each district in the event that the coming year is a Compact Call Year. By the following January 31, if necessary, the URNRD will provide DNR with details regarding existing management alternatives (such as execution of existing surface water leases) in lieu of additional ground water regulations or controls to make up for the expected shortfall.
The procedures developed to complete the forecast will be reviewed annually by the DNR to determine if modifications are necessary. The forecast will project the next year's balance (projected Nebraska allocation plus projected Imported Water Supply less the projected Computed Beneficial Consumptive Use, or CBCU), and the projected water short year and normal year accounting balances. These balances will be utilized in conjunction with other information to determine if a Compact Call Year exists.

The DNR's calculation of allowable ground water depletions for the URNRD and determination of the necessity for additional controls will utilize additional ground water model information, estimated end-of-year information for reservoir volumes, and estimated stream flow to determine on an annual basis whether additional NRD-specific controls must be implemented.

a. Determination of Available Stream Flow

The forecast will typically determine the forecast values for both Guide Rock (water short year accounting point) and Hardy (normal year accounting point). The DNR's forecast values for Guide Rock will include: 1) the one-year balance (projected allocation less the projected CBCU plus the imported water supply); two-year average, and three-year average. The DNR's forecast values for Hardy will include: 1) the one-year balance (projected allocation less the projected CBCU plus the imported water supply); and 2) the five-year average. These forecasted values will be used in conjunction with sections IX.B.2.b, IX.B.2.c, IX.B.2.d and IX.B.2.e to determine when management actions or controls must be implemented. The DNR will calculate forecast values for the next year using the variables in table 2:

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Table 2. Information Used for 2010 Forecast of Allowable Depletions.

Year	Item	Information Source
T – 3		Draft; current Accounting Procedures (v. 2005)
T – 2		Draft; current Accounting Procedures (v. 2005)
T – 1		Draft; current Accounting Procedures (v. 2005)
Provisional Data for T = 0 (Current Year or Immediate Past Irrigation Season)	Pumping	Power records estimate
	Surface Water Use	Estimated from preliminary data and previous years values
	Stream Flow	Available provisional records end of year estimated
	Evaporation	T – 1 records
Forecast Year T + 1 (Coming Irrigation Season)	Ground water Consumptive Use and Imported Water Supply Credit	Average values for T = 0 and T - 1
	Surface Water Consumptive Use	Colorado: Average of T – 1 and T – 2 use Kansas: + (.1858 x HCL content) + 9,575 Nebraska: - ($4x10^{-7}$) x (NE lake volume)^2 + (0.52) x (NE lake volume) - 42,000
	Stream Flow	+ (5-year average of state line flows) x 0.41 + 0.23 x HCL content - 27,450

In accordance with *Neb. Rev. Stat.* § 46-703(6), DNR, NRDs, and surface water project sponsors shall meet prior to the final forecast of allowable stream flow depletions and determination of Compact Call Years. At this meeting the involved parties will discuss the forecasted streamflow and surface water consumptive use. From these discussions, surface water project sponsors may present a plan to DNR to achieve a consumptive use that is less than forecasted consumptive use. Such a plan could allow surface water project sponsors to avoid a potential Compact Call Year. This plan must be completed and provided to the Department no later than December 1 of the current year (T=0).

The following equations will be utilized to determine the one year balance for the forecast year.

$$CWS = + SwCBCU_{NE} + SwCBCU_{KS} + SwCBCU_{CO} + GwCBCU_{NE} + GwCBCU_{KS} + GwCBCU_{CO} + \text{Stateline Stream flow}$$

$$\text{Nebraska Allocation} = CWS * 0.5$$

$$CBCU_{NE} = SwCBCU_{NE} + GwCBCU_{NE}$$

IWS = Imported Water Supply Credit

Hardy One Year Balance = Nebraska Allocation + IWS – $CBCU_{NE}$

Guide Rock One Year Balance = Hardy One Year Balance * 0.89 – 9040

Where:

T-3 = Three years ago from the current year

T-2 = Two years ago from the current year

T-1 = One year ago from the current year

T=0 = The current year

T+1 = The upcoming year that is being forecasted

CWS = Computed Water Supply

GW $CBCU_{NE, KS, CO}$ = Ground water Computed Beneficial Consumptive Use for each respective state

SW $CBCU_{NE, KS, CO}$ = Surface Water Computed Beneficial Consumptive Use for each respective state

Nebraska Allocation = CWS x 0.5: The amount of water the State of Nebraska is allowed to use over one year

Balance = The sum of Nebraska's Allocation, plus the Nebraska Imported Water Supply, less Nebraska's Computed Beneficial Consumptive Use

The one year balance for normal year accounting (Hardy One Year Balance) and water short year accounting (Guide Rock One Year Balance) will be utilized to project the two-year and three-year average balances above Guide Rock and the five-year average balance above Hardy.

b. Compact Call Year Evaluation

This section of the monitoring plan specifies the process that will be completed by the DNR to determine the Compact Call Years, as detailed in Attachment 1, Republican River Water Supply Evaluation and Required Actions Flowchart. This evaluation takes into account reservoir content and recent balances above Guide Rock and Hardy and the annual forecast as described above in Section IX.B.2.a. This process will be completed and provided to the URNRD by DNR prior to January 1 of each year.

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Checklist A. Water short year Test

1) Is the forecast projection for the coming year's irrigation supply less than 119 kAF?
    a. Yes. Proceed to Checklist B.
    b. No. Proceed to Checklist C.

Checklist B. Water short year

1) Is the current year's balance (T = 0) above Guide Rock sufficient to offset the dry year forecast for next year's balance above Guide Rock minus 10 kAF[1]?
    a. Yes. Proceed to Checklist D.
    b. No. COMPACT CALL YEAR: The DNR will determine each NRD's share of any potential overuse and propose adjustments in accordance to Section IX.B.2.c. of this IMP.

Note: If it is beneficial to utilize the alternative water short year provisions from the FSS (the previous two years have a greater balance than last year alone), and an alternative water short year plan has been approved by the RRCA, then the two-year balance (for T = 0, the current year, and the prior year, T – 1) will be substituted for the current year's balance in Checklist B.

Checklist C. Early Warning System for Water short year Compliance

1) When Harlan County Lake declines from one year to the next, the December end-of-month (EOM) content is generally about 84% of what it was last year. A December EOM of 246 kAF provides a high level of confidence that the coming year (T+1) will not be water short. Based on the current year's (T=0) Harlan County Lake December EOM content, compute a dry-year projection for next year (T+1) based on this relationship. Is the value greater than 246 kAF?
    a. Yes. Proceed to Checklist D.
    b. No. Advance to question 2.

2) Is the dry year forecast for next year's (T+1) balance above Guide Rock greater than zero?
    a. Yes. Proceed to Checklist D.
    b. No. Advance to question 3.

3) Is the current year's balance (T = 0) above Guide Rock sufficient to offset the dry year forecast for next year's balance (T + 1) above Guide Rock minus 10 kAF[2]?
    a. Yes. Proceed to Checklist D.

[1] In the event it is the second consecutive Compact Call Year, this value will be reduced to 5kAF. For any remaining consecutive Compact Call Years, it will be reduced to zero.
[2] In the event it is the second consecutive Compact Call Year, this value will be reduced to 5kAF. For any remaining consecutive Compact Call Years, it will be reduced to zero.

b. No. COMPACT CALL YEAR: The DNR will determine each NRD's share of any potential overuse and propose adjustments in accordance to Section IX.B.2.c. of this IMP.

Checklist D. Normal Year Administration

1) Will the forecast for next year (T + 1) result in a 5-year balance at Hardy that is greater than 50 kAF?
   a. Yes. Analyze long term trends and additional adjustments in accordance to Section IX.B.2.e
   b. No. Advance to question 2.

2) Will both the forecast for next year result in a 5 year balance at Hardy (T – 3, T – 2, T – 1, T = 0, and T + 1) that is greater than zero and the balance at Hardy of the most recent four years (T – 2, T – 1, T = 0, and T + 1) be greater than zero?

   a. Yes. Analyze long term trends and additional adjustments in accordance to Section IX.B.2.e
   b. No. COMPACT CALL YEAR: The DNR will determine each NRD's share of any potential overuse and propose adjustments in accordance to Section IX.B.2.c. of this IMP.

c. Calculation of Allowable Ground water Depletions for the URNRD and Determining the necessity of Additional Controls

This section of the monitoring plan specifies the calculations which will be completed by the DNR to determine the allowable ground water depletions for the URNRD in any Compact Call Year. These procedures will be utilized to indicate when additional controls must be implemented by the URNRD and DNR to ensure compliance with this IMP in the event that the DNR's forecast, provided prior to January 1 of each year, indicates a Compact Call Year These procedures will incorporate information provided by the URNRD (contracts for water leasing, augmentation, etc.) to the DNR by January 31 of each year following a forecast that indicates a Compact Call Year. When such Compact Call Year is indicated, the DNR will implement additional surface water controls (Section VII.F of this IMP). The procedures for determining the allowable ground water depletion for the URNRD are as follows.

The Allowable ground water depletion for the URNRD =
(Nebraska Allocation + IWS – $SWCBCU_{NE}$ – Other NRD CBCU) * 0.44

Where:

Nebraska Allocation = Nebraska available water supply under the Compact

IWS = Imported Water Supply credit

$SWCBCU_{NE}$ = The surface water consumptive use by Nebraska, includes net evaporative losses

Other NRD CBCU = The $GWCBCU_{NE}$ calculated for the South Platte NRD, Twin Platte NRD, Tri-Basin NRD, Central Platte NRD, and Little Blue NRD

The DNR will utilize information provided by the URNRD by January 31, to evaluate the following.

Step 1. URNRD Estimated Ground water Depletions

Ground water depletions for the URNRD will be based on the previous 2-year average (as described in Table 2 above), unless such plan provided by the URNRD indicates that additional restrictions on groundwater pumping will be imposed. If the additional restrictions would limit the pumping to be less than the previous two year average then the lower estimate will be used. In cases where that year's allocation will be less the URNRD will provide the DNR a map indicating the geographic area subject to the allocation for that year and the maximum allocation available. The DNR will utilize the information provided by the URNRD and represent such information in the RRCA GWM.

Step 2. Potential yield from URNRD surface water leases/agreements, augmentation, etc.

The DNR will determine the potential yield from any surface water lease/agreement, augmentation, etc. entered into or provided by the URNRD. In the event that augmentation is utilized, procedures for determining the project yield must have been approved by the RRCA. This potential yield will be incorporated as NRD management actions in section IX.B.2.d.

If a Compact Call Year is reached as a result of checklist B1 or C3 the final step to determine if additional ground water and surface water controls (refer to Section VI.B.1. and VII.F of this IMP) must be implemented is as follows.

Allowable ground water depletions for URNRD (as determined above) - Forecasted URNRD's portion of $GWCBCU_{NE}$ (Step 1) + Potential yield from URNRD surface water leases/agreements, augmentation, etc. (Step 2) + Current Year's Balance (T = 0) – 3333[3].

If the resulting balance is greater than or equal to negative one hundred (-100) ac-ft, no additional ground water and surface water controls will be implemented.

[3] In the event it is the second consecutive Compact Call Year, this value will be reduced to 1667. For any remaining consecutive Compact Call Years, it will be reduced to zero.

If the resulting balance is less than negative one hundred (-100) ac-ft, the additional ground water and surface water controls (refer to Section VI.B.1. and VII.F of this IMP) must be implemented. This potential yield will be incorporated as NRD management actions in section IX.B.2.d.

Note: If it is beneficial to utilize the alternative water short year provisions from the FSS (the previous two years have a greater balance than last year alone), and an alternative water short year plan has been approved by the RRCA, then the two-year balance (for T = 0, the current year, and the prior year, T – 1) will be substituted for the current year's balance in Checklist B.

If a Compact Call Year is reached as a result of checklist D2 the final step to determine if additional ground water and surface water controls (refer to Section VI.B.1. and VII.F of this IMP) must be implemented is as follows.

Allowable ground water depletions for URNRD (as determined above) - Forecasted URNRD's portion of GWCBCU $_{NE}$ (Step 1) + Potential yield from URNRD surface water leases/agreements, augmentation, etc. (Step 2) + Previous Years Balances (T = -3, T = -2, T = -1, T = 0 or if applicable + T = -2, T = -1, T = 0).

If the resulting balance is greater than or equal to negative one hundred (-100) ac-ft, no additional ground water and surface water controls will be implemented.

If the resulting balance is less than negative one hundred (-100) ac-ft, the additional ground water and surface water controls (refer to Section VI.B.1. and VII.F of this IMP) must be implemented. This potential yield will be incorporated as NRD management actions in section IX.B.2.d.

d. Calculation of Compact Call Stream flow Volume

This section of the monitoring plan specifies the calculation which will be completed by the DNR to determine the stream flow volume necessary to ensure Compact compliance in any Compact Call Year. These procedures will be utilized to indicate when additional controls must be implemented by the URNRD and DNR to ensure compliance with this IMP in the event that the DNR's forecast, provided prior to January 1 of each year, indicates a Compact Call Year. These procedures will incorporate information provided by the URNRD (contracts for water leasing, augmentation, etc.) to the DNR by January 31 of each year following a forecast that indicates a Compact Call Year. When such Compact Call Year is indicated, the DNR will implement additional surface water controls (Section VII.F of this IMP). Criteria that will be used to determine when administration for the "Compact Call" is no longer necessary will be based on ensuring sufficient stream flow volumes have been achieved at the compliance point. Determination of sufficient stream flow volumes to ensure Compact compliance will be determined through the following procedures.

Compact Call Stream flow Volume = Forecasted Stream flow + NRD Management Actions + Surface Water Curtailment Benefit

Where:

Forecasted Stream flow = Stream flow for T+1; (5-year average of state line flows) x 0.41 + 0.23 x HCL content – 27,450.

NRD Management Actions = Actions taken by the URNRD and/or other basin NRDs to enhance stream flow. These actions may include surface water or ground water leases, augmentation, or curtailment.

Surface Water Curtailment Benefit = Actions taken by DNR to ensure compact compliance in the event that Basin NRD Management Actions are not sufficient to overcome the projected negative balance.

e. Additional adjustments related to long-term trends

The DNR and URNRD in conjunction with the other basin NRDs will annually meet to consult to determine if additional reductions from the 98-02 pumping volumes may be warranted. Through this consultation, the DNR and URNRD will review expected long term (5-20 years) increases in depletions to stream flow and discuss potential mitigation measures that may be necessary.

f. Harlan County Lake Operations

In the event that operations of Harlan County Lake are not in accordance with Appendix K of the Final Settlement Stipulation, the DNR will work in consultation with the NRDs to modify Sections VI, VII, and IX of this IMP until normal operations resume.

X. INFORMATION CONSIDERED

Information used in the preparation and to be used in the implementation of this IMP can be found in:

- Simulation runs of the Republican River Compact Administration Ground water Model,
- The formulae and data compliance tables of the Final Settlement Stipulation for the Compact,
- The URNRD's Rules,
- The URNRD's Ground water Management Plan,
- Arbitrator's Final Decision, Karl Dreher, June 30, 2009, and
- Additional data on file with the URNRD and the DNR.
- Nebraska statutes and case law.

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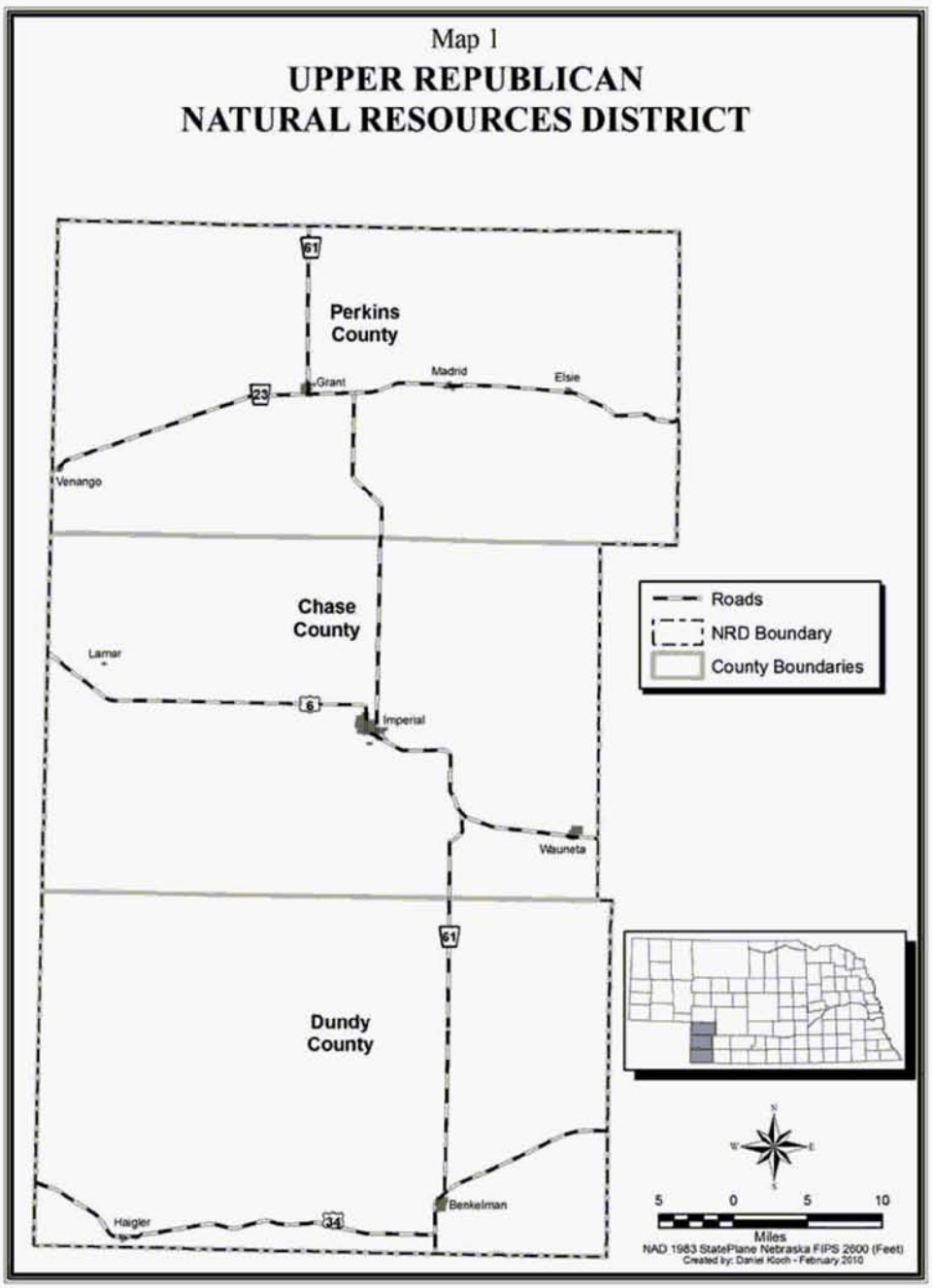
MAP 1. Upper Republican Natural Resource District



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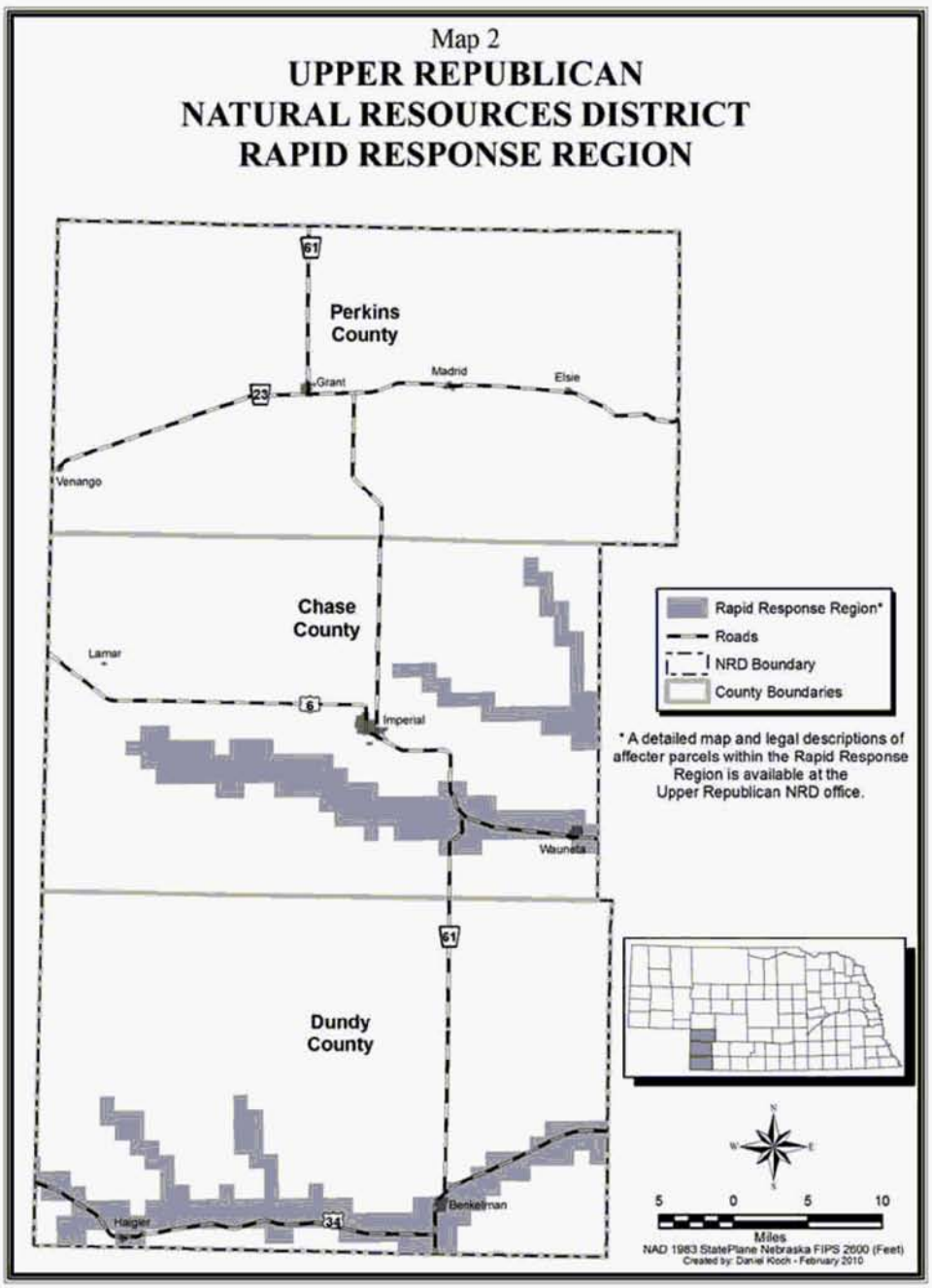
MAP 2. Upper Republican Natural Resource District Rapid Response Region



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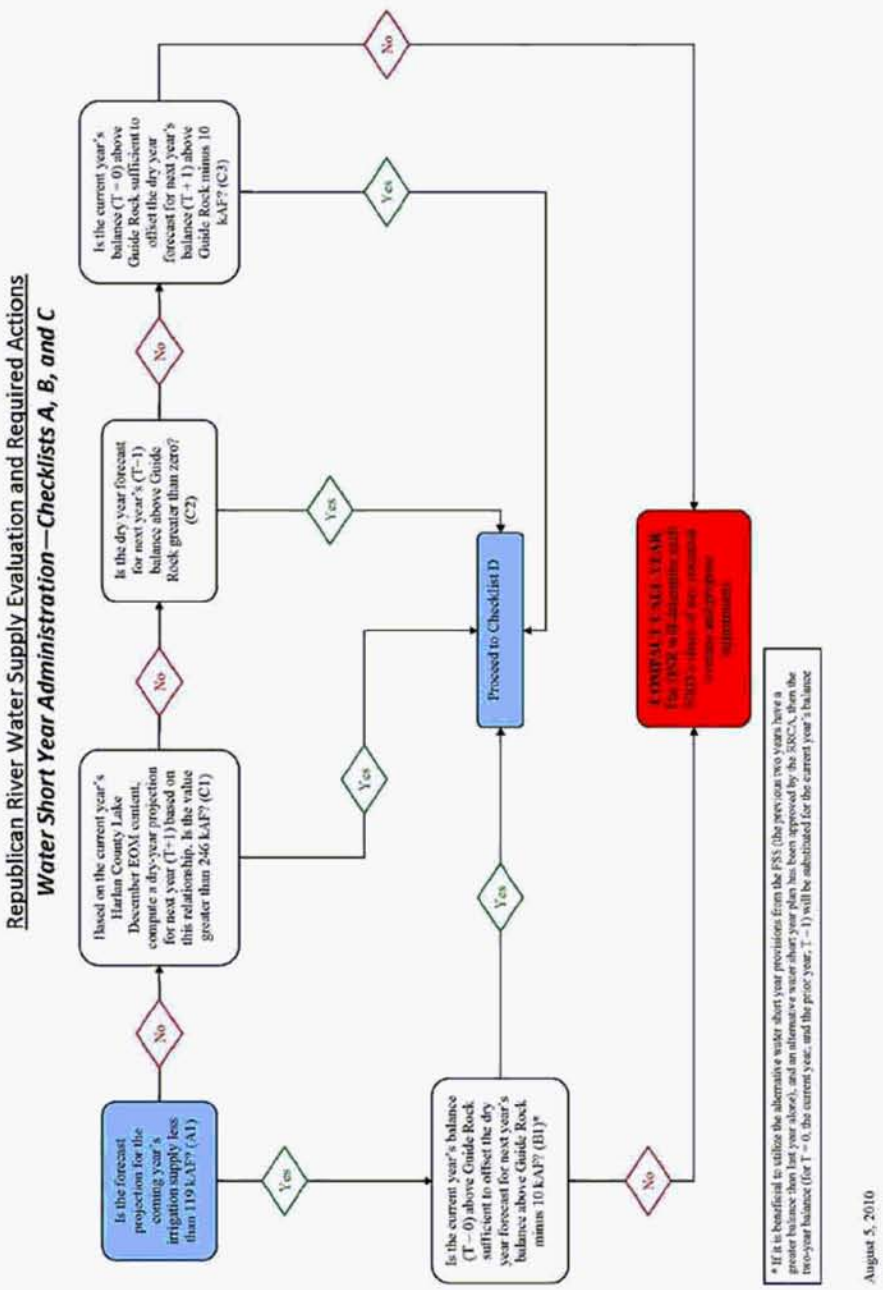
ATTACHMENT 1. Republican River Water Supply Evaluation and Required Actions



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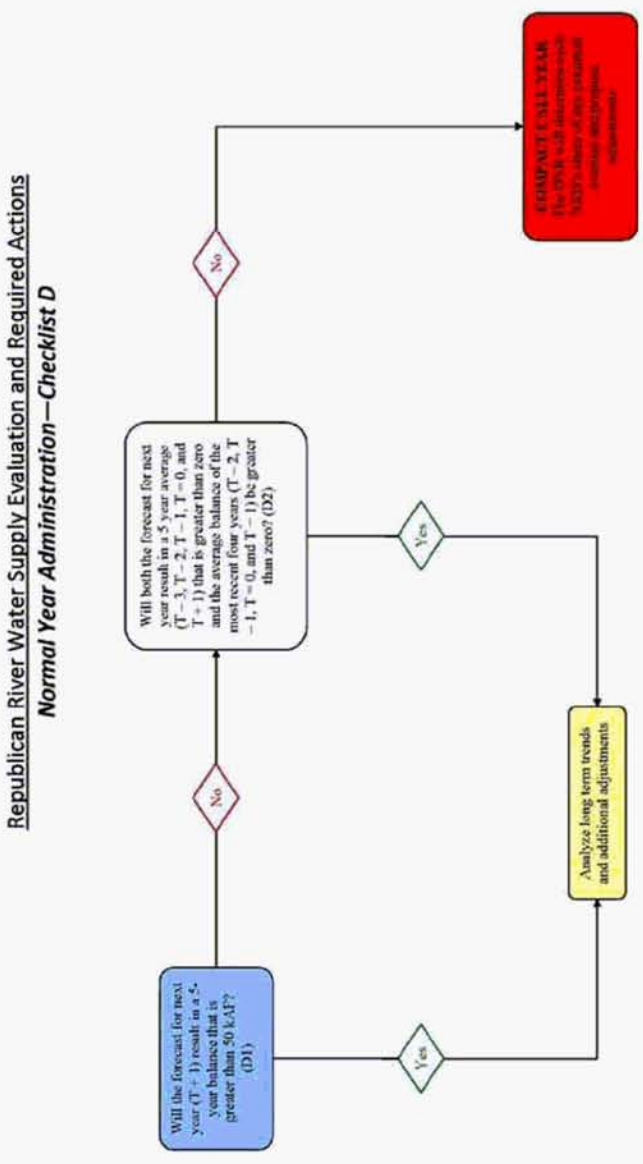
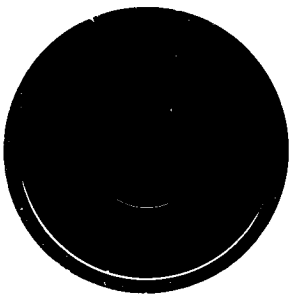


Nebraska's Responsive Expert Report
Concerning Nebraska's Future Compliance
and References
Bates # NE 0500401

James C. Schneider, Ph.D.
March 15, 2012
Disc 1 of 2

A supplemental disc with a Bates # NE0500401A was supplemented to this report via a April 6, 2012 submittal by Nebraska to the Court. The disc contained inadvertently omitted reference material. The data contained on that disk was also provided via FTP.

Nebraska's Responsive Expert Report
Concerning Nebraska's Future Compliance
and References
Bates # NE 0500402



James C. Schneider, Ph.D.
March 15, 2012
Disc 2 of 2