Republican River Compact:

Recent Compliance Issues for Nebraska

Jim Schneider, Ph.D.
Nebraska Department of Natural Resources
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Since the Republican River Compact (Compact) Settlement in 2002, Nebraska's computed beneficial consumptive use (CBCU) has consistently exceeded its Compact allocation. Even though Nebraska has decreased its CBCU in recent years, Nebraska's Compact allocations have shrunk to record low levels. Several factors have contributed to this, most significantly the low rainfalls and record levels of pumping in Nebraska since 2000. However, the interrelationships between these factors and their effects on stream baseflows are complex; it is impossible to understand the current situation based on a single factor (e.g. rainfall trends). The following discussion summarizes the historical flow system in the Republican Basin and the differences between the current situation and the recent past.

Historic Precipitation

A summary of rainfall trends for the Republican River Basin, utilizing the cumulative departure from average rainfall, is presented in Figure 1. This analysis includes the rainfall gages used in the Republican River Compact Model (RRCM), and also looks at the subset of those gages that are located in Nebraska. The cumulative departure from average is very useful in characterizing the rainfall conditions for a given period of time. When the trend in this plot is relatively flat, this indicates a relatively average period of rainfall. Upward and downward trends indicate wet and dry periods, respectively.

Following a relatively average period in the 1920's, several significant upward and downward trends occur from the 1930's through the mid-1950's. Then, a period characterized by average to above average rainfall occurred from the mid-1950's through the mid-1990's. This trend is even more apparent for the rainfall stations located in Nebraska than for the entire group of Compact stations. This is not to say that rainfall was always average or above average during this period. There are clearly several short periods showing a downward trend (e.g. late 1980's). However, the overall trend for this period as a whole is clearly increasing, indicating that above average rainfalls always came back to make up for the short periods of lower precipitation.

The period from the mid to late-1990's through 2005 is characterized by average to below average rainfall. Average annual rainfall in 2002 was the lowest in the basin since the 1930's. Aside from that year, the trend is mostly flat, indicating relatively average rainfall. However, in contrast to dry periods that occurred in the previous interval (mid-1950's to mid-1990's), no above average rainfall has occurred to make up for the below average years.

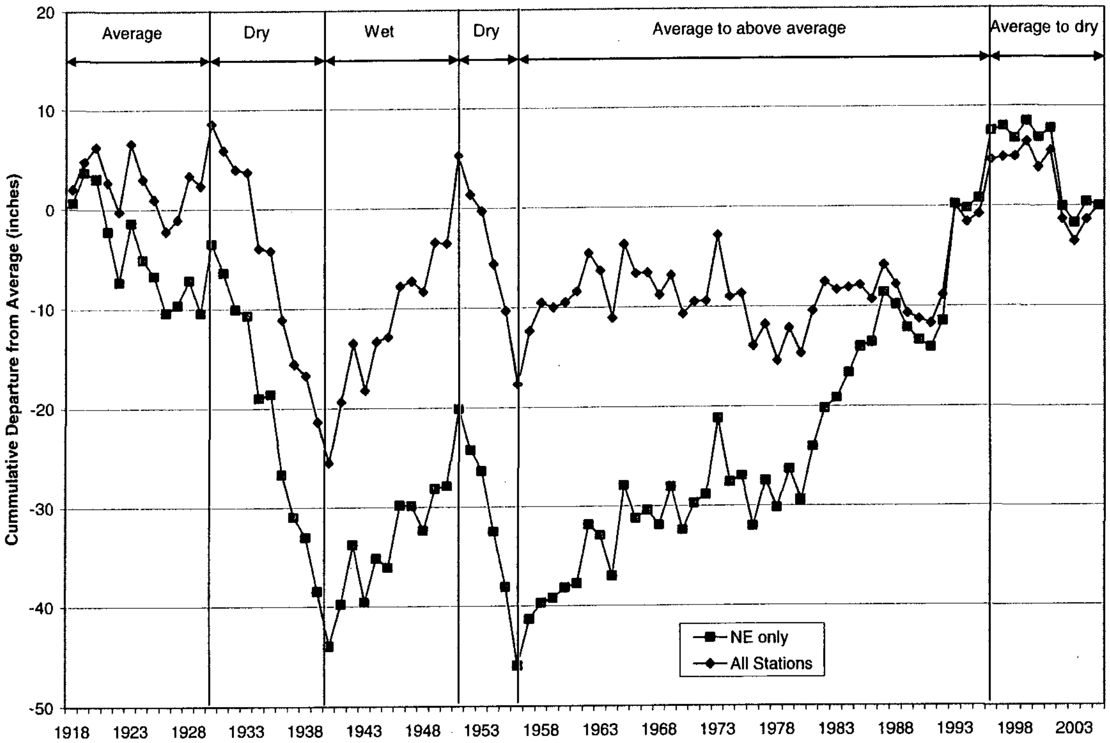


Figure 1. Cumulative departure from average rainfall for RRCM precipitation stations.

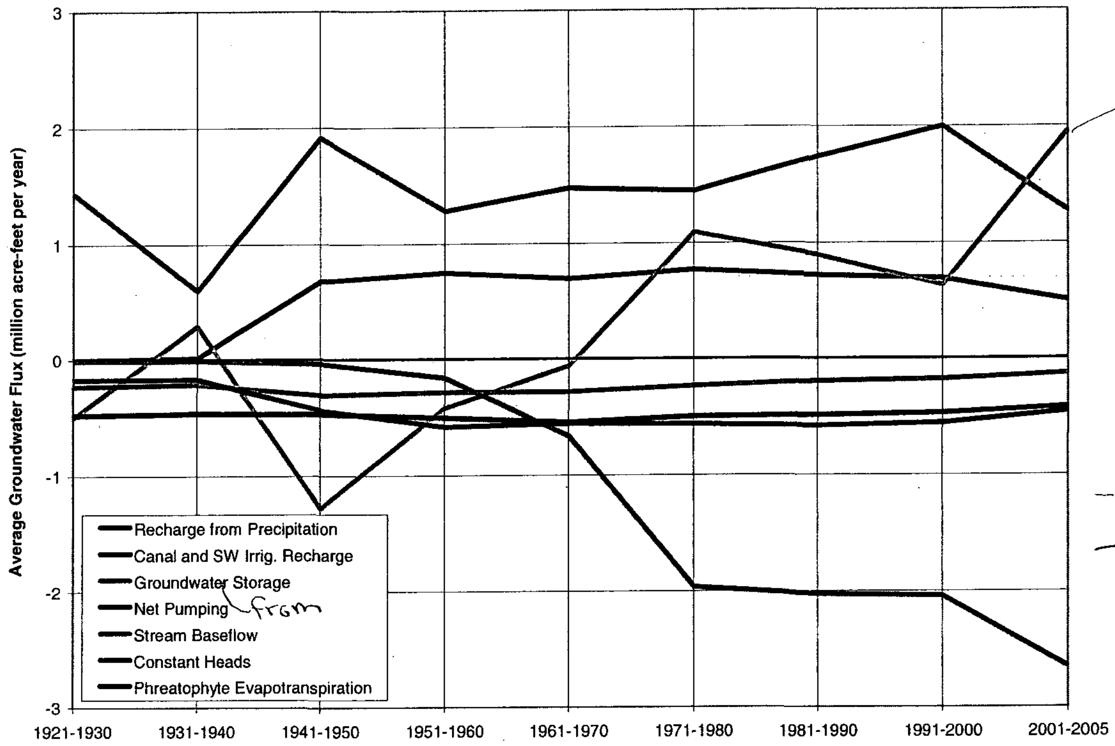
Components of the Groundwater Flow System

Figure 2 presents a historical summary of the components of groundwater flow within the Republican River Basin, as generated from the RRCM. In this graph, the positive terms represent sources of water to the system and the negative terms represent sinks through which water is removed from the system. A short description of each of these components follows.

- **Recharge from precipitation.** The RRCM uses the recorded rainfall for 34 stations located within and near the groundwater model domain. The total rainfall for each month is contoured and translated into recharge using a set of rainfall-recharge curves and the distribution of soil types. This component is always positive because recharge is only added to a system, never taken away (i.e. always a source, never a sink).
- **Canal and surface water irrigation recharge.** Another component of recharge in the RRCM is the seepage from canals and the deep percolation of surface water irrigation. This is computed for each month of each year based on records of canal diversions and deliveries. This component is also always positive.
- **Groundwater storage.** A major flow component of any groundwater system is the transfer of water into and out of groundwater storage. When the water table in a given area shows a net increase, this represents an addition to groundwater storage. Conversely, water table declines represent a decrease in groundwater storage. This component can be either positive or negative, representing a

+ flux = ins stream flow

withdrawal from storage or an addition to storage, respectively. This concept is a bit counterintuitive. A positive storage flux reduces water levels in the model to make this water available to sinks within the model (i.e. creates an additional source), such as pumping. Alternately, a negative storage flux represents flow into storage as water tables increase due to an excess supply (e.g. large recharge), or a minimized loss (e.g. low pumping), or both (i.e. a negative storage is a sink for excess water).



+ ∴ less in GW

-- inputs

— ~~outputs~~ model outputs

Figure 2. Average groundwater flux by decade (except for 2001-2005 interval) from the entire RRCM. See text for description of components.

- **Net Pumping.** Net pumping merely represents the total simulated pumping minus the return flows from groundwater irrigation. This is always negative, or always a sink for water.
- **Stream baseflow.** This is the discharge of groundwater into the streams within the model. These are primarily the mainstem and tributaries of the Republican River, but also include some other streams in Kansas (though these are not considered in the Compact accounting). Stream baseflow can be either a source or a sink for water in the model, since discharge from a stream can soak back into the aquifer further downstream under some conditions. However, the net baseflow for the model as a whole is always negative, indicating a net sink for water from the model.
- **Constant heads.** A constant head is frequently used in groundwater models to represent certain boundary conditions. In the RRCM, a constant head boundary is used to simulate the Platte River along the *northern* boundary of the model domain. This term is also always negative.

- **Phreatophyte Evapotranspiration** (ET). The RRCM also simulates the loss of water from the aquifer to phreatophytes located along the streams in the model. This component is always a sink for water (i.e. always negative).

To summarize, the sources of water to the flow system are recharge from precipitation, canal and surface water irrigation recharge, and water stored in the aquifer (i.e. groundwater storage) and the sinks for water from the flow system are water added to aquifer storage, pumping, stream baseflows, constant head boundaries (i.e. Platte River), and phreatophyte ET.

Relationships within the Groundwater Flow System

The trends of these components are all interrelated. When a source of water increases (e.g. more rainfall), the extra water increases flow into one or more sinks to the system. This might occur through increased baseflow, increased ET, increased pumping, additions to groundwater storage, or some combination of these. When flow into a groundwater sink is increased (e.g. increased pumping), this extra water must come from some source, such as increased recharge or a release from aquifer storage. Some of these sources and sinks are controlled from outside of the system (e.g. pumping and recharge are determined independently by actions of man and climatic conditions) and other sources and sinks simply react to the water available to the system (e.g. stream baseflow goes up and down and storage is increased and decreased in response to the available supply).

The three primary components to the Republican Basin groundwater flow system are recharge, changes in storage, and pumping (Figure 2). In the first several decades of the model period, recharge and net changes in storage are closely related. During periods of greater recharge water is added to storage (negative storage flux) and during dry periods water is removed from storage. The stream baseflows and phreatophyte ET react in a similar way to changes in recharge, but at a much smaller scale than the storage changes. This indicates that changes in groundwater storage significantly dampen the impacts of large swings in recharge on other components, such as stream baseflow. During the 1940's and 1950's there was a substantial increase in groundwater storage, in large part representing the formation of the groundwater mound south of the Platte River due to surface water irrigation from the Platte. To illustrate this, Figure 3 shows the groundwater declines (and increases) for Nebraska at 1970. Most of the Republican Basin had either remained unchanged or had experienced water level increases.

Beginning around 1960, groundwater pumping began to substantially increase in the basin. An average rate of around 2 million acre-feet per year was reached during the 1970's and maintained through the next few decades. Losses to aquifer storage peaked during the 1970's but were mitigated during the 1980's and 1990's due to increasing recharge from precipitation. Nonetheless, there was a significant net loss in aquifer storage during these three decades, though water level declines occurred primarily in the western part of the Nebraska portion of the Republican Basin (Figure 4), as well as in Kansas and Colorado. In fact, by 2000, the losses in storage during the later part of the century had completely offset the increases in storage from the decades before for the entire basin.

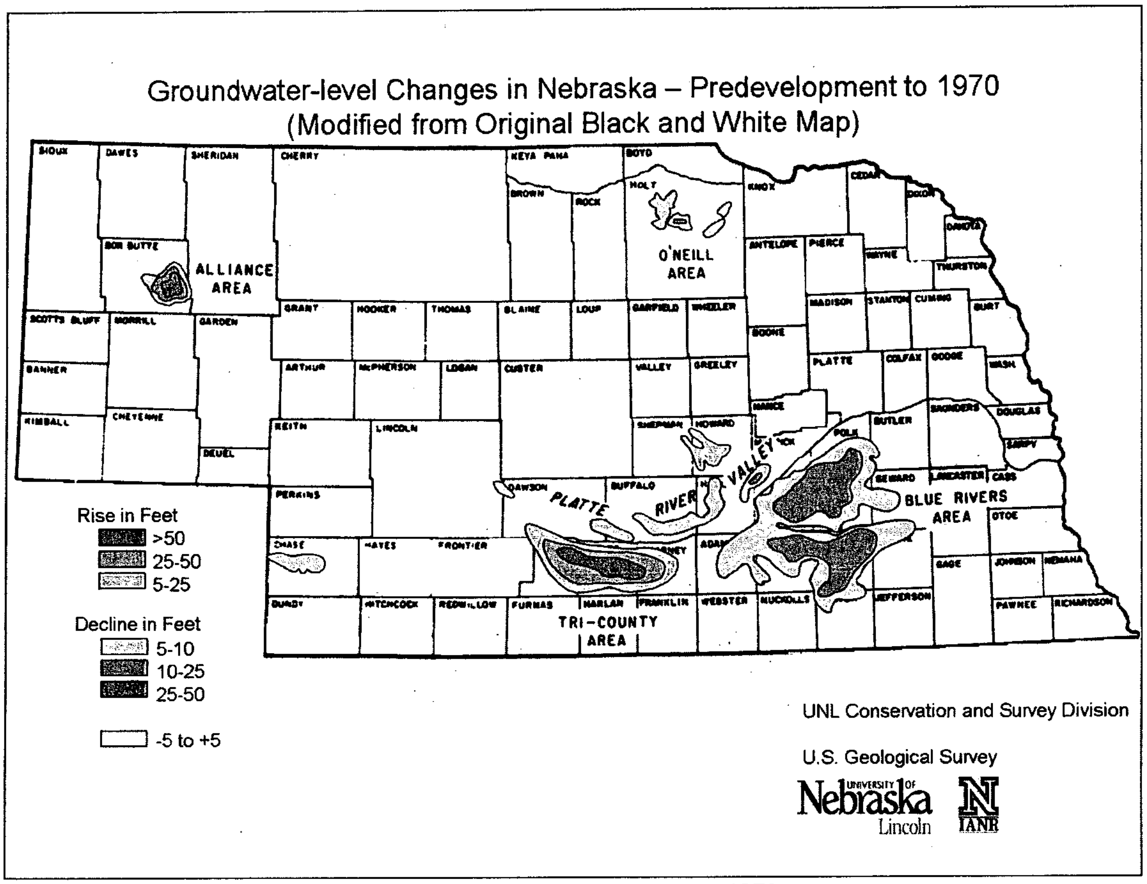


Figure 3. Water levels changes in Nebraska, predevelopment to 1970

There has been a steady decline in stream baseflows and phreatophyte ET since the 1960's. However, the increased recharge in the 1980's and 1990's helped to mitigate these declines. *It is important to emphasize this fact: the entire period of increased groundwater pumping, from the 1950's through the 1990's, coincided with either increasing or stable recharge from both rainfall and canal/surface water sources. Without this, the declines in stream baseflow (as well as the losses from storage) would have been much more significant than was actually experienced during this time.*

In the last period represented in Figure 2, 2001-2005, several things occurred. Groundwater pumping increased substantially and recharge from precipitation and canal and surface water irrigation recharge declined. The result was a greater than doubling of the rate of loss from aquifer storage. This is evident in Figure 5, which shows the water level changes from 2001-2005. Almost every portion of the Republican Basin experienced at least modest groundwater declines (declines between 1 and 5 feet), while many areas experienced severe rates of decline (declines of 5 to 10 feet or more in a period of 5 years).

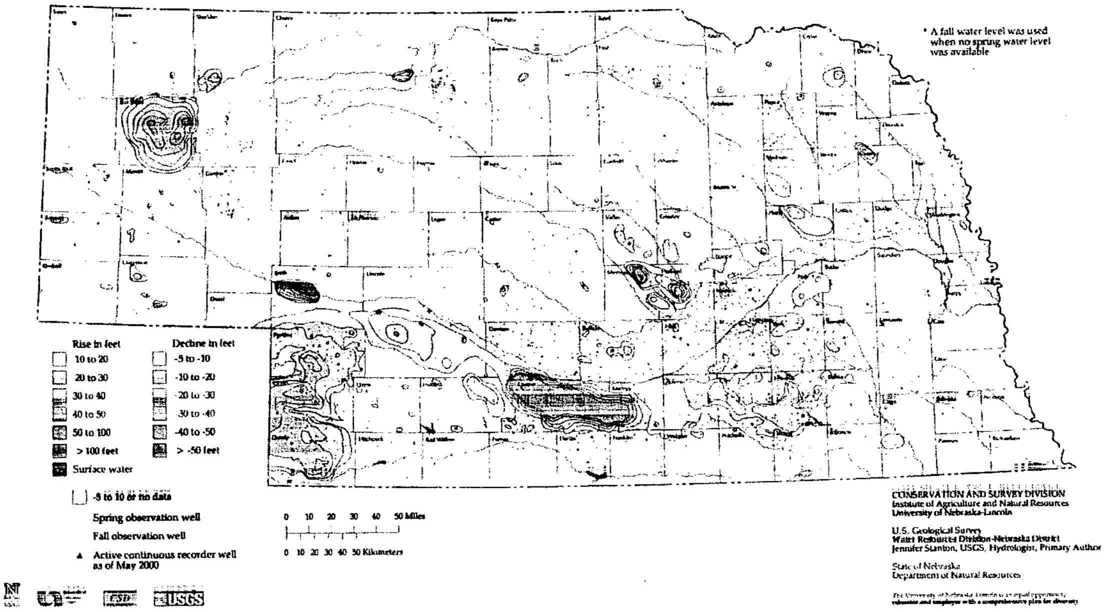


Figure 4. Groundwater level changes in Nebraska, predevelopment to 2000.

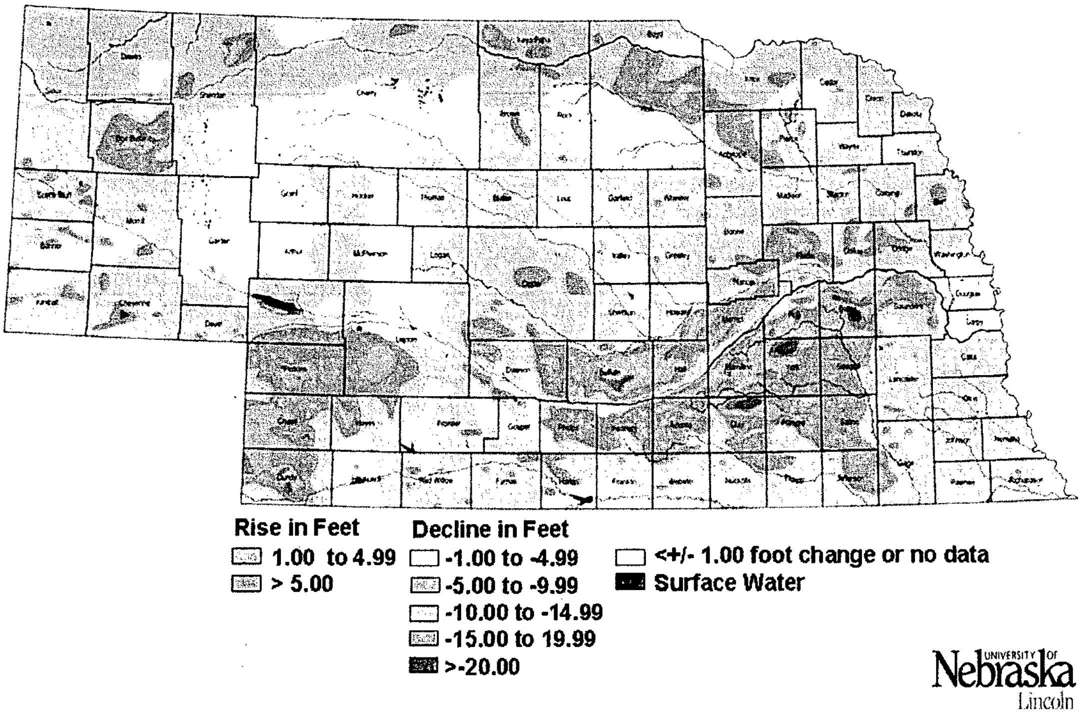
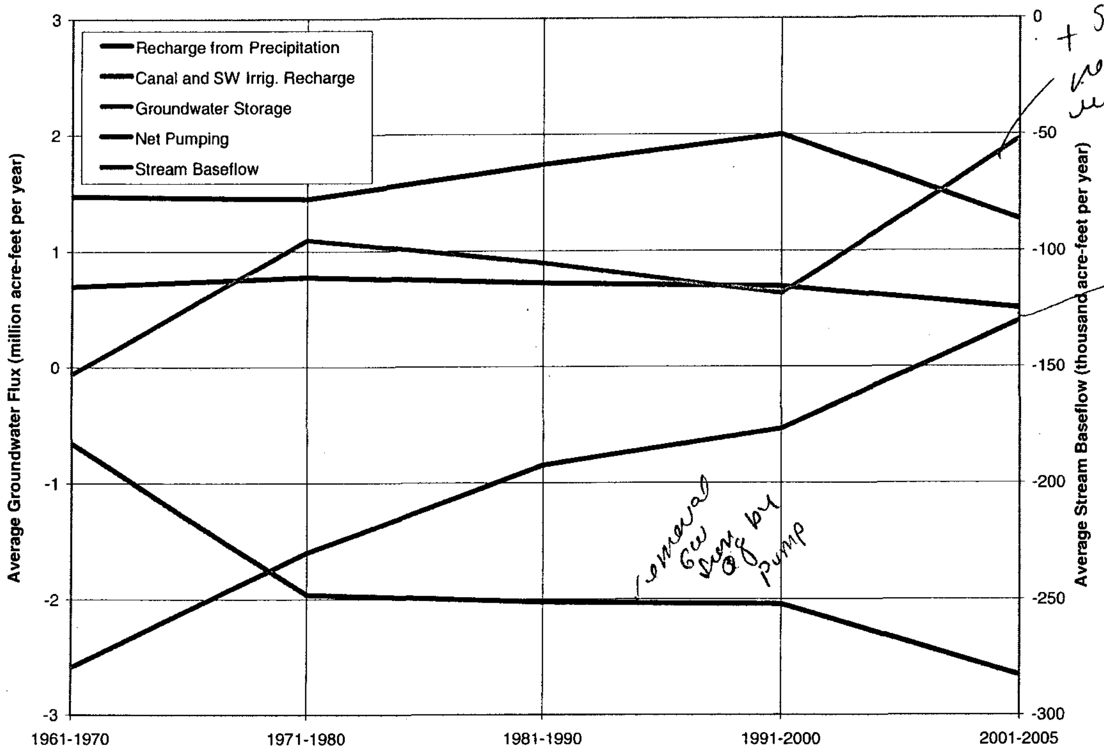


Figure 5. Groundwater level changes in Nebraska, 2000 to 2005.

Consequently, the rate of decline in stream baseflow increased dramatically. Figure 6 zooms in on the last few time intervals shown in Figure 2, and also plots the stream baseflow on a separate axis to accentuate the trends in that flow component. The reduction in average stream baseflow for the entire basin during the 2001-2005 period (from 177 thousand acre-feet per year to 130 thousand acre-feet per year) is almost equal to the total reductions in stream baseflow that occurred during the preceeding 20 year period (230 thousand acre-feet down to 177 thousand acre-feet between 1980 and 2000).



+ storage flux
reduce gw levels
ie water to pumping

water
GW to stream

removal
GW storage by
pump

Figure 6. Average groundwater flux for the entire RRCM. Note that the stream baseflow is plotted on the right axis and all other components are plotted on the left axis.

Figure 6 is an excellent illustration of what happens to the stream baseflow and aquifer storage (i.e. groundwater levels) in response to the combination of pumping and recharge stresses. First look at the difference between the 1960's and the 1970's. Pumping increased dramatically while recharge was essentially unchanged. This resulted in large changes in the rates of storage withdrawals and stream baseflows. During the 1980's and 1990's pumping levels total average pumping in the basin did not change much. The increased recharge rates during this time allowed the rate of storage withdrawal to go down and significantly reduced rate of change in the stream baseflows. After 2000, the large increase in pumping and reduction of recharge (net pumping exceeded total recharge for the first time) combined to significantly reduce aquifer storage and stream baseflow. This indicates a system that is dramatically out of equilibrium (i.e. the supplies are far less than the demands).

The Future of Water Supplies in the Republican Basin

An increase in sources of water (i.e. increased recharge) will help bring this system back into balance, as will a reduction in demand (i.e. reduced pumping). However, simply bringing the system back into balance will not increase the water supply in the basin. As Figure 6 shows, groundwater storage has been significantly impacted in the basin, particularly in recent years. Without an increase in the groundwater storage, water levels will remain at current levels and stream baseflows will not improve. Baseflow is a major component in the total streamflow, and measured streamflows are a major component in the Compact Computed Water Supply (CWS).

The average CWS for the 1990's was greater than 600 thousand acre-feet per year, resulting in an average NE allocation of greater than 300 thousand acre-feet per year. During 2001-2005, the average CWS was reduced to approximately 420 thousand acre-feet per year, reducing the average NE allocation to approximately 225 thousand acre-feet per year. In fact, in 2005 the CWS and the NE allocation were at ~345 thousand acre-feet and ~191 thousand acre-feet respectively, both record lows.

The trends in Nebraska's consumptive use were much less dramatic. Nebraska's consumptive use of virgin groundwater increased from an average of about 180 thousand acre-feet per year in the 1990's to about 190 thousand acre-feet per year in 2001-2005. Average surface water consumptive use was reduced (primarily due to reduced streamflows) from about 100 thousand acre-feet in the 1990's to about 60,000 acre-feet for 2001 through 2005, for a net decrease in total NE CBCU. If the basins water supply continues to decrease, the groundwater depletions to streamflow will decrease as well, regardless of pumping levels, because there will be less and less streamflow to deplete.

The large decrease in the CWS (and consequently the NE compact allocation) is mostly attributable to the declining streamflows, a result of the declining aquifer levels in recent years (Figure 5), which is due to the increased pumping and decreased recharge. Reduced pumping (along with any increases in recharge) is needed simply to bring the basin into balance with the remaining available supply (i.e. to curb further reduction in the CWS). The basin water supply (and the NE allocation) will not increase until the system moves toward an imbalance in the opposite direction (i.e. inputs exceeding the outputs), which will require a dramatic increase in recharge, a dramatic decrease in pumping, or both.

Provisional Information

Under Review

	Overall % =	15	Add. QR =	25	Meter adj. (est.)			Depletion by NRD		
	Net NE	CREP	Alloc.	Reduction	LR	MR	New Net NE	LR	MR	UR
2003	-16260									
2004	-27950									
2005	-31708									
2006	-35904	2,231	1,823		872	137				
2007	-27955.5	4,151	3,457		1,234	263	-18,851			
2008	-27955.5	5,568	4,106	4,653	1,450	352	-11,827	1,210	1,396	2,047
2009	-27955.5	6,288	4,134	7,354	1,329	451	-8,400	1,912	2,206	3,236
2010	-27955.5	7,596	6,712	9,421	1,549	482	-2,196	2,449	2,826	4,145
2011	-27955.5	6,519	7,689	10,456	1,732	526	-1,034	2,719	3,137	4,601
2012	-27955.5	7,539	7,250	10,877	1,730	579	20	2,828	3,263	4,786

	Overall % =	5	Add. QR =	34	Meter adj. (est.)			Depletion by NRD		
	Net NE	CREP	ALL	Reduction	LR	MR	New Net NE	LR	MR	UR
2003	-16260									
2004	-27950									
2005	-31708									
2006	-35904	2,231	1,823		872	137				
2007	-27955.5	4,151	3,457		1,234	263	-18,851			
2008	-27955.5	5,568	4,106	4,476	1,450	352	-12,004	1,164	1,343	1,969
2009	-27955.5	6,288	4,134	7,120	1,329	451	-8,634	1,851	2,136	3,133
2010	-27955.5	7,596	6,712	9,103	1,549	482	-2,514	2,367	2,731	4,005
2011	-27955.5	6,519	7,689	10,240	1,732	526	-1,250	2,662	3,072	4,505
2012	-27955.5	7,539	7,250	10,786	1,730	579	-71	2,804	3,236	4,746

	Overall % =	32	Add. QR =	0	Meter adj. (est.)			Depletion by NRD		
	Net NE	CREP	ALL		LR	MR	New Net NE	LR	MR	UR
2003	-16260									
2004	-27950									
2005	-31708									
2006	-35904	2,231	1,823		872	137				
2007	-27955.5	4,151	3,457		1,234	263	-18,851			
2008	-27955.5	5,568	4,106	4,273	1,450	352	-12,206	1,111	1,282	1,880
2009	-27955.5	6,288	4,134	6,772	1,329	451	-8,982	1,761	2,031	2,980
2010	-27955.5	7,596	6,712	8,673	1,549	482	-2,944	2,255	2,602	3,816
2011	-27955.5	6,519	7,689	9,789	1,732	526	-1,700	2,545	2,937	4,307
2012	-27955.5	7,539	7,250	10,783	1,730	579	-75	2,804	3,235	4,744

	Overall % =	0	Add. QR =	40	Meter adj. (est.)			Depletion by NRD		
	Net NE	CREP	ALL		LR	MR	New Net NE	LR	MR	UR
2003	-16260									
2004	-27950									
2005	-31708									
2006	-35904	2,231	1,823		872	137				
2007	-27955.5	4,151	3,457		1,234	263	-18,851			
2008	-27955.5	5,568	4,106	4,531	1,450	352	-11,948	1,178	1,359	1,994
2009	-27955.5	6,288	4,134	7,241	1,329	451	-8,513	1,883	2,172	3,186
2010	-27955.5	7,596	6,712	9,270	1,549	482	-2,347	2,410	2,781	4,079
2011	-27955.5	6,519	7,689	10,361	1,732	526	-1,129	2,694	3,108	4,559
2012	-27955.5	7,539	7,250	10,799	1,730	579	-59	2,808	3,240	4,751

Provisional Information

Under Review

Average Baseline Volume

	QR	Upland	Total	% Use
Total	272,805	768,993	1,041,798	
LR	113,190	146,929	260,119	0.25
MR	97,741	178,279	276,020	0.26
UR	61,873	443,785	505,658	0.49

Percent of Impacts	
LR	0.26
MR	0.3
UR	0.44

Average Baseline Acres

	QR	Upland	Total	Cert. Acres
Total	265,930	720,106	986,036	1085000
LR	119,641	153,642	273,283	325000
MR	91,458	160,535	251,993	312000
UR	54,832	405,929	460,761	448000

Certified Acres

QR	Upland	Total
321,170	768,425	1,089,595
142,944	185,453	328,397
108,226	204,972	313,198
70,000	378,000	448,000

estimate

Scenario 1

	Overall = 0.15		QR = 0.25	
	QR Vol	Upland Vol	Total	% Use
Total	173,913	653,644	827,557	
LR	87,478	116,938	204,416	0.25
MR	68,073	143,674	211,748	0.26
UR	18,361	393,031	411,392	0.50
	QR Reduction	Upland Reduction	Total Reduction	% Total Reductions
Total	98,892	115,349	214,241	
LR	25,712	29,991	55,703	0.26
MR	29,668	34,605	64,272	0.30
UR	43,512	50,754	94,266	0.44
	QR Allocation	Upland Allocation		
LR	7.3	7.6		
MR	7.5	8.4		
UR	3.1	12.5		

Percent of Baseline volume allowed

	QR	Upland	Total
Total	0.64	0.85	0.79
LR	0.77	0.80	0.79
MR	0.70	0.81	0.77
UR	0.30	0.89	0.81

Scenario 2

	Overall = 0.05		QR = 0.34	
	QR Vol	Upland Vol	Total	% Use
Total	171,049	730,543	901,592	
LR	86,733	136,932	223,665	0.25
MR	67,214	166,744	233,958	0.26
UR	17,100	426,867	443,967	0.49
	QR Reduction	Upland Reduction	Total Reduction	% Total Reductions
Total	101,756	38,450	140,206	
LR	26,457	9,997	36,454	0.26
MR	30,527	11,535	42,062	0.30
UR	44,773	16,918	61,691	0.44
	QR Allocation	Upland Allocation		
LR	7.3	8.9		
MR	7.5	9.8		
UR	2.9	13.6		

Percent of Baseline volume allowed

	QR	Upland	Total
Total	0.63	0.95	0.87
LR	0.77	0.93	0.86
MR	0.69	0.94	0.85
UR	0.28	0.96	0.88

Provisional Information

Under Review

Scenario 3

	Overall = 0.32		QR = 0.00	
	QR Vol	Upland Vol	Total	% Use
Total	185,507	522,915	708,423	
LR	90,493	82,949	173,441	0.24
MR	71,552	104,456	176,007	0.25
UR	23,462	335,511	358,973	0.51
	QR Reduction	Upland Reduction	Total Reduction	% Total Reductions
Total	87,298	246,078	333,375	
LR	22,697	63,980	86,678	0.26
MR	26,189	73,823	100,013	0.30
UR	38,411	108,274	146,685	0.44
	QR Allocation	Upland Allocation		
LR	7.6	5.4		
MR	7.9	6.1		
UR	4.0	10.7		

Percent of Baseline volume allowed

	QR	Upland	Total
Total	0.68	0.68	0.68
LR	0.80	0.56	0.67
MR	0.73	0.59	0.64
UR	0.38	0.76	0.71

Scenario 4

	Overall = 0.00		QR = 0.40	
	QR Vol	Upland Vol	Total	% Use
Total	163,683	768,993	932,676	
LR	84,818	146,929	231,747	0.25
MR	65,004	178,279	243,283	0.26
UR	13,859	443,785	457,644	0.49
	QR Reduction	Upland Reduction	Total Reduction	% Total Reductions
Total	109,122	0	109,122	
LR	28,372	0	28,372	0.26
MR	32,737	0	32,737	0.30
UR	48,014	0	48,014	0.44
	QR Allocation	Upland Allocation		
LR	7.1	9.5		
MR	7.2	10.4		
UR	2.4	14.1		

Percent of Baseline volume allowed

	QR	Upland	Total
Total	0.60	1.00	0.90
LR	0.75	1.00	0.89
MR	0.67	1.00	0.88
UR	0.22	1.00	0.91

Medicine Creek Sub basin	**Harry Strunk Res. released for RRCA**	**Harry Strunk Res. released for Irrigation in Cambridge Canal**	**Differents**
Change in storage	0	0	
Medicine Creek Below (gaging station)	26800	26800	
Nebraska's % of Medicine Creek's VWS = 9.1%	9.1%	9.1%	
Nebraska's VWS in AF for Medicine Cr sub basin based on gaged discharge (9.1%)	2439	2439	
Unallocated VWS AF	24361	24361	
Nebraska Mainstem percentage 48.9%	48.9%	48.9%	
Nebraska's Mainstem VWS based on Medicine Cr below gage in AF	11913	11913	
Nebraska's total VWS from gaged discharge at Medicine Cr. Gage	14351	14351	
Kansas' VWS from gaged discharge at Medicine Below	12449	12449	
Cambridge Canal Diversions (90% of HS releases)	0	24120	
% Return flows??	0.00	0.54	
Cambridge Canal CBCU	0	13025	
48.9% of Cambridge's CU that is added to Nebraska's VWS at Rep. R. Hardy Gage.	0	6369	
Estimated that 40 % of Cambridge Canal CBCU would make it to Hardy where Nebraska would receive 48.9% for Main stem	2548	0	
Nebraska'a reduction in CBCU	13025	0	
Nebraska's increase in VWS	16899	20721	
Overall gain/loss for Nebraska	32472	20721	11751
Payment to FCID			10,500,000
Price per AF			$893.54

To develop percentages to distribute Allocation - Used Tc, not Vc for amount allowed to deplete to also restrict use of IWS Tri-Basin NRD is not included as long as IWS greater than 0. This rule reflects that fact that there is no obligation that water imports from the Platte must be maintained. If IWS becomes zero, new accounting and distribution of allocation will have to be developed to reflect the depletions due to wells within the RRCA basin in Tri-Basin that are depleting Republican River stream flow.

Total Allocation* = 288,462

		Allocation to SW and NRD		
Allocation to Surface Water	34%	96,804	Total SW	96,804
Allocation to URNRD Ground Water	29%	84,329		
Allocation to MRNRD Ground Water	20%	57,497		
Allocation to LRNRD Ground Water	17%	49,831		
			Total GW	191,658
	100%	288,462		288,462

*For example equals average allocation for years 1998-2002

For administration, total surface water depletions would be limited to the maximum of allocated supply or diversions - return flows with actual administration being done on surface water first in time, first in right.

Such administration would require a continued accounting of surface water diversions and calculations of the resulting compact depletions. This method would allow surface water users to use their fair share of water based on the 1998-2002 calculations but would protect any other inflows due to restrictions of ground water use from further depletion by surface water diversions.

If water was purchased as part of an augmentation plan, the purchased water could be protected from further surface water diversions.

Example of Distribution of Nebraska's Allocation to Surface Water and Ground Water Uses

This distribution is based on the 1998-2002 depletions to stream flow by surface water and ground water uses.

	Depletions			Percent of Total Depletion	
	GW	SW	Total	GW	SW
1998	185460	112290	297750	62.3%	37.7%
1999	203490	99400	302890	67.2%	32.8%
2000	184020	112510	296530	62.1%	37.9%
2001	212870	79450	292320	72.8%	27.2%
2002	180440	85470	265910	67.9%	32.1%
Average				66%	34%

Percent Depletion of GW by NRD

URNRD	44%
MRNRD	30%
LRNRD	26%
	100%

Total Percentage of Nebraska Allocation Used by Surface Water and by NRD Ground Water Pumping 1998-2002

SW	34%
URNRD	29%
MRNRD	20%
LRNRD	17%
	100%

YEAR	Depletion Volume Acre Feet UPPER REPUBLICAN	MIDDLE REPUBLICAN	LOWER REPUBLICAN	Total
1990	61,742	45,675	36,231	143,648
1991	64,826	49,433	37,990	152,249
1992	67,036	57,818	39,886	164,740
1993	74,053	56,861	43,157	174,071
1994	62,647	41,397	42,044	146,088
1995	71,320	53,840	48,321	173,481
1996	81,183	69,168	48,004	198,355
1997	69,794	49,404	46,155	165,353
1998	72,889	48,653	43,929	165,471
1999	80,522	60,444	44,387	185,353
2000	73,692	42,920	44,631	161,243
2001	77,339	65,508	46,175	189,022
2002	66,364	43,315	40,648	150,327
Averages				
1991-2002	71,805	52,649	43,197	166,877
0-2002 no1	70,780	52,298	43,200	166,278

ar Running Average

1994	66,061	50,237	39,862	156,159
1995	67,976	51,870	42,280	162,126
1996	71,248	55,817	44,282	171,347
1997	71,799	54,134	45,536	171,470
1998	71,567	52,492	45,691	169,750
1999	75,142	56,302	46,159	177,603
2000	75,616	54,118	45,421	175,155
2001	74,847	53,386	45,055	173,288
2002	74,161	52,168	43,954	170,283

Depletion Volume Acre Feet UPPER REPUBLICAN	MIDDLE REPUBLICAN	LOWER REPUBLICAN	Total
43.0%	31.8%	25.2%	100.0%
42.6%	32.5%	25.0%	100.0%
40.7%	35.1%	24.2%	100.0%
42.5%	32.7%	24.8%	100.0%
42.9%	28.3%	28.8%	100.0%
41.1%	31.0%	27.9%	100.0%
40.9%	34.9%	24.2%	100.0%
42.2%	29.9%	27.9%	100.0%
44.0%	29.4%	26.5%	100.0%
43.4%	32.6%	23.9%	100.0%
45.7%	26.6%	27.7%	100.0%
40.9%	34.7%	24.4%	100.0%
44.1%	28.8%	27.0%	100.0%
43.0%	31.5%	25.9%	100.5%
42.6%	31.5%	26.0%	100.0%

42.3%	32.2%	25.5%	100.0%
41.9%	32.0%	26.1%	100.0%
41.6%	32.6%	25.8%	100.0%
41.9%	31.6%	26.6%	100.0%
42.2%	30.9%	26.9%	100.0%
42.3%	31.7%	26.0%	100.0%
43.2%	30.9%	25.9%	100.0%
43.2%	30.8%	26.0%	100.0%
43.6%	30.6%	25.8%	100.0%

44%	**30%**	**26%**

Total Pumpage Volume Acre Feet

YEAR	UPPER REPUBLICAN	MIDDLE REPUBLICAN	LOWER REPUBLICAN	Total
1990	505,015	298,455	214,375	1,017,846
1991	463,137	300,297	275,895	1,039,329
1992	334,973	169,657	145,458	650,088
1993	256,709	60,881	41,515	359,105
1994	494,951	271,512	174,458	940,921
1995	439,376	280,015	246,010	965,401
1996	328,475	174,909	124,411	627,794
1997	489,546	288,260	237,626	1,015,432
1998	503,415	297,421	194,440	995,276
1999	380,234	135,750	153,409	669,392
2000	663,490	380,069	263,751	1,307,310
2001	466,841	307,861	238,542	1,013,244
2002	644,833	426,294	361,303	1,432,430
Averages				
1990-2002	459,307	260,875	205,476	925,659

Percentage Total Pumping in Compact Basin

UPPER REPUBLICAN	MIDDLE REPUBLICAN	LOWER REPUBLICAN	Total
50%	29%	21%	100%
45%	29%	27%	100%
52%	26%	22%	100%
71%	17%	12%	100%
53%	29%	19%	100%
46%	29%	25%	100%
52%	28%	20%	100%
48%	28%	23%	100%
51%	30%	20%	100%
57%	20%	23%	100%
51%	29%	20%	100%
46%	30%	24%	100%
45%	30%	25%	100%
50%	28%	22%	100%

ar Running Average

1994	410,957	220,160	170,340	801,458
1995	397,829	216,472	176,667	790,969
1996	370,897	191,395	146,370	708,662
1997	401,811	215,115	164,804	781,731
1998	451,153	262,423	195,389	908,965
1999	428,209	235,271	191,179	854,659
2000	473,032	255,282	194,727	923,041
2001	500,705	281,872	217,554	1,000,131
2002	531,763	309,479	242,289	1,083,530

51%	27%	21%	100%
50%	27%	22%	100%
52%	27%	21%	100%
51%	28%	21%	100%
50%	29%	21%	100%
50%	28%	22%	100%
51%	28%	21%	100%
50%	28%	22%	100%
49%	29%	22%	100%

Sent to Mike Clements 10/06

year	UR	MR	LR	TB	Other	Total Impact (acre-ft)	UR	MR	LR	TB	Other
1981	50,771	47,662	34,285	6,430	127	139,275	36.5%	34.2%	24.6%	4.6%	0.1%
1982	50,778	39,540	32,510	5,403	140	128,371	39.6%	30.8%	25.3%	4.2%	0.1%
1983	47,117	30,077	31,661	5,308	176	114,339	41.2%	26.3%	27.7%	4.6%	0.2%
1984	51,033	40,042	34,005	5,300	-105	130,275	39.2%	30.7%	26.1%	4.1%	-0.1%
1985	55,514	45,318	38,381	7,955	203	147,371	37.7%	30.8%	26.0%	5.4%	0.1%
1986	53,350	39,330	32,852	6,008	36	131,576	40.5%	29.9%	25.0%	4.6%	0.0%
1987	56,840	43,808	34,431	7,675	160	142,914	39.8%	30.7%	24.1%	5.4%	0.1%
1988	57,229	38,740	33,812	6,051	270	136,102	42.0%	28.5%	24.8%	4.4%	0.2%
1989	56,937	37,409	33,521	7,007	355	135,229	42.1%	27.7%	24.8%	5.2%	0.3%
1990	60,916	42,208	35,024	8,071	391	146,610	41.5%	28.8%	23.9%	5.5%	0.3%
1991	63,031	45,852	36,623	7,526	541	153,573	41.0%	29.9%	23.8%	4.9%	0.4%
1992	65,634	53,720	38,260	11,062	539	169,215	38.8%	31.7%	22.6%	6.5%	0.3%
1993	73,008	52,256	40,980	11,011	636	177,891	41.0%	29.4%	23.0%	6.2%	0.4%
1994	62,266	37,051	40,368	8,667	631	148,983	41.8%	24.9%	27.1%	5.8%	0.4%
1995	70,391	49,689	46,749	9,666	656	177,151	39.7%	28.0%	26.4%	5.5%	0.4%
1996	79,901	63,741	46,763	13,106	779	204,290	39.1%	31.2%	22.9%	6.4%	0.4%
1997	68,944	45,154	44,775	10,830	801	170,504	40.4%	26.5%	26.3%	6.4%	0.5%
1998	72,091	44,966	42,582	10,175	821	170,635	42.2%	26.4%	25.0%	6.0%	0.5%
1999	79,557	56,416	42,901	12,746	911	192,531	41.3%	29.3%	22.3%	6.6%	0.5%
2000	72,858	39,637	43,258	10,579	888	167,220	43.6%	23.7%	25.9%	6.3%	0.5%
2001	76,913	61,776	43,891	12,579	1,022	196,181	39.2%	31.5%	22.4%	6.4%	0.5%
2002	66,937	41,262	38,652	7,672	993	155,516	43.0%	26.5%	24.9%	4.9%	0.6%
2003	72,315	37,052	44,131	10,794	937	165,229	43.8%	22.4%	26.7%	6.5%	0.6%
2004	67,786	43,700	48,026	12,648	926	173,086	39.2%	25.2%	27.7%	7.3%	0.5%
2005	66,268	49,496	48,644	13,764	1,198	179,370	36.9%	27.6%	27.1%	7.7%	0.7%
Average 1	62,408	44,631	38,187	8,529	448	154,203	40.5%	28.9%	24.8%	5.5%	0.3%
2003-2005 Average	68,790	43,416	46,934	12,402	1,020	172,562	40.0%	25.1%	27.2%	7.2%	0.6%

TABLE 4

FOR PLANNING PURPOSES ONLY

Using Model Scenario Acreage

	Target Pumpage Volume Ranges		
	Quick Response Zone	Upland Zone	NRD
Upper Republican NRD	13,000 - 26,000	375,000	388,000 - 401,000
Middle Republican NRD	20,000 - 40,000	150,000	170,000 - 190,000
Lower Republican NRD	24,000 - 48,000	125,000	149,000 - 173,000

	Acreage for In/Ac Allocation Calculation		
	Quick Response Zone	Upland Zone	NRD
Upper Republican NRD	55,000	405,000	460,000
Middle Republican NRD	90,000	160,000	250,000
Lower Republican NRD	120,000	155,000	275,000

	Calculated In/Ac Allocation Ranges		
	Quick Response Zone	Upland Zone	NRD Average
Upper Republican NRD	2.8 - 5.7	11.1	10.1 - 10.5
Middle Republican NRD	2.7 - 5.3	11.3	8.2 - 9.1
Lower Republican NRD	2.4 - 4.8	9.7	6.5 - 7.5

Using IMP Planning Acreage Not certified

	Target Pumpage Volume Ranges		
	Quick Response Zone	Upland Zone	NRD
Upper Republican NRD	13,000 - 26,000	375,000	388,000 - 401,000
Middle Republican NRD	20,000 - 40,000	150,000	170,000 - 190,000
Lower Republican NRD	24,000 - 48,000	125,000	149,000 - 173,000

	Acreage for In/Ac Allocation Calculation			
	Quick Response Zone	Upland Zone	NRD	cert
Upper Republican NRD	55,000	400,000	455,000	
Middle Republican NRD	90,000 76,830 acres	200,000	290,000	312,000
Lower Republican NRD	120,000	157,000	277,000	325,000

	Calculated In/Ac Allocation Ranges		
	Quick Response Zone	Upland Zone	NRD Average
Upper Republican NRD	2.8 - 5.7 - 8.55	11.3	10.2 - 10.6
Middle Republican NRD	2.7 - 5.3 8.0	9.0	7.0 - 7.9
Lower Republican NRD	2.4 - 4.8 [illegible]	9.6	6.5 - 7.5

↑

15/50

FOR PLANNING PURPOSES ONLY

Potential Solution to the Republican River
By
Mike Delka

I offer this proposal in an attempt to minimize the potential conflicts and damages the basin and state may be subject to with other actions and lack of actions. I will make several basic assumptions in this proposal with the largest being that the reader has some knowledge of the history and conditions in the basin.

My proposal is simplistic in nature and I believe if it can be kept from to many complications it may offer hope to all.

PROPOSAL

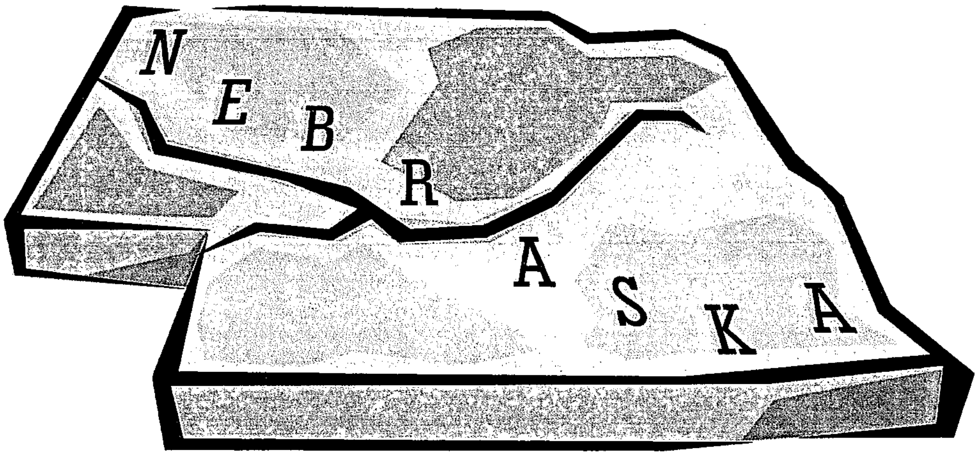
1. All basin wells have a base allocation of 6 acre-inches per acre. This will allow all wells to be treated equally and should put the basin in compliance with the Republican River compact.
2. Anyone wanting additional water will be charged a rate (recommended $4/acre inch) for additional water. This rate would be similar to rates charged on projects for surface water. If an additional acre-inch of water will does not have more value than expense it will not be used. The fee will encourage conservation. It is anticipated the ability to buy additional water will provide drought tolerance and allow for best management practices. NRD's must pay for any funds not collected due to water banking policies or bad debt.
3. The revenue generated from the sale of water will be used to fund acreage retirement, augmentation, damages to surface irrigators and conservation. Although it is recognized the greatest income potential is in the west it is also in the west where the most work needs to be done to off set depletions.
4. The Natural Resource Districts should have a program to convert surface irrigated acres to wells. This would maintain local tax bases and increase management potentials through NRD programs and policies.
5. The Department of Natural Resources should encourage and assist in the transfer of acres from service by irrigation canal to service from the river.
6. Irrigation Districts, Bureau of Reclamation, Department of Natural Resources and Natural Resource Districts should jointly develop a program to transfer acres and their assessments from Irrigation District acres to Natural Resource Districts. The NRD would pay the Irrigation District the assessments annually for the acres transferred to them. This "banking" would allow individuals wanting out of Irrigation Districts to remove their acres without increasing costs to those who remain. This program would serve as an augmentation program to allow the NRD to utilize the water that would have been delivered to those acres to off set over use at a minimal cost. As more acres are retired and transferred to the NRD's it
7. The base allocation and additional water rate may change annually once compact compliance is attained and surface water users remaining have an adequate water supply.

Respectfully,
Mike Delka

Bleed

Integrated Management Meeting

Republican River Natural Resource Districts
&
The Department of Natural Resources



January 25, 2007
Lincoln, Nebraska

Privileged and Confidential Attorney Client Communication
And Attorney Work Product

Potential Agenda for RRNRD Meeting

January 25, 2007
8:00 A.M. DNR Office, Lincoln

Meeting goals:

1. Develop a list of all feasible options for maintaining Compact compliance;
2. Develop a list of options for allocating the available water supplies among NRDs and between surface water and ground water users
3. Develop a work plan and decision making process with the goal of having plans ready before the next Compact meeting.

Agenda

1. Required IMP goals include Compact Compliance, what objectives are we trying to achieve?

2. What tools can we use?
   a. Near-term
      i. 2007
      ii. 2008-2010
   b. Long-term

3. How do we distribute the allocated supply
   a. Among NRDs?
   b. Between surface water and ground water users

4. Status of current studies to develop better methods for Compact compliance

5. Review available data and determine additional data needs

6. Develop decision making process for developing new or changed components of the plan

Session on model

7. Develop a schedule and task assignments for work completion

Points to Consider

1. Controls proposed for adoption in IMP shall, when considered together with any applicable incentive programs
   a. Sustain a balance between supply and use

   b. Remain in compliance with Republican River Compact
   c. Protect ground water users and surface water appropriators whose water wells and appropriations are dependent on the river from stream flow depletions from uses begun after the date the river basin was designated as fully appropriated (Neb.Rev. Stat. 46-715).

2. Potential Objectives
   a. Maximize economic and environmental beneficial consumptive use of Nebraska's Compact allocation
   b. Minimize nonbeneficial consumptive use of water
   c. Minimize the adverse economic and social impacts on the basin that will result from the necessary reductions in water use
   d. Distribute allocation fairly among users
   e. Promote long-term stability
3. Tools to achieve objectives
   a. Reduce pumping allocations and the number of certified aces in the next IMP cycle to meet Compact requirements
      i. Regulatory controls
         1. Allocations
         2. Reductions in irrigated acres
      ii. Incentive plans CREP, EQIP
      iii. Other?
   b. Methods to allow flexibility to make maximum use of water given the wide fluctuations in water supply
      i. Use of Quick Response Area wells and surface water supplies to achieve timely response to river
         1. Dry-year leasing
      ii. Other augmentation plans
      iii. Other?
   c. Methods to optimize the use of surface water infrastructure to conjunctively manage available water supplies
   d. Methods to increase productivity per acre-foot of water consumed
   e. Methods to decrease nonbeneficial consumptive use of water (removal of water consuming invasive species and vegetation in the river channel)
   f. Other?

We need to take
a break.

RRCA
Compact Accounting without non-federal reservoir evaporation below Harlan County

Table 1: Annual Virgin and Computed Water Supply, Allocations, and Computed Beneficial Consumptive Uses by State, Main Stem, and Sub-Basin

2005	Virgin Water Supply	Computed Water Supply	Allocations				Computed Beneficial Consumptive Use		
Basin			Colorado	Kansas	Nebraska	Unallocated	Colorado	Kansas	Nebraska
North Fork	44,800	44,800	10,040	0	11,020	23,740	17,530	20	4,290
Arikaree	2,370	2,370	1,860	120	400	-10	810	160	250
Buffalo	6,050	6,050	0	0	2,000	4,050	310	0	3,510
Rock	9,360	9,360	0	0	3,740	5,620	60	0	3,830
South Fork	26,050	27,550	12,230	11,080	390	3,850	18,660	7,520	1,370
Frenchman	110,950	110,950	0	0	59,470	51,480	40	0	86,800
Driftwood	3,400	3,400	0	230	560	2,610	0	10	1,480
Red Willow	16,360	14,560	0	0	2,800	11,760	0	0	8,800
Medicine	39,990	34,390	0	0	3,130	31,260	0	0	21,320
Beaver	4,560	4,560	910	1,770	1,850	30	0	1,660	2,730
Sappa	-310	-310	0	-130	-130	-50	0	-1,180	790
Prairie Dog	11,720	11,620	0	5,310	880	5,430	0	8,180	40
Main Stem	116,560	90,960	0	46,480	44,480	0	-1,950	27,940	117,480
Total All Basins	391,860	360,260	25,040	64,860	130,590	139,770	35,460	44,310	252,690
Main Stem Including Unallocated		230,730	0	117,900	112,830				
Total	391,860	360,260	25,040	136,280	198,940	0	35,460	44,310	252,690

Negative numbers represent the residual accounting impacts from groundwater well pumping. Reference RRCA accounting user's manual for comprehensive explanation.

This data has not been finally adopted by the RRCA as of Jan 25, 2007

RRCA
Compact Accouting without non-federal reservoir evaporation below Harlan County

Table 3A: Colorado's Five-Year Average Allocation and CBCU

Year	Allocation	Computed Beneficial Consumptive Use	Imported Water Supply Credit	Allocation - (CBCU - IWS Credit)
2003	21,420	33,470	NA	(12,050)
2004	21,540	33,670	NA	(12,130)
2005	25,040	35,460	NA	(10,420)
2006			NA	
2007			NA	
Average	22,670	34,200		(11,530)
Sum				(34,600)

Table 3B: Kansas's Five-Year Average Allocation and CBCU

Year	Allocation	Computed Beneficial Consumptive Use	Imported Water Supply Credit	Allocation - (CBCU - IWS Credit)
2003	167,780	48,910	NA	118,870
2004	137,450	38,120	NA	99,330
2005	136,280	44,310	NA	91,970
2006			NA	
2007			NA	
Average	147,170	43,780		103,390
Sum				310,170

Table 3C: Nebraska's Five-Year Average Allocation and CBCU

Year	Allocation	Computed Beneficial Consumptive Use	Imported Water Supply Credit	Allocation - (CBCU - IWS Credit)
2003	227,580	262,780	9,780	(25,420)
2004	205,630	252,650	10,380	(36,640)
2005	198,940	252,690	11,965	(41,785)
2006				
2007				
Average	210,720	256,040	10,710	(34,620)
Sum				(103,845)

RRCA AccountingFor2005 w NFR evap above HC.xls This data has not been finally adopted by the RRCA as of Jan 25, 2007

RRCA
Compact Accounting without non-federal reservoir evaporation below Harlan County

Table 1: Annual Virgin and Computed Water Supply, Allocations, and Computed Beneficial Consumptive Uses by State, Main Stem, and Sub-Basin

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North Fork	44,800	44,800	10,040	0	11,020	23,740	17,530	20	4,290
Arikaree	2,370	2,370	1,860	120	400	-10	810	160	250
Buffalo	6,050	6,050	0	0	2,000	4,050	310	0	3,510
Rock	9,360	9,360	0	0	3,740	5,620	60	0	3,830
South Fork	26,050	27,550	12,230	11,080	390	3,850	18,660	7,520	1,370
Frenchman	110,950	110,950	0	0	59,470	51,480	40	0	86,800
Driftwood	3,400	3,400	0	230	560	2,610	0	10	1,480
Red Willow	16,360	14,560	0	0	2,800	11,760	0	0	8,800
Medicine	39,990	34,390	0	0	3,130	31,260	0	0	21,320
Beaver	4,560	4,560	910	1,770	1,850	30	0	1,660	2,730
Sappa	-310	-310	0	-130	-130	-50	0	-1,180	790
Prairie Dog	11,720	11,620	0	5,310	880	5,430	0	8,180	40
Main Stem	116,560	90,960	0	46,480	44,480	0	-1,950	27,940	117,480
Total All Basins	391,860	360,260	25,040	64,860	130,590	139,770	35,460	44,310	252,690
Main Stem Including Unallocated		230,730	0	117,900	112,830				
Total	391,860	360,260	25,040	136,280	198,940	0	35,460	44,310	252,690

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Table 3A: Colorado's Five-Year Average Allocation and CBCU

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2004	21,540	33,670	NA	(12,130)
2005	25,040	35,460	NA	(10,420)
2006			NA	
2007			NA	
Average	22,670	34,200		(11,530)
Sum				(34,600)

Table 3B: Kansas's Five-Year Average Allocation and CBCU

Year	Allocation	Computed Beneficial Consumptive Use	Imported Water Supply Credit	Allocation - (CBCU - IWS Credit)
2003	167,780	48,910	NA	118,870
2004	137,450	38,120	NA	99,330
2005	136,280	44,310	NA	91,970
2006			NA	
2007			NA	
Average	147,170	43,780		103,390
Sum				310,170

Table 3C: Nebraska's Five-Year Average Allocation and CBCU

Year	Allocation	Computed Beneficial Consumptive Use	Imported Water Supply Credit	Allocation - (CBCU - IWS Credit)
2003	227,580	262,780	9,780	(25,420)
2004	205,630	252,650	10,380	(36,640)
2005	198,940	252,690	11,965	(41,785)
2006				
2007				
Average	210,720	256,040	10,710	(34,620)
Sum	250 $\frac{34}{210}$	$\frac{256}{210}$		(103,845)

6% 15 39%

380560

10 = 9%

~~8%~~

76%

Kaq 24%

245330

73% — 27%

RRCA
Compact Accounting with non-federal reservoir evaporation below Harlan County

Table 1: Annual Virgin and Computed Water Supply, Allocations, and Computed Beneficial Consumptive Uses by State, Main Stem, and Sub-Basin

2005	Virgin Water Supply	Computed Water Supply	Allocations				Computed Beneficial Consumptive Use		
Basin			Colorado	Kansas	Nebraska	Unallocated	Colorado	Kansas	Nebraska
North Fork	44,800	44,800	10,040	0	11,020	23,740	17,530	20	4,290
Arikaree	2,370	2,370	1,860	120	400	-10	810	160	250
Buffalo	6,050	6,050	0	0	2,000	4,050	310	0	3,510
Rock	9,360	9,360	0	0	3,740	5,620	60	0	3,830
South Fork	26,050	27,550	12,230	11,080	390	3,850	18,660	7,520	1,370
Frenchman	110,950	110,950	0	0	59,470	51,480	40	0	86,800
Driftwood	3,400	3,400	0	230	560	2,610	0	10	1,480
Red Willow	16,360	14,560	0	0	2,800	11,760	0	0	8,800
Medicine	39,990	34,390	0	0	3,130	31,260	0	0	21,320
Beaver	4,560	4,560	910	1,770	1,850	30	0	1,660	2,730
Sappa	-310	-310	0	-130	-130	-50	0	-1,180	790
Prairie Dog	11,720	11,620	0	5,310	880	5,430	0	8,180	40
Main Stem	117,610	92,010	0	47,020	44,990	0	-1,950	27,940	118,530
Total All Basins	392,910	361,310	25,040	65,400	131,100	139,770	35,460	44,310	253,740
Main Stem Including Unallocated		231,780	0	118,440	113,340				
Total	392,910	361,310	25,040	136,820	199,450	0	35,460	44,310	253,740

Negative numbers represent the residual accounting impacts from groundwater well pumping. Reference RRCA accounting user's manual for comprehensive explanation.

RRCA
Compact Accounting with non-federal reservoir evaporation below Harlan County

Table 3A: Colorado's Five-Year Average Allocation and CBCU

Year	Allocation	Computed Beneficial Consumptive Use	Imported Water Supply Credit	Allocation - (CBCU - IWS Credit)
2003	21,420	33,470	NA	(12,050)
2004	21,540	33,670	NA	(12,130)
2005	25,040	35,460	NA	(10,420)
2006			NA	
2007			NA	
Average	22,670	34,200		(11,530)
Sum				(34,600)

Table 3B: Kansas's Five-Year Average Allocation and CBCU

Year	Allocation	Computed Beneficial Consumptive Use	Imported Water Supply Credit	Allocation - (CBCU - IWS Credit)
2003	167,780	48,910	NA	118,870
2004	137,450	38,120	NA	99,330
2005	136,820	44,310	NA	92,510
2006			NA	
2007			NA	
Average	147,350	43,780		103,570
Sum				310,710

Table 3C: Nebraska's Five-Year Average Allocation and CBCU

Year	Allocation	Computed Beneficial Consumptive Use	Imported Water Supply Credit	Allocation - (CBCU - IWS Credit)
2003	227,580	262,780	9,780	(25,420)
2004	205,630	252,650	10,380	(36,640)
2005	199,450	253,740	11,965	(42,325)
2006				
2007				
Average	210,890	256,390	10,710	(34,800)
Sum				(104,385)