Colorado's Report in Response to Nebraska Expert Report in Support of Counterclaim and Crossclaim: Nebraska's Proposed Changes to the RRCA Accounting Procedures

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1. Introduction

This report provides a response to *Nebraska Expert Report in Support of Counterclaim and Crossclaim: Nebraska's Proposed Changes to the RRCA Accounting Procedures* by Dr. James C. Schneider dated November 18, 2011 (the "Report"). The Report builds upon a previous report titled *Estimating Computed Beneficial Consumptive Use for Groundwater and Imported Water Supply under the Republican River Compact* by Dr. David P. Ahlfeld, Michael G. McDonald and James C. Schneider dated January 20, 2009 (the "2009 Report").

The Report presents "The Problem" and "The Solution" as if there is a single problem and a single solution. This is incorrect. There are in fact a number of different mechanisms at work leading to the observations cited in the Report. Furthermore, not all these observations are necessarily errors in the RRCA Groundwater Model or the application of the Model. Instead, these observations are manifestations of the nonlinear behavior of the complex hydrology of the Republican River Basin itself.

To explain "The Problem", Nebraska introduces an analogy based on a simple weight scale with a limited capacity to weigh multiple objects. This analogy is misleading and inaccurate because it compares the RRCA Groundwater Model and Accounting Procedures to a flawed, nonlinear measurement device attempting to quantify a process that is inherently linear. The RRCA Groundwater Model is nonlinear because the underlying groundwater flow system in the Republican River Basin is nonlinear, and not as a result of any sort of flaw in the Model itself. Nebraska's analogy is therefore totally inappropriate and not helpful as an illustration.

As for "The Solution", it is but one of many different applications of the Model that will provide a result. However, Nebraska's proposed solution does not solve the underlying problem, is cumbersome in execution, and introduces new problems. Even if one were to accept what the Report characterizes as an error, the solution proposed by Nebraska is not appropriate.

Furthermore, the proposed solution burdens the States for the consumption of imported water in direct contradiction of the Final Settlement Stipulation (FSS) dated December 15, 2002. In fact, the proposed solution exacerbates the problem by increasing the amount of consumption of imported water added to the Computed Beneficial Consumptive Use (CBCU) of groundwater ($CBCU_G$)[1] for all three States.

The core of the Nebraska proposal is not to determine the Virgin Water Supply. Even under the proposed Nebraska procedures, the Virgin Water Supply could be very simply calculated using the difference between the historical simulation and a simulation with all pumping and imported water turned off. Instead, its complex procedure is required to attribute this difference to the States. Nebraska's proposed procedure would burden the States not only for the actual depletions to stream

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1 Generally, the Compact accounting and equations uses the abbreviation CBCU to generically refer to Computed Beneficial Consumptive Use. A subscript is used to refer to some specific type of CBCU. Thus the total CBCU for all groundwater consumption is $CBCU_G$, while Nebraska's total groundwater consumption is $CBCU_N$, etc.

flows, but also for the potential depletions to stream flows that would have been caused had the other States not been pumping – a purely hypothetical exercise. Such a procedure benefits the State with the largest impacts, because it considers the potential impacts that would have occurred in the absence of the major stress that historically occurred in the basin. Since, historically, Nebraska's pumping impacts comprise more than 80% of all the pumping impacts to streams in the basin, this obviously favors Nebraska.

By burdening States with potential depletions rather than actual depletions, the Nebraska proposal essentially shifts the burden of some of Nebraska's pumping depletions to Colorado and Kansas, and thus reduces the ability of Colorado and Kansas to use their full allocations guaranteed under the Compact.

Colorado therefore objects to Nebraska's proposal to change the approved procedure to calculate the CBCU of groundwater for each State on the following technical grounds:

1. Nebraska's proposed solution burdens Colorado and Kansas, but mostly Nebraska itself, with consumption of imported water supply. This is counter to the conditions agreed to in the Accounting Procedures and Reporting Requirements attached as Appendix C to the FSS.

2. Nebraska's proposed method subtracts imported water from the gaged flow that would only have occurred in the absence of well pumping in Nebraska. This overestimates the amount of imported water that was actually measured under historical conditions.

3. Nebraska's proposed method does not match the net pumping minus imported water supply calculations within Nebraska, but rather overestimates the net impact within Nebraska.

4. Nebraska bases the necessity for changing the currently approved procedures on highlighting selected locations and periods where the current model application does not favor Nebraska. The magnitude of this deficiency is overstated. In agreeing to the current approved procedures, the States recognized that the RRCA Groundwater Model is an imperfect analog of reality that cannot be perfectly accurate in every location for every year. To mitigate the Model's limitations, the States agreed to assess Compact Compliance using a five year running average.

5. Nebraska's proposed method burdens Colorado and Kansas with impacts that would only have occurred if Nebraska had not been pumping, a situation outside of Colorado or Kansas' control. For example, Nebraska's pumping has dried up parts of Frenchman Creek. The proposed method includes impacts caused by wells in Colorado as if wells in Nebraska had never pumped and never dried up parts of Frenchman Creek.

6. Nebraska's proposed method assumes that the accuracy of the RRCA Groundwater Model is the same under all conditions. In reality, model results becomes increasingly uncertain the further away they get from the conditions the model was calibrated to. The currently approved method was adopted to deviate from the calibrated conditions only to the extent absolutely necessary to determine depletions to baseflow caused by groundwater withdrawals and to determine the effect of the imported water supply on surface streams. In Nebraska's proposed method, the impact calculation is dominated by conditions to which the RRCA Groundwater

Model was not calibrated.

7. The procedure proposed by Nebraska is but one of many alternatives to the procedure approved by the States and the RRCA as part of the FSS. If there is indeed a problem with the calculation of Imported Water Supply Credit in the approved procedure, the procedure proposed by Nebraska is not the appropriate solution. A method will be demonstrated that corrects a deficiency in computing the Imported Water Supply Credit without introducing additional complexity or introducing new problems.

This report will address the observations cited by Nebraska as well as the specific solution proposed by Nebraska, and demonstrate that the proposed modifications to the Accounting Procedures are inappropriate. In addition, this report will address consumption of imported water. This is mentioned in the Nebraska report, but Nebraska's proposal does not correct this problem. As an example of alternative procedures, this report will present a procedure designed to address this issue, although the procedure proposed in the report may not be the sole solution to the problem.

The graphs and results shown in this report are based on model simulations supplied by Nebraska to support its current Report and the report Nebraska submitted in support of its proposals in the 2009 nonbinding arbitration (2009 Report).

2. The perceived problem

Nebraska contends that the approved RRCA Accounting Procedures are flawed because the impacts computed for individual States do not equal the impacts for the three States combined, for each sub-basin, and for each year.

This result is not indicative of any error. Instead, this result is simply the consequence of the nonlinear behavior inherent in the Republican River groundwater system which is correctly represented in the RRCA Groundwater Model. The approved RRCA Accounting Procedures recognize that the nonlinearities in the model could cause the pumping impacts of wells in Colorado or Kansas to be greater in the absence of any pumping in Nebraska than the pumping impacts of wells in Colorado or Kansas when wells in Nebraska were actually pumping, as they did historically.

The approved RRCA Accounting Procedures satisfy an important requirement that Nebraska's proposed method does not: ***The pumping impacts assigned to a State cannot exceed the amount of additional baseflow that would be generated by curtailment of all the wells in only that State.*** Therefore, if all the wells in Colorado were curtailed, Colorado's Computed Beneficial Consumptive Use of Groundwater under the Compact cannot be greater than the amount of additional baseflow generated by only that action. This is not by accident. The committees that constructed the RRCA Groundwater Model and formulated the accounting procedures were well aware of the nonlinearities in the groundwater system and that were represented in the Model. The procedure in the RRCA Accounting Procedures to calculate the Computed Beneficial Consumptive Use of Groundwater for each State was agree to after careful consideration of such nonlinearities. Under Nebraska's proposed method, Colorado would be burdened with not only the additional baseflow that would be generated by curtailment of wells in Colorado, but also with the additional amount of baseflow that would have been generated had Nebraska never developed any wells, even though Nebraska had the right to develop and administer wells in Nebraska.

The primary purpose of the RRCA Groundwater Model is to determine the amount, location, and timing of stream flow depletions to the Republican River caused by well pumping and to determine stream flow accretions from recharge of water imported from the Platte River Basin in to the Republican River Basin[2]. This is accomplished by determining the effects of groundwater pumping and the imported water supply on baseflow[3] and the gaged surface flows. These calculations are complicated by factors that contribute to the nonlinear behavior of the model. Specifically, evapotranspiration by native vegetation, which constitutes a large fraction of the overall water budget, changes in response to changes in water levels. In addition, significant portions of some streams dry up, especially during dry periods, resulting in additional nonlinearities. This leads to a complex interaction between imported water and pumping impacts.

At times, some of the stream reaches dry out due to natural conditions, a condition that occurred historically and prior to development of the RGDSS Groundwater Model. However, imported water can increase the stream flows to the point where streams remain wet, and hence increase the potential for well pumping to cause additional depletions. It is therefore important to consider the interaction between the imported water and depletions caused by well pumping.

2.1 Nebraska's Demonstration of the Problem

To demonstrate the existence of a problem, Nebraska cites examples where Nebraska would benefit from a change in the approved accounting procedures. Specifically, in the 2009 Report, Nebraska demonstrates that in 2003 Nebraska would receive a larger allocation under the proposed method on Beaver Creek because the combined impacts for Kansas and Nebraska are greater than the individual impacts of Kansas and Nebraska added together. Further, Nebraska demonstrates that it will receive a larger allocation in 2003 under the proposed method on Frenchman Creek because the combined impacts for Colorado and Nebraska are greater than the individual impacts of Colorado and Nebraska added together. In addition, Nebraska demonstrates that in 2003, the imported water supply on the Main Stem under the proposed method would be greater than under the approved method. In the current Report, Nebraska concentrates on the Swanson-Harlan mainstem reach to illustrate how under the proposed method, Nebraska would benefit from a change in the procedures under projected future conditions.

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2 This imported water or "imported water supply" is a water supply imported to the Republican River Basin by a state resulting from the activities of man. Here we are concerned with water diverted from the Platte River in Nebraska, a portion of which recharges the groundwater system within the Republican River Basin, also referred to as "the mound." This water can result in additional baseflow and even CBCU that would not exist but for the imported water supply.

3 In simplified terms, "baseflow" may be thought of as the water that accretes to surface streams from an aquifer. It is a portion of, but not necessarily the entire amount, of water recorded at a stream gage. Gaged flows may also contain water that reached the stream directly from surface runoff, usually due to precipitation events.

Nebraska's conclusion that these demonstrations are indicative of errors in the current RRCA Accounting Procedures is not correct. Specifically, Nebraska's demonstrations rely on the necessary nonlinear behavior of the Model to show that if there had been no well development in Nebraska, then Kansas would have had bigger impacts on Beaver Creek and Colorado would have had bigger impacts on Frenchman Creek. Nebraska presents their proposed change to the accounting procedure as a correction needed because the approved method underestimates the virgin water supply.

However, Nebraska's proposed procedure incorrectly increases the calculation of Kansas and Colorado's well impacts on baseflow by basing that determination on a scenario where no other state developed its groundwater resources. Thus, the proposed method increases the calculated impacts of Kansas and Colorado wells on baseflow beyond their actual physical impact on the hydrologic system. For example, Nebraska's proposed method calculates that in 2003 Colorado pumping impacted Frenchman Creek by 2,565 acre-feet. However, the current application of the model shows that if Colorado had never developed a single well, there would be only 19 acre-feet of additional baseflow in Frenchman Creek. Similarly, Nebraska's proposed method calculates that in 2003 Kansas pumping impacted Beaver Creek by 2,021 acre-feet. However, the current application of the model shows that if Kansas had never developed a single well, there would be only 323 acre-feet of additional baseflow in Beaver Creek.

The reasons why the RRCA Groundwater Model predicts greater impacts from pumping in Colorado and Kansas in the absence of well development in Nebraska are detailed below.

2.2 Nonlinearity in the RRCA Groundwater Model

The RRCA Groundwater Model is, by necessity, a non-linear model. That means that the model outputs are not directly proportional to the model inputs. For example, if x acre-feet of pumping results in y acre-feet of stream depletions, then $2x$ acre-feet of pumping will not necessarily result in $2y$ acre-feet of stream depletions.

There are a number of mechanisms contributing to nonlinearity in the physical system, and therefore in the Model, including evapotranspiration, springs and streams. In particular, the MODFLOW stream package is used to track surface water along a stream course and will let streams go dry when losses exceed the inflow to a stream reach. When a stream reach goes dry, well impacts to streams will not increase as well pumping increases, because there is no baseflow to impact, leading to significantly nonlinear behavior.

The RRCA Groundwater Model is applied in a transient[4] mode, but the results are summarized on an annual basis for Compact Accounting purposes. Some of the nonlinear behavior may occur during only part of the year, but still result in nonlinear behavior on an annual basis. The nonlinear behavior may be exacerbated when, for example, the period of time during which the stream is dry changes between the simulations being compared.

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4 Generally, groundwater models are run in either steady state or transient modes. Transient simulations are needed to analyze time-dependent problems. Transient simulations produce a set of groundwater heads or elevation for each time step, i.e. twice monthly, whereas steady-state simulations generate only one set of groundwater heads representing an average over time.

Although the nonlinear behavior of the RRCA Groundwater Model is recognized and accepted, it is also recognized that the Model will need to be operated on an ongoing basis. Therefore, a number of appropriate simplifications were incorporated into the Model. For example, instead of allowing the Model to calculate the saturated thickness as a function of change in water levels, the Model is operated with a saturated thickness that does not vary over time. This makes the Model behavior less nonlinear, but also results in a Model that is considerably more robust and easier to operate. All three States and the United States agreed to these modeling procedures and protocols.

The Accounting Procedures section III.D.1 establishes the procedure for running the Model in order to determine to what extent each State's consumption of groundwater depletes baseflow in the Republican River Basin. This procedure evaluates state by state pumping impacts by making paired Model runs which evaluate the difference in baseflow both with and without pumping within the State in question. Note that for this evaluation, whether the Model is linear or nonlinear does not affect the evaluation procedure. The Model can be used to directly compute the outputs for a given set of inputs. Whether a model is linear or nonlinear only matters when there is an expectation that the differences derived from these paired model simulations can be combined to derive a result without actually re-running the model.

The difference in the baseflow caused by turning off the wells is by definition the impact. Whether the baseflow is linearly or nonlinearly related to the pumping is immaterial when evaluating the impacts for one state using the RRCA approved method since the Model directly calculates the change in flow while considering all the nonlinear relationships. The Model explicitly evaluates the two conditions and by definition the change in baseflow between the conditions are the baseflow impacts used in the Compact Accounting. Nonlinearity only plays a role when it is expected that the individual State impacts should sum to the total impact computed as the difference between a simulation representing historical conditions and a simulation representing predevelopment conditions [5].

2.3 Computing Impacts

The procedure for estimating pumping impacts approved by the RRCA is defined in the Accounting Procedures III.D.1

> ***D. Calculation of Annual Computed Beneficial Consumptive Use***
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> ***1. Groundwater***
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> *Computed Beneficial Consumptive Use of groundwater shall be determined by use of the RRCA Groundwater Model. The Computed Beneficial Consumptive Use of groundwater for each State shall be determined as the difference in stream flows using two runs of the model:*
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> *The "base" run shall be the run with all groundwater pumping, groundwater pumping*

5 A predevelopment condition means that no well development or imported water supply occurred anywhere in the basin.

recharge, and surface water recharge within the model study boundary for the period 1940 to the current accounting year "on".

The "no State pumping" run shall be the run with the same model inputs as the base run with the exception that all groundwater pumping and pumping recharge of that State shall be turned "off."

An output of the model is baseflows at selected stream cells. Changes in the baseflows predicted by the model between the "base" run and the "no-State pumping" model run is assumed to be the depletions to stream flows. i.e., groundwater computed beneficial consumptive use, due to State groundwater pumping at that location. The values for each Sub-basin will include all depletions and accretions upstream of the confluence with the Main Stem. The values for the Main Stem will include all depletions and accretions in stream reaches not otherwise accounted for in a Sub-basin. The values for the Main Stem will be computed separately for the reach above Guide Rock, and the reach below Guide Rock

Therefore the approved procedure for estimating pumping impacts approved by the RRCA compares baseflow in a historical simulation with baseflow in a simulation where pumping for a State is removed. Similarly the imported water supply credits are calculated by subtracting stream flows in a simulation where the imported water supply is removed from the historical simulation. Following the nomenclature introduced by Nebraska in Table 10 of the 2009 Report, the approved methods for estimating impacts are

$CBCU_C = KMN – CKMN$ **(1a)**
$CBCU_K = CMN – CKMN$ **(1b)**
$CBCU_N = CKM – CKMN$ **(1c)**
$IWS = CKMN - CKN$ **(1d)**
so that
$CBCU_C + CBCU_K + CBCU_N - IWS = KMN + CMN + CKM + CKN – 4CKMN$ **(1e)**
$CBCU_N - IWS = (CKM-CKMN) – (CKN-CKMN) = CKM + CKN - 2 CKMN$ **(1f)**

The physical interpretation of Eq. 1e and 1f is that the total basin wide impact and total Nebraska impact are simply the sum of the individual components that make up the sum. In general these sums will not match the values computed as Θ-CKMN and CK-CKMN if the model behaves nonlinearly, as it should in this circumstance.

The procedure first proposed by Nebraska in the January 2009 Report modifies the approved procedure to be

$CBCU_C$ = (KMN-CKMN)/4 + (Θ-C)/4+
(K-CK)/12+(M-CM)/12+(N-CN)/12+(KM-CKM)/12+(KN-CKN)/12+(MN-CMN)/12 **(2a)**
$CBCU_K$ =(CMN-CKMN)/4 + (Θ-K)/4+
(C-CK)/12+(M-KM)/12+(N-KN)/12+(CM-CKM)/12+(CN-CKN)/12+(MN-KMN)/12 **(2b)**
$CBCU_N$ =(CKM-CKMN)/4 + (Θ-N)/4+
(C-CN)/12+(M-MN)/12+(K-KN)/12+(CM-CMN)/12+(CK-CKN)/12+(KM-KMN)/12 **(2c)**
IWS =(CKMN-CKN)/4 + (M-Θ)/4+
(CM-C)/12+(KM-K)/12+(MN-N)/12+(CKM-CK)/12+(CMN-CN)/12+(KMN-KN)/12 **(2d)**
so that
$CBCU_C$ + $CBUC_K$ + $CBCU_N$ - IWS = Θ-CKMN **(2e)**
$CBCU_N$ - IWS = (CKM-CKMN)/4 +
(Θ-N)/4+(C-CN)/12+(M-MN)/12+(K-KN)/12+(CM-CMN)/12+(CK-CKN)/12+(KM-KMN)/12
\+ (CKN-CKMN)/4 +
(Θ-M)/4+(C-CM)/12+(K-KM)/12+(N-MN)/12+(CK-CKM)/12+(CN-CMN)/12+(KN-KMN)/12
=(Θ-CKMN)/2 + (K-M)/6+(C-N)/6+(CK-MN)/6+(CKM-CMN)/6+(CKN-KMN)/6 **(2f)**

Note that the Nebraska proposal shown in Eqs. 2a-d assigns ¼ the weight to the original equation shown in Eqs. 1a-d, respectively. It then adds with the same ¼ weight the difference between a simulation where there is no development in the basin and a simulation where pumping in only one state is developed, or only surface water imports occur. The remaining six terms each have a 1/12 weight and adds to half the total weight. These six terms evaluate different combinations of development in well pumping or surface water imports.

The rationale provided in the Nebraska Report for this procedure is that the States should not only be charged for the **actual** depletions they caused, but also for the **potential** depletions they would have caused in the absence of pumping from other States. Furthermore, it should be noted that in half the simulations shown in Eqs. 2a-d imported water supply is included, which burdens all three states with the depletion of imported water in direct contradiction to the FSS.

The sixteen runs can be combined as weighted pairs in numerous different ways. Mathematical manipulation of the averages can lead to different results, but just because mathematical manipulation of the results provides a desirable outcome, it does not mean that it produces a "better", much less correct result for the three States, or enhances administration of the Republican River. It is important that the mathematical manipulation of these equations be interpreted in terms of the physical meaning of the terms. For example, in Section 3.1 below it will be shown how Eq. 2a physically means that the impact assigned to Colorado is the average of the impact that actually occurred historically and impacts that would have occurred had Nebraska never developed any wells. This is untenable. The mathematical manipulations must be tempered by sound engineering judgment as to whether such a procedure is "better" and correct under the Compact.

Nebraska's proposal has at its core the goal of matching the sum of state impacts to the total directly computed impacts Θ-CKMN. In order to achieve this goal, correctly computing the total Nebraska impact is sacrificed as shown in Eq. 2e. If instead, the goal is to correctly compute the impacts for each state, the model may, for example, be utilized in the following manner:

$CBCU_C = KN - CKN$ **(3a)**
$CBUC_K = CN - CKN$ **(3b)**
$CBCU_N = CK - CKN$ **(3c)**
$IWS = CKMN - CKN$ **(3d)**
so that
$CBCU_C + CBUC_K + CBCU_N - IWS = KN + CN - 2CKN + CK - CKMN$ **(3e)**
$CBCU_N - IWS = (CK-CKN) - (CKN-CKMN) = CK - CKMN$ **(3f)**

Note that Eqs. 3a-c are the same as Eqs. 1a-c except that pumping impacts are evaluated in the absence of the imported water supply, hence dropping the M factor from each term. Eq. 3d is identical to Eq. 1d. The physical interpretation of Eq. 3e is again that the total impact is simply the sum of the individual impacts. However, Eq. 3f shows that the Nebraska total impact matches the directly computed Nebraska impact. In practice, Eqs. 3a and 3b yield essentially the same result as Eqs. 1a and 1b since the Colorado and Kansas pumping impacts are not affected by imported surface water in more than a *de minimis* amount. However, under proper modeling protocols the pumping impacts should be evaluated in a consist manner.

This is not to suggest that the current approved protocol is necessarily in error, only that models and model results may be manipulated in any number of ways to reach a different result depending upon the goal of those who operate the model.

2.4 Quantitative Results

Tables 1 and 2 show the quantitative impact of the different methods shown above. Tables 1a-z show the results for each year from 1981-2006. Tables 2a, 2b and 2c show the average values for 1981-2000, 2001-2006 and 1981-2006, respectively.

Each table shows the amount calculated for $CBCU_C$, $CBUC_K$, $CBCU_N$ and IWS. In addition, the NE Residual column shows the residual calculated as for just Nebraska as

Nebraska Residual = $(CBCU_N - IWS) - (CK - CKNM))$, **(4)**

while the Basin Residual column shows the basin wide residual computed as

Basin Residual = $(CBCU_C + CBUC_K + CBCU_N - IWS) - (\Theta - CKNM))$. **(5)**

For each term in Tables 1 and 2, three methods are shown. The column labeled RRCA is the approved method currently in use.[6] The Jan09 column refers to the results computed using the Nebraska proposal of January 2009 as shown in Eqs. 2a-d. The NEnet column refers to results computed using the example computation shown in Eqs. 3a-d.

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6 As noted in the introduction, the results shown are based on model runs provided by Nebraska. The values shown here as RRCA are calculated using the approved RRCA procedure, but using the Nebraska runs in order to provide a consistent comparison of the different methods. However, these impacts do not match the impacts calculated by the official version of the RRCA Groundwater Model and approved by the RRCA. The differences derive from the fact that the Nebraska simulations used incorrect stresses for the initial stress period and used a different stream package for period until 2000, which has lagged effects for several years beyond 2000. Correcting these errors does not materially alter the results or conclusions.

As can be seen in Tables 1 and 2, the Basin Residual using the method proposed by Nebraska (Jan09 column) is always zero. This is a matter of mathematical necessity as shown in Eq. 2e, but does not necessarily mean the Nebraska's method is appropriate. Similarly, the Nebraska Residual is always zero when using the NEnet method, as it must be from Eq. 3f.

It is also interesting to note that Table 2c shows that using the RRCA approved method from 1981 to 2006, the average Basin Residual is 361 acre-feet/year. That means that over this period, the individual computed impacts using the existing approved method matches the directly computed impacts to within 361 acre-feet/year out of a total of about 197,000 acre-feet/year, a residual of 0.18%. This residual is well within the accuracy of the RRCA Groundwater Model and two orders of magnitude smaller than the accuracy of surface water stream gages.

While the Basin Residual using the method proposed by Nebraska is identified as zero, Table 2c shows that the method has an average residual inside Nebraska of 3,470 acre-feet for 1981-2006. That means that the total impact inside Nebraska is overestimated by 3,470 acre-feet on average from 1981-2006. This is primarily the result of including consumption of imported water, as will be demonstrated below.

As shown in Tables 1 and 2, the different methods result in computed impacts that are quite different. In particular, Table 2c shows that on average for each year from 1981-2006, the method proposed by Nebraska increases the pumping impacts of Colorado by 2,096 acre feet, increases the pumping impacts of Kansas by 1,494 acre-feet, and decreases the pumping impacts of Nebraska by 206 acre-feet, while the Imported Water Supply is increased by 3,746 acre-feet.

By comparison, the method shown in Eqs. 3a-d results in Colorado's pumping impacts decreasing by 7 acre-feet, impacts of Kansas pumping decreasing by 233 acre-feet, impacts of Nebraska pumping by 7,422 acre-feet and Imported Water Supply remaining unchanged.

The different methods therefore do lead to quantitatively different outcomes. It appears that the method proposed by Nebraska may have been chosen based on the fact that it produces a result that is beneficial to Nebraska, rather than scientific merit.

2.5 Model Calibration and Uncertainty

The RRCA Groundwater Model was calibrated to historical conditions based on a steady state simulation to provided initial conditions for January 1, 1918, followed by a transient simulation from 1918 to 2000. The study period was selected to cover the period over which the Republican River Basin was developed which spanned approximately 1940 to 2000. However, since the Dust Bowl years immediately preceded this period, the lingering effects of the Dust Bowl would be difficult to estimate. The study period was therefore extended to before the Dust Bowl era. For these early years, precipitation recharge is the primary aquifer stress and the starting date for the transient simulation was therefore determined by the availability of precipitation data. For the pre-1918 initial steady state, the average precipitation recharge for 1918 to 1940 was calculated and then reduced to 75% of that amount based on observed water levels during later years.

The Model was not calibrated to pre-1918 conditions. Instead, the Model was calibrated in transient mode based on observed water levels and baseflow in the streams. Gaged stream flow records extend from approximately 1940 to 2000, although individual gage records may be for much shorter or intermittent periods. Groundwater levels for calibration extend to 1909, but most groundwater levels are from 1950 onwards.

The Model is calibrated to historical conditions which included well development over time and surface water imports, and the effects of these mechanisms on water levels. In the current RRCA approved procedures, the Model runs start from this historical condition which is based upon actual measured data and deviates only as necessary to evaluate the impacts of the various activities of man. In part, this approach was selected to minimize the uncertainty in the results produced by the model.

The uncertainty in a model's results is least under conditions to which the a model was calibrated. Under these conditions, the RRCA Groundwater Model has been shown to reproduce reasonably accurate representations of historical baseflow and water levels. One therefore has confidence that the RRCA Groundwater Model will be able to accurately predict changes from that condition. However, the further removed model predictions are from the conditions to which that model was calibrated, the more uncertain the model predictions. The more nonlinear a model is, the faster that uncertainty grows.

The Nebraska proposal gives equal weight to differences from the historical and the simulation without any development, despite the differences in their relative reliability. This is not a correct modeling protocol.

2.6 Selecting the best method

While the different methods differ quantitatively, determining which is the “best” method is not simply a matter of selecting a desirable outcome.

Nebraska argues that their proposal is appropriate as it results in no Basin Residual. However, it requires (1) that States be burdened with impacts that did not actually occur; (2) including consumption of imported water; (3) overestimating the net impacts inside Nebraska; and (4) computational awkwardness.

One could argue that the alternate method shown in Eq. 3a–f above is “better” because (1) it does not burden the States for impacts that did not historically occur; (2) it explicitly excludes consumption of imported water; (3) it has no net residual inside Nebraska; and (4) it requires no more complex computations than the approved method currently approved by the RRCA.

The States agreed to the current method after careful deliberation and considering numerous facts such as those enumerated above. Nebraska presents their proposal as an improvement based on a single criterion. Colorado disagrees with this position. As demonstrated by Table 2c, the average residual for the RRCA currently approved method is indeed small. Furthermore, there are many possible solutions, as demonstrated by the one alternative example cited. Nor is the Basin Residual criteria the only measure that can be used to evaluate the perceived “accuracy” of the procedure.

Nebraska is therefore wrong in arguing that there is one solution. Colorado therefore disagrees with the imperative to change the RRCA approved procedure and specifically finds Nebraska's proposal unacceptable, both in terms of proper modeling protocol and in terms of attempting to predict the depletions caused to the streams by each State's actual groundwater withdrawals.

3.0 Deficiencies in Nebraska's Proposed Solution

Even if one were to agree that the demonstration provided by Nebraska does indeed indicate that there is a problem with the current RRCA approved Accounting Procedures, it would not automatically follow that the Nebraska's proposed solution is appropriate. In fact, as will be demonstrated below, Nebraska's proposed procedure suffers from several deficiencies that preclude the results from being acceptable.

In the following sections, the specific demonstrations provided by Nebraska will be examined. It will be shown that what Nebraska identifies as a problem is not necessarily actually a problem, and that Nebraska's proposed procedure does not adequately address the deficiencies identified, but will instead introduce new problems.

3.1 Frenchman Creek Impacts

Frenchman Creek starts in Colorado. It appears on maps extending west of the town of Holyoke, Colorado, but has generally been farmed over and flows only for relatively short periods after exceptional rain events. The Republican River Compact allocates to Colorado the entire water supply of the Frenchman Creek drainage basin in Colorado. In the RRCA Groundwater Model, Frenchman Creek is modeled using the extent of perennial streams as described by the USGS. Figure 1 shows the model cells used to represent Frenchman Creek in the RRCA Groundwater Model from near the Colorado State Line until the Frenchman Creek near Imperial gage above Enders Reservoir.

Impacts to Frenchman Creek are comprised of three parts. The first is impacts to Frenchman Creek between the Colorado State Line and the Frenchman Creek at Imperial stream gage. The second is impacts to Enders Reservoir. The third is impacts to Frenchman Creek from Enders Reservoir to the creek's confluence with the main stem of the Republican River. The impacts are calculated as differences between simulations. The difference in baseflow at the Frenchman Creek near Imperial gage, the difference in leakage for Enders reservoir, and the difference in baseflow at the confluence with the Main Stem are summed to give the total predicted impact to Frenchman Creek. The stage in Enders Reservoir is based on historical measurements, and baseflow is set to zero at Enders dam, so the three terms are effectively independent of each other.

Figure 1 shows the cells where Frenchman Creek is a live stream in the RRCA Groundwater Model as light blue cells. Each Model cell represents one square mile. Cells where the Model indicates that the stream is dry are shown in yellow. Note that under historical conditions, the Model shows that in July 2003, there are some sections where Frenchman Creek is a live stream, but others where it dries out. Only for the last three model cells is there a continuous live stream above the Frenchman Creek near Imperial gage. In effect, Frenchman Creek does not become a continuous live stream until more than 20 miles east of the Colorado State line, about two miles from the Frenchman Creek near Imperial gage.

Figure 2 shows the RRCA Groundwater Model predicted baseflow along Frenchman Creek as a blue line. The horizontal axis in Figure 2 represents stream reaches in the Model which does not translate linearly to river miles but does show the progression from upstream to downstream. The vertical axis represents the baseflow. The model predicts that under historical conditions, there is some baseflow from reaches 14 to 30, but that the stream dries up and only becomes live for reaches 34 to 39 which represent approximately the last two miles above the Frenchman Creek near Imperial gage.

When the RRCA Groundwater Model is run under predevelopment conditions, that is a simulation where no pumping occurs in either Colorado, Kansas or Nebraska and there are is no imported water supply, the Model predicts stream flows shown by a purple line in Figure 2. Note that in this simulation, there is a continuous live stream from reach 3 until the Frenchman Creek near Imperial gage. Figure 1 shows that the continuous live stream extends from about four miles from the Colorado State Line all the way to the Frenchman Creek near Imperial gage.

The Model can also be run assuming that these same historical conditions occur, except that no wells were ever developed in Colorado. The result of that simulation is shown as a green line in Figure 2. The difference between the green line and the blue line measures the predicted impact that the wells in Colorado have on the stream flow, and is highlighted in orange. As can be seen in Figure 2, in the absence of wells in Colorado, there is a small increase in stream flow from reach 14 to 23, but then the stream dries out regardless of whether any wells in Colorado pump or not. When the stream does become live at reach 34 the increase in baseflow at the Frenchman Creek near Imperial gage in the absence of Colorado pumping is 0.044 cfs.

If instead the Model is run assuming that only wells in Colorado were developed, and that no wells were developed in Kansas or Nebraska and no imported water supply occurred, the Model predicts baseflow shown as a red line in Figure 2. The impact of Colorado well pumping on Frenchman Creek under these conditions is the difference between the purple and red lines, which is shaded in yellow. As a result of lowering the water table, the reduction in stream gains in the form of baseflow in stream reaches 3 to 8 propagate all the way to the Frenchman Creek near the Imperial gage. In Figure 1, these impacts occur in the westernmost blue cells shown in the predevelopment frame, approximately four to six miles from the Colorado state line.

The July 2003 situation illustrated in Figures 1 and 2 is not unique. Figure 3 shows the Model predicted baseflow at the Frenchman Creek near Imperial gage. The horizontal axis represents time and covers the period from 1950 through 2006. The vertical axis represents baseflow at the Frenchman Creek near Imperial gage. Model simulated baseflow for different simulations are shown as lines in colors consistent with Figure 2. The difference between the green and blue lines which is colored orange shows that if wells in Colorado would have never pumped under otherwise historical conditions, additional baseflow would have only rarely showed up at the Frenchman Creek near Imperial gage. During 2003, this additional flow averages about 0.026 cfs.

However, Figure 3 also shows that there is a dramatic decline in baseflow at the Frenchman Creek at Imperial gage from about 1970 to 2000. This decline in baseflow is caused almost exclusively by nearby pumping in Nebraska. The Model simulations show that in the absence of any well development, baseflow would remain around 70 cfs as indicated by the purple line. More importantly, in the absence of well pumping in Nebraska, there would be a live stream from near the Colorado State Line to the Frenchman Creek near Imperial gage. The proximity of this live stream to wells in Colorado would cause greater stream depletions, resulting in baseflow shown as the red line, and hence the impacts from these wells would be the difference between the red and purple lines which is shaded in yellow.

Figure 3 shows that, had there never been well development in Nebraska, wells in Colorado would have impacted the amount of baseflow that reached the Frenchman Creek near Imperial gage. However, given the historical reality that wells in Nebraska were in fact developed, the Model simulations show that even if there had never been any well development in Colorado, there would be little additional baseflow at the Frenchman Creek near Imperial gage.

It is instructive to construct the Nebraska method for the simplified two state case that occurs on Frenchman Creek. Ignoring the impacts of imported water supply (the mound or M) and Kansas pumping K because they are so small on Frenchman Creek, the total impact on Frenchman Creek using the Nebraska definition is approximately Θ-CN. From basic arithmetic, we know that we can split one into two halves. Also, if you add and subtract the same quantity, the net result does not change. Therefore, we can split Θ and CN and add and subtract ½C and ½N without altering the result as

$$\begin{aligned} \Theta\text{-}CN &= (\tfrac{1}{2}\Theta + \tfrac{1}{2}\Theta) - (\tfrac{1}{2}CN + \tfrac{1}{2}CN) + (\tfrac{1}{2}C - \tfrac{1}{2}C) + (\tfrac{1}{2}N - \tfrac{1}{2}N) \\ &= \tfrac{1}{2}(\Theta\text{-}C) + \tfrac{1}{2}(N\text{-}CN) + \tfrac{1}{2}(\Theta\text{-}N) + \tfrac{1}{2}(C\text{-}CN) \end{aligned} \qquad \textbf{(6)}$$

after regrouping the terms on the right hand side. Assigning terms differing in N to Nebraska and terms differing in C to Colorado, Eq. 6 can be rewritten as

$$\Theta\text{-}CN = CBCU_C + CBCU_N \qquad \textbf{(7)}$$

where

$$CBCU_C = \tfrac{1}{2}(\Theta\text{-}C) + \tfrac{1}{2}(N\text{-}CN) \qquad \textbf{(8a)}$$

$$CBCU_N = \tfrac{1}{2}(\Theta\text{-}N) + \tfrac{1}{2}(C\text{-}CN) \qquad \textbf{(8b)}$$

Note that Eqs. 8a and 8b demonstrate mathematically that the essence of the Nebraska proposal is to average the actual and the potential depletions. The Colorado CBCU is the average of the actual historical depletion caused by Colorado N-CN and the depletion that would have occurred in the absence of Nebraska pumping Θ-C. Since pumping in Nebraska is much more and closer to Frenchman Creek than pumping in Colorado, the potential impacts Θ-C are much larger than then actual impacts N-CN. In particular for 2003, Θ-C is 5,099 acre-feet, while N-CN is 19 acre-feet. On the other hand Θ-N and C-CN are very similar because Colorado's pumping impacts to Frenchman Creek are small compared to those of Nebraska.

The full Nebraska proposal for the calculation of Colorado's pumping impacts ($CBCU_C$) is summarized in Figure 4. The proposal uses sixteen simulations. These sixteen simulations are viewed as eight pairs, each where one simulation includes and one excludes Colorado pumping. Figure 4 shows these eight pairs in individual frames. The $CBCU_C$ is then calculated as the weighted average of the different simulations.

Figure 4 shows that the eight pairs fall into two categories, four where the wells in Nebraska are pumping and four where there is no well pumping in Nebraska. In fact, the four combinations in each group of four, with or without Kansas pumping and with or without the imported water supply, makes so little difference as to be indistinguishable. For all practical purposes, therefore, the $CBCU_C$ for Frenchman Creek is the average of the two impacts shown in Figure 3. (Due to their distance from pumping in Colorado, the contribution from pumping impacts to Enders Reservoir and Frenchman Creek below Enders are *de minimis*). The approximation in the simplified two state example shown in Eqs. 8a and 8b therefore captures the essence of the Nebraska proposal for Frenchman Creek.

The Colorado pumping impact calculated as baseflow that occurs under historical conditions had Colorado wells never pumped is 19 acre-feet in 2003. The Colorado pumping impact calculated as the reduction in baseflow from predevelopment conditions if only Colorado wells pumped is 5,099 acre-feet in 2003.

The Nebraska pumping impact calculated as baseflow that occurs under historical conditions had Nebraska wells never pump is 81,188 acre-feet in 2003. The Nebraska pumping impact calculated as the reduction in baseflow from predevelopment conditions if only Nebraska wells pumped is 86,231 acre feet in 2003.

The total impact for 2003 estimated as the increase in baseflow if wells in Colorado never pumped (19 acre-feet) plus if wells in Nebraska never pumped (81,188 acre-feet) is 81,207 acre-feet. However, the total impact for Frenchman Creek calculated as Ѳ-CKMN is 86,231 acre-feet, which is 5,024 acre-feet more.

If one were to insist that the sum of the impacts match the total, one could increase the values proportionately. Since the Nebraska impacts are 99.976% of the total under historical conditions, one could proportionately apportion the 5,024 acre-feet as 5,023 acre-feet to Nebraska and 1 acre-feet to Colorado.

However, the method proposed by Nebraska essentially averages the historical conditions and the predevelopment conditions. So for Colorado, the 19 acre-feet under historical conditions and 5,099 acre-feet under predevelopment conditions are averaged. A strict arithmetic average as in Eq. 8a would be 2,559 acre-feet, but the full procedure proposed to Nebraska combines other simulations so that the result is actually 2,562 acre-feet, a difference of 3 acre-feet. For Nebraska, the 81,207 under historical conditions and 86,213 acre-feet under predevelopment conditions are averaged. A strict arithmetic average as in Eq. 8b would yield 83,710 acre-feet, but the full Nebraska proposal results in 83,704 acre-feet, a difference of 6 acre-feet.

The procedure proposed by Nebraska allocates the 5,099 acre-feet difference by increasing the Colorado impact by 2,543 acre-feet and the Nebraska impact by 2,516. This increases the Colorado impact by 13,384%, and the Nebraska impact by 3.1%. The justification given for this procedure is that Colorado's impacts would have been greater if Nebraska had never developed wells, a situation that is contrary to historical reality and completely out of the State of Colorado’s control.

Colorado has no specific Compact Allocation for groundwater CBCU on Frenchman Creek. Therefore, Nebraska's proposed change increases Colorado's obligation under the Compact by 2,543 acre-feet based purely on impacts that did not and could not actually occur, but would have occurred only if Nebraska had never developed any wells. Such a procedure is untenable.

Another way to view the effect of the Nebraska proposal is that when a stream dries up, additional pumping cannot have any other effect on the stream itself, but the pumping continues to withdraw groundwater from storage in the aquifer itself. Nebraska's proposal essentially takes that amount of groundwater withdrawn from storage and divides it equally among the two states and charges those withdrawals as CBCU, even though there is no stream impact at that time from the withdrawals from storage. In the previous non-binding arbitration, Arbitrator Karl J. Dreher viewed the Nebraska proposal in this manner and found Nebraska's proposal inappropriate. Arbitrator's Final [Corrected] Decision, In *re Non-Binding Arbitration in Accordance with: Final Settlement Stipulation* (July 13, 2009) at ¶¶ 29-33. The Compact does not restrict the depletion of the groundwater aquifer, only the impact the aquifer depletions have on the surface streams.

3.2 Beaver Creek

The Beaver Creek sub-basin is the longest sub-basin in the Republican River Basin. It extends approximately 175 miles starting about 30 miles inside Colorado and ending at the confluence with Sappa Creek about 15 miles upstream of Harlan County Reservoir. The Beaver Creek stream channel is generally dry within Colorado.

In the RRCA Groundwater Model, the representation of Beaver Creek starts about 25 miles downstream of the Colorado state line inside Kansas, due to the historically dry stream channel in Colorado. Figure 5 shows the Model cells used to represent Beaver Creek. Color is used to represent dry and wet stream cells in the model for June 2003. Blue cells represent a live stream, and yellow cells represent cells where the stream dried up.

Figure 6 shows the June 2003 information as a graph of flow versus distance. The horizontal axis represents model stream reaches numbered consecutively from upstream to downstream, while the vertical axis represents the stream flow. The jump in stream flow at reach 76 occurs as a result of inflow from the Little and North Fork of Beaver Creek which is shown in Figure 5. The stream crosses the Kansas/Nebraska state line at reach 149 and is indicated in Figure 6 as a vertical line.

The Model predicted flow under historical conditions is shown as a blue line in Figure 6. The stream flows and dries out for some distance from the upstream end as shown by yellow cells in Figure 5. Then, from reach 34 there is a continuous live stream until reach 170. In Figure 5 it can be seen that this represents the stream from about 20 miles upstream of the confluence of Little and North Beaver Creeks to approximately 10 miles into Nebraska. From that point on there are some live sections of the stream, but for the most part the stream is dry.

In the absence of any actions of man, Beaver Creek is a gaining stream along most of its course through Kansas. This is shown as a purple line in Figure 6. Then, as it crosses the Kansas/Nebraska state line, it becomes a losing stream for about ten miles, after which the flow remains approximately constant.

In the absence of well pumping in Kansas, the Model predicted baseflow in Beaver Creek is essentially the same as under predevelopment conditions as illustrated by the green line in Figure 6. However, as the stream crosses into Nebraska, this baseflow is rapidly depleted by the wells in

Nebraska, such that at the confluence with Sappa Creek, where there is less than one cfs of flow remains.

In the absence of well pumping in Nebraska, the Model predicted baseflow in Beaver Creek is essentially the same as under historical conditions as illustrated by the red line in Figure 6. However, as the stream Beaver Creek crosses into Nebraska, the baseflow mirrors the behavior seen under predevelopment conditions. So for approximately the first ten miles inside Nebraska, the stream loses water, and then remains approximately the same.

Figure 6 shows that as long as either wells in Nebraska or wells in Kansas are pumping, the baseflow reaching the confluence with Sappa Creek will be minimal. Therefore even if there had never been any well pumping in Kansas there would be little improvement in baseflow.

Figure 7 shows the same information as Figure 6, but for June 1965. It is interesting to note that the modeled baseflow in 1965 shows qualitatively the same behavior as in 2003 with one significant exception. As in 2003, the baseflow in Kansas is practically the same as the predevelopment baseflow when the wells in Kansas are not pumping and the baseflow in Kansas is practically the same as the historical when the wells are pumping. Then, as Beaver Creek crosses into Nebraska, the stream flows for scenarios where Nebraska wells are not pumping (predevelopment and No Nebraska Pumping) and scenarios where Nebraska wells are pumping (historical and No Kansas Pumping) parallel each other.

The cause for the behavior discussed in the Report is clear from Figures 6 and 7. As a result of stream depletions caused by Nebraska wells, from where Beaver Creek crosses into Nebraska until the confluence with Sappa Creek, there is little improvement in baseflow in this reach of Beaver Creek even when there is no pumping in Kansas.

Figure 8 further illustrates this behavior. The red and green lines represent the increase in baseflow at the confluence of Beaver Creek with Sappa Creek in the absence of well pumping in Nebraska and Kansas, respectively. By definition, these are the pumping impacts for wells in Nebraska and Kansas on Beaver Creek, respectively. Adding the Nebraska and Kansas impacts together yields the blue line. The purple line is the combined impact of both Kansas and Nebraska, which in Figures 6 and 7 would be the difference between the predevelopment and historical predicted baseflow.

It is interesting to note in Figure 8 that until 1969, the sum of the individual impacts matches the combined impact. However, from 1970 onwards, the blue and purple lines increasingly diverge. There are period such as 1976-1978, 1988-1992 and 2002-2005 when the sum of the individual Nebraska and Kansas impacts are significantly lower than the combined Nebraska and Kansas impact. As demonstrated in Figures 6 and 7, this is largely caused by well pumping in Nebraska. To further illustrate the point, the total amount of agricultural well pumping in Furnas and Red Willow counties is shown in Figure 8. Beaver Creek flows into Red Willow County and then on into Furnas County. As can be seen in Figure 8, there is good correlation between increased well pumping in Nebraska and differences between the sum of the pumping impacts and combined impacts.

As in the case of Frenchman Creek above, the procedure proposed by Nebraska imposes impacts on Kansas that would have occurred only if there had been no wells in Nebraska. Figure 6 shows that, had there been no wells in Kansas, Beaver Creek baseflow would only increase by about 0.9 cfs, the difference between the blue and green lines. However, the Nebraska method also adds the more than 8 cfs difference between the purple and red lines, that is the amount of increase in stream flow that would have occurred had there not been any well development in Nebraska.

Again as in the case of Frenchman Creek, Nebraska seeks to impose an impact that did not occur historically, but would only have occurred had Nebraska not developed wells. And again, as found by Arbitrator Dreher, Nebraska is essentially taking the reduction in groundwater storage caused by pumping that does not result in stream depletions and averaging that change in storage between the states. This is not appropriate.

Therefore the procedure proposed by Nebraska is not sufficiently rigorous and does not supply the answer that the Compact requires.

3.3 Main Stem Swanson-Harlan

The purpose of the RRCA Groundwater Model is to estimate the net result of actions of man within the state on stream baseflows. In Colorado and Kansas, there is only one action of man being evaluated, namely well pumping. However, in Nebraska, the Model is used to evaluate two actions of man, namely well pumping and the imported water supply, and these two actions counteract each other.

Figure 9a shows a hydrograph of the inflow into Harlan County Reservoir. The simulated inflow in the historical simulation is shown as a blue line, while the simulated inflow in the absence of pumping in Nebraska is shown as a red line. By definition the impact of Nebraska pumping on the inflow into Harlan County Reservoir is the difference between the historical and No Nebraska Pumping simulations, which is depicted using yellow shading.

Figure 9b also shows a hydrograph of the inflow into Harlan County Reservoir. The blue line is the same simulated inflow from the historical simulation, while the purple line represents the simulated inflow in the absence of imported water from the mound. The difference between these simulations is the result of imported water, also called the Imported Water Supply (IWS) or Mound Credit.

Figure 9a represents the approved method for evaluating Nebraska's pumping impacts on stream flow. Figure 9b represents the approved method for evaluating the effects of Nebraska's imported water supply from the Platte River Basin on stream flow. As shown in Figure 9b there is very little inflow into Harlan County reservoir under historical conditions that can attributed to imported water supply. As shown by the purple line, in the absence of imported water supply, the inflow is zero except for a short period in 2001.

From Figure 9a and 9b one could conclude that Pumping Impacts on the inflow to Harlan County Reservoir do not depend on the imported water supply. This can be verified by performing a simulation where both Nebraska pumping and imported water supply are simultaneously switched off as shown in Figure 9c. In Figure 9c the purple line represents the no imported water supply simulation as shown in Figure 9b, and the green line represents the flow in a simulation where both Nebraska pumping and imported water supply are removed. The difference between these simulations represent the Nebraska pumping impacts in the absence of the imported water supply.

Comparing Figures 9a and 9c, it is clear that the pumping impacts with imported water supply are often greater than pumping impacts in the absence of the imported water supply. This trend is especially noticeable in dry years such as 2003 and 2004 when the stream would be mostly dry except but for the imported water supply. This is the result from the inherent and necessary nonlinear behavior in the RRCA Groundwater Model. The inflow into Harlan County Reservoir is greater when water is imported then when it is not. This is true regardless of whether wells in Nebraska are pumping or not. Nebraska's fallacy lies in the expectation that the inflow would increase by the same amount when the wells are pumping than when they are not.

Figures 9 show the impacts on baseflow at the inflow to Harlan County Reservoir. These flows are, of course, in part the result of changes of upstream inflows. Therefore, the term that appears in the RRCA Compact Accounting is actually the difference between the flow at this location and the sum of five upstream inflows, namely those from Frenchman, Driftwood, Medicine, Red Willow and Sappa creeks, and is called the Swanson-Harlan Mainstem Impacts. This pumping impacts evaluated in this way is by definition the groundwater ($CBCU_G$) used in the Compact Accounting.

Figure 10a shows the $CBCU_N$ in yellow calculated for the Swanson-Harlan reach as the difference between the historic simulation shown as a blue line and a No Nebraska Pumping simulation shown as a red line. Figure 10b shows the IWS in yellow calculated for the Swanson-Harlan reach as the difference between the historic simulation shown as a blue line and the No Nebraska Mound simulation shown as a purple line. Figure 10c shows $CBCU_N$ calculated for the Swanson-Harlan reach in the absence of imported water as the difference between a No Nebraska Pumping or Mound simulation shown in green, and the No Nebraska Mound simulation shown in purple.

Figure 10a represents the $CBCU_N$ calculated using the RRCA approved method shown in Eq. 1c. Figure 10c represents the $CBCU_N$ calculated using the alternate method shown in Eq. 3c. As shown in Figures 10a and 10c, the Nebraska pumping impacts for the Swanson-Harlan reach are greater with the imported water supply than without the imported water supply. As shown in Figure 9, this is primarily caused by the fact that in the absence of well pumping in Nebraska, more of the imported water supply reaches Harlan County Reservoir, than when the wells are operating at historical levels.

Figure 10c demonstrates why Eqs. 3a-d are effective in evaluating the impacts of pumping in a manner that does not include consumption of imported water. The method proposed by Nebraska, on the other hand, ***does*** include the consumption of imported water. In particular, Eq. 2c can be rewritten as

$$CBCU_N = [3(CKM-CKMN) + (M-MN) + (CM-CMN) + (KM-KMN)]/12+ [3(\Theta\text{-}N) + (C-CN) + (K-KN) + (CK-CKN)]/12 \quad \textbf{(9)}$$

Eq. 9 is algebraically identical to Eq. 2c, but Eq. 9 is written in this way to group Model simulations with the imported water supply "on" together (the name contains an M) and simulations with imported water supply "off" together (the name does not contain an M). Note that in Eq. 9 the coefficients of the first group of terms sum to ½, as does the second group of terms. Therefore the Nebraska proposal to estimate Nebraska's pumping impacts essentially averages the impacts calculated with imported water supply "on" and impacts calculated with imported water supply "off".

As shown in Figure 10, any simulation where the imported water supply is "on" will include consumption of the imported water supply. The Nebraska simulations that project 50 years into the future starting in 2009 are shown in Figure 11. The three frames in Figure 11 show the same quantities as Figure 10, just for the different period. Figure 11b shows that in this projection, almost no imported water supply reaches this reach of the stream. However, Figure 11a indicates that Nebraska's $CBCU_{G,}$ indicated in yellow, will steadily rise because in the absence of pumping in Nebraska (the red line), the baseflow would steadily rise. This rise can be attributed to the imported water supply that would have reached the stream in the absence of Nebraska pumping.

The method proposed by Nebraska would continue to include this imported water supply in the $CBCU_G$ calculations. In fact, because the Nebraska method uses potential depletions, the $CBCU_G$ for all the states would contain increasing amounts of imported water supply in violation of the FFS.

By contrast, the alternative method illustrated in Figure 11c shows that the alternative method effectively filters out the effect of the imported water supply, and that the $CBCU_G$ calculated in the absence of imported water supply remains essentially the same over time.

The Imported Water Supply calculation is intended to subtract the imported water from the actual flow measured at the surface water gages. The purpose of this calculation is to correct the observed gaged surface flows for the increases due to the imported water supply. As in the case of estimating pumping impacts, Nebraska's proposed method calculates the imported water supply as a weighted average. Half of these differences included in the weighted average will consider the situation where wells in Nebraska had never been pumping. As demonstrated in Figures 9 and 10, the amount of the imported water supply that reaches the gage is greater in the absence of Nebraska pumping than when Nebraska pumping is present. The average would therefore overestimate the amount of imported water supply at the gage.

The surface water gages measure the actual historical surface water flow, including baseflow, overland or surface flow and imported water that makes it to the stream. The purpose of the Imported Water Supply calculation must therefore be to subtract the actual amount of imported water supply that was included as surface water flow in the measured gage flow. Eqs. 1d and 3d are identical, and reflect exactly what is required. The Nebraska proposal reflected in Eq. 2d incorrectly incorporates imported water supply that did not show up in the gage flow historically, and only would have shown up had wells in Nebraska never pumped.

As a result Nebraska's proposed method is not acceptable modeling protocol and is not a reasonable representation of the physical system.

4. Nebraska's Scale Analogy

In the their Report, Nebraska uses the analogy of a scale which is used to measure weights but reads low beyond a certain weight as an analogy to describe what they consider "The Problem". This analogy is very misleading, and is incorrect in several respects.

4.1 The Analogy Applies a Nonlinear Tool to a Linear Process

Weights are linearly additive. When two or more weights are added to the scale, the scale reading should be the sum of the individual weights. If the scale does not show a weight equal to the sum of the individual weights, the scale is operating incorrectly. This is entirely a failure in the scale and does not correctly reflect the behavior of the underlying process.

By using the scale as an analogy for the RRCA Groundwater Model, the implication is that the Model is operating incorrectly. This implication is totally incorrect. It implies that there is an underlying linear process, and that it is the failure is in the measurement tool. These implications are incorrect and misleading.

The groundwater flow system of the Republican River Basin is not linearly additive, but is inherently nonlinear. That means that the impacts of well pumping and similar operations on streams flows are not directly proportional. This behavior is caused by natural processes like evapotranspiration, and the complex interaction of surface and groundwater.

The RRCA Groundwater Model reasonably reflects this nonlinear behavior. The nonlinearities in the Model results are not a flaw in the Model, but rather a true reflection of the underlying physical processes. A model of the Republican River Basin which yields linear results would in fact be a poor approximation of the underlying nonlinear system.

By using the scale analogy, Nebraska implies that the nonlinearities are an artifact of the RRCA Groundwater Model (the scale), whereas the underlying groundwater flow processes are linear (the weights). Nothing could be further from the truth. The nonlinearities in the Model results are a reasonable representation of the underlying nonlinear processes in the groundwater system. As such, the scale analogy is misleading and not useful.

4.2 Using the Scale to Measure Allocation and Use

The Nebraska scale analogy is also misleading because it suggests that an unfair bargain was struck. Nebraska insinuates that the failure to measure correctly is purely the result of a bad tool. As such, Nebraska implies that the States are not allotted their correct measure of the water in the Republican River Basin under the Compact.

An important consideration, however, is that the same measure is used to not only determine the allotment, but also the consumptive use. The $CBCU_G$ term calculated by the RRCA Groundwater Model is used to calculate both the consumptive use by each State, and the Virgin Water Supply.

Nebraska has framed the argument as a failure of the RRCA Accounting Procedures to allocate to Nebraska its full entitlement. However, the opposite is also true. Fully applying Nebraska's theory, the RRCA Accounting Procedures shows that, under Nebraska's Theory, the Accounting Procedures also have not attributed to Nebraska the full impact of Nebraska's actual historical consumption of water.

The Virgin Water Supply can be readily calculated as the difference between a Model simulation with pumping in all three states and the imported water supply turned off, and a historical Model simulation with all these effects on.[7] The purpose of the remaining fourteen simulations is merely to allocate this difference among the States.

In the scale analogy, the scale is incapable of measuring the combined weight because it is beyond the maximum amount that the scale can measure. In the case of the RRCA Groundwater Model, however, Nebraska has argued that the Model can accurately measure this full difference. In fact, the whole purpose of the Nebraska procedure is to make the parts add up to this difference.

The scale analogy is therefore inappropriate because it implies that Nebraska was not allotted its due measure, but was charged a fair measure of use. In fact, using the RRCA approved procedure, the same tool was used to estimate both the groundwater components of allotment and use. The difficulties that arise due to the inherent nonlinear relationship between stream depletions and actions such as well pumping are not the result of an untrustworthy measuring device or an upper limit on the amount that can be measured.

4.3 Positive and negative weights

The scale analogy also fails because the concept of a negative weight is difficult to comprehend. In the case of the imported water supply from the Platte River Basin, it is necessary to consider negative weights (imported water supply) that offset positive weights (consumption of native water).

One might invoke an analogy of a symmetric balance scale, where weights are placed on both the side being measured and the reference side, but this analogy also fails because it requires that the negative weight simply adds linearly to the reference weights. Such linearity does not exist in this groundwater system. Besides, in order for a symmetric balance scale to read incorrectly, the reference weights have to be crooked, which is an inappropriate insinuation.

5. Summary and Conclusions

The RRCA has approved a procedure for the calculation of impacts to baseflow caused by pumping in Colorado, Kansas and Nebraska. The procedure also specifies the method for estimating the amount of the Imported Water Supply.

Nebraska demonstrated their perceived problem using examples from 2003, a year of extreme drought. The problem was presented in the light that the approved method underestimates the Virgin Water Supply. It should be noted, however, that the CBCU amounts are not only used to estimate the Virgin Water Supply and hence the allocation, but also is used to set the depletions for which the states are responsible under the Compact.

Using the RRCA approved procedure, the depletions attributed to a State cannot exceed the amount of additional baseflow that can be generated by complete curtailment of all wells in the corresponding

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7 The condition with all the pumping and mound in the basin turned off is very different from the condition to which the Model was calibrated. The validity of such a run is therefore in question. However, for the sake of this argument, it is assumed that such a result would be reliable.

State. Under the procedure proposed by Nebraska, it has been demonstrated that the depletions attributed to a State can be more than two orders of magnitude greater than what can be achieved by complete well curtailment in that State.

Nebraska has proposed a different procedure as “The Solution” to “The Problem”. Their proposal uses as its justification the fact that under their proposed procedure the sum of the individual impacts matches the basin wide impacts. This is an incorrect conclusion.

While the Nebraska procedure does result in no basin wide residual, it does so at the expense of physical realism. In essence, the method calculates a weighted average of eight differences. As demonstrated above, this has the effect of including impacts that did not occur and never could occur. Specifically, upstream states are burdened with impacts that would only have occurred had Nebraska never developed wells. These impacts are typically the result of streams that historically have been dry in large part due to pumping in Nebraska, but would have been live and therefore could have been depleted, had the Nebraska well pumping not occurred. Furthermore, the Nebraska procedure adjusts the measured gage flows for the Imported Water Supply that would have occurred had there not been well pumping in Nebraska. These mathematical devices may yield no basin wide residual, but have no basis in reality. They are simply mathematical manipulations to achieve a desired result.

Some of the issues raised by Nebraska are caused by the inclusion of the imported water supply in the $CBCU_G$ calculations, even though this is contrary to the FSS. Nebraska's proposed solution actually increases the amount of $CBCU_G$ attributable to imported water, but Nebraska favors this solution because Nebraska's burden is effectively shifted to Colorado and Kansas so that Nebraska benefits overall. The alternative procedure demonstrated in this report provides an effective means to exclude the imported water supply from the $CBCU_G$ calculations without increasing the complexity of the calculations or simulations. This alternate procedure provides relief to Nebraska in terms of reduced $CBCU_G$ due to excluding the imported water supply approximately equal in magnitude to the benefit that would be provided by using the Nebraska proposal.

The scale analogy used by Nebraska to illustrate the problem is totally inappropriate. It is misleading in that it uses the analogy of a flawed tool with limited range to measure a linear process. The RRCA Groundwater Model and Accounting Procedures on the other hand deal with the complexity of an inherently nonlinear process, and the deviations from linearity reflect the physical reality, not a flaw in the tool or the analysis.

In addition, the Nebraska proposal implicitly assumes that all model runs are equally accurate. In reality, any model’s predictions are increasingly uncertain the further the modeled scenario deviates from the historical conditions to which the model was calibrated. This is true for the RRCA Groundwater Model as well. Nebraska's proposed procedure increases the reliance on simulations far removed from the historical, which increases the uncertainty in the Model’s predictions.

Finally, the procedure proposed by Nebraska is unnecessarily complex. As an example, a method was demonstrated that corrects for the consumption of imported water without adding any complexity to the current RRCA approved procedure.

Nebraska has failed to demonstrate an imperative need for changing the procedure as approved by the

RRCA. To the extent that imperfections exist in the procedure approved by the RRCA, the procedure proposed by Nebraska's proposed procedure fails to cure these imperfections and introduces new, much greater flaws. As such Nebraska has failed to demonstrate that their proposed procedure is in any way an improvement over the procedure currently approved by the RRCA or is otherwise reasonable.

6. References

In the Supreme Court of the United States, Case Number 126 Original, State of Kansas v. State of Nebraska and State of Colorado, *Final Settlement Stipulation*, December 15, 2002.

Nebraska Department of Natural Resources. Nebraska-*Related Documents for Special Meeting of the Republican River Compact Administration*, March, March 11-12, 2008

Nebraska Department of Natural Resources and McDonald Morrissey Associates Inc. and Dr. David P Ahlfeld. *Analysis of Current Methods Used to Calculate Groundwater Impacts for the Republican River Compact, August* 6, 2008.

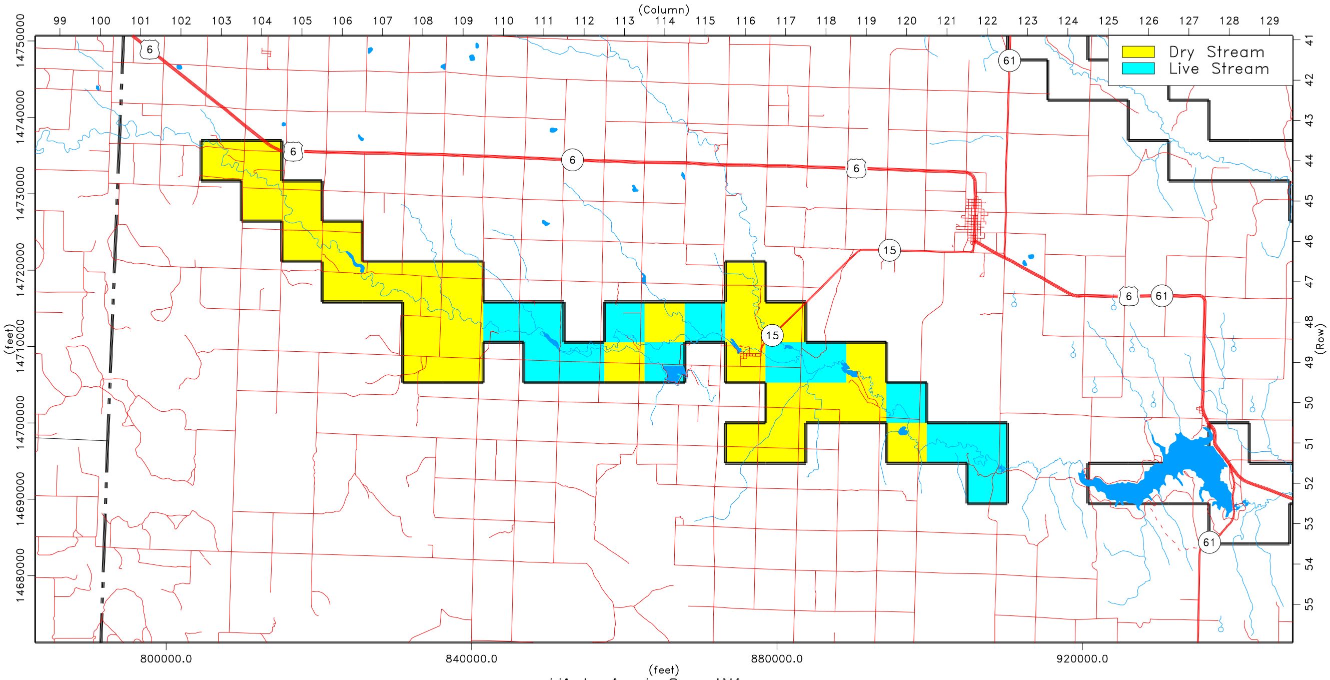
Dr. David P. Ahlfeld, Michael G. McDonald and James C. Schneider. *Estimating Computed Beneficial Consumptive Use for Groundwater and Imported Water Supply under the Republican River Compact, January* 20, 2009.

W.A. Schreüder. *Report in Response to Estimating Computed Beneficial Consumptive Use for Groundwater and Imported Water Supply under the Republican River Compact,* February 2009.

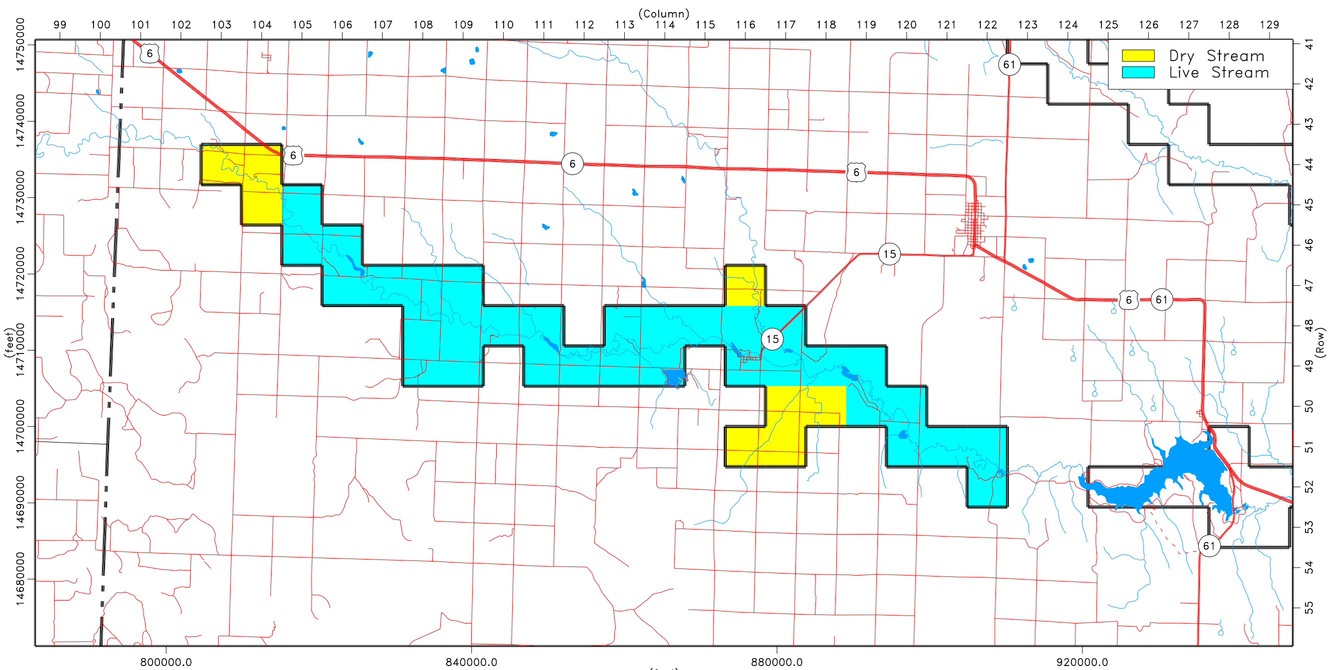
Arbitrator's Final [Corrected] Decision, In *re Non-Binding Arbitration in Accordance with: Final Settlement Stipulation* (July 13, 2009).

Frenchman Creek as Modeled for July 2003

Republican River Compact Administration Groundwater Model



Historical Conditions



Predevelopment Conditions

Figure 1.

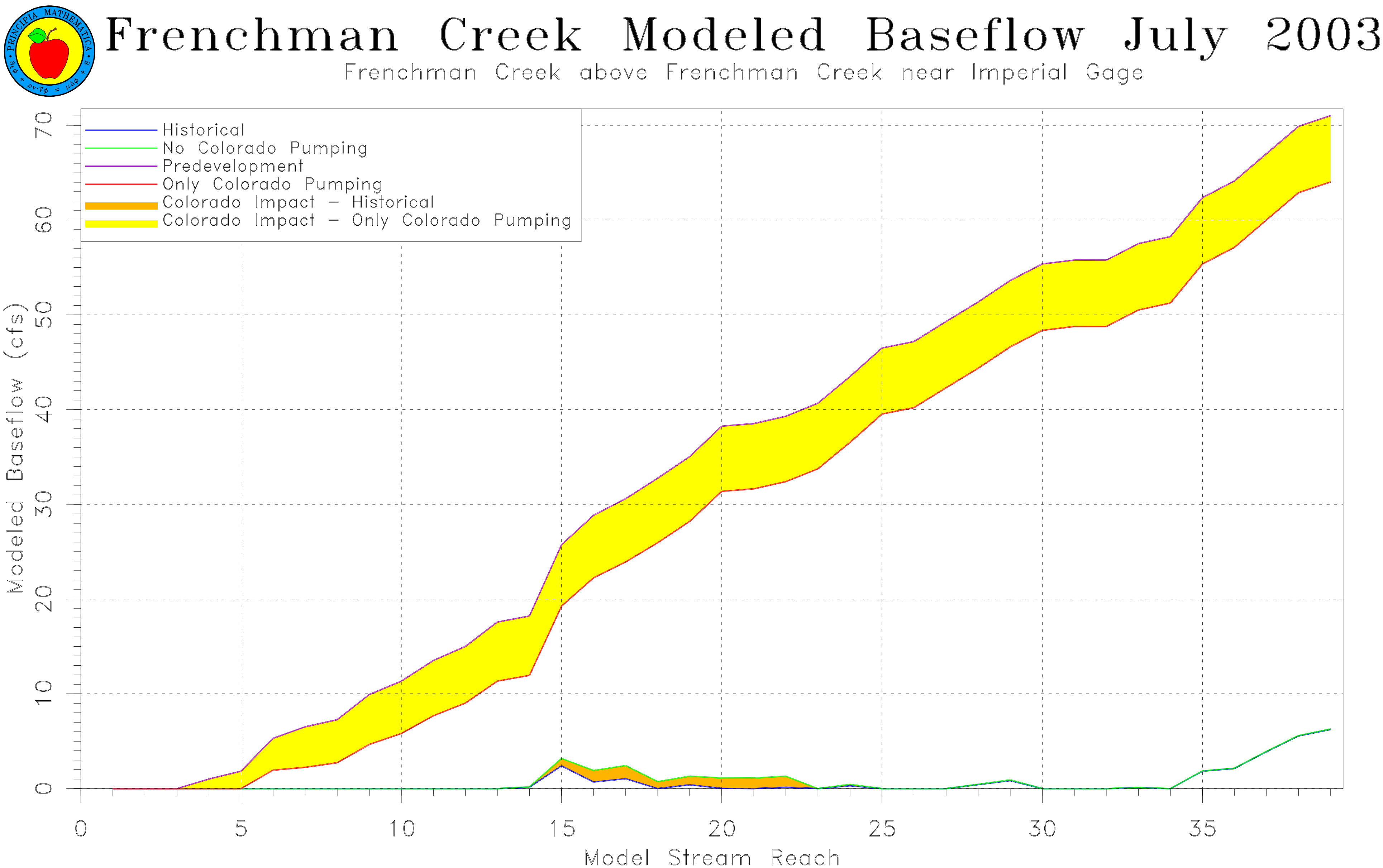

Frenchman Creek Modeled Baseflow July 2003
Frenchman Creek above Frenchman Creek near Imperial Gage
Historical
No Colorado Pumping
Predevelopment
Only Colorado Pumping
Colorado Impact – Historical
Colorado Impact – Only Colorado Pumping
Modeled Baseflow (cfs)
0
10
20
30
40
50
60
70
0
5
10
15
20
25
30
35
Model Stream Reach

Figure 2

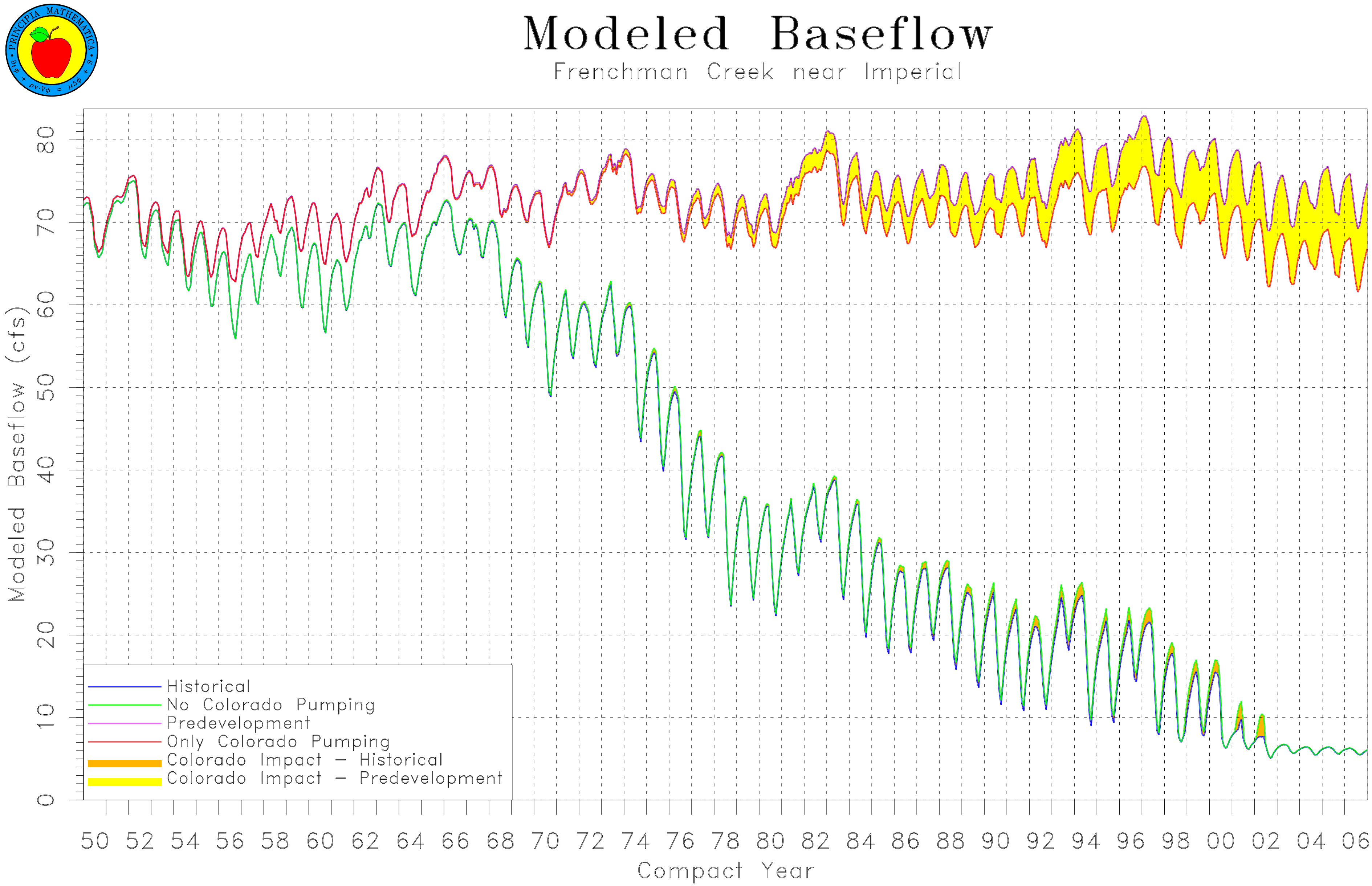

Modeled Baseflow
Frenchman Creek near Imperial
Modeled Baseflow (cfs)
0
10
20
30
40
50
60
70
80
50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80 82 84 86 88 90 92 94 96 98 00 02 04 06
Compact Year
Historical
No Colorado Pumping
Predevelopment
Only Colorado Pumping
Colorado Impact – Historical
Colorado Impact – Predevelopment

Figure 3.

CBCU$_C$: Nebraska Proposal **C-01**

Frenchman Creek near Imperial

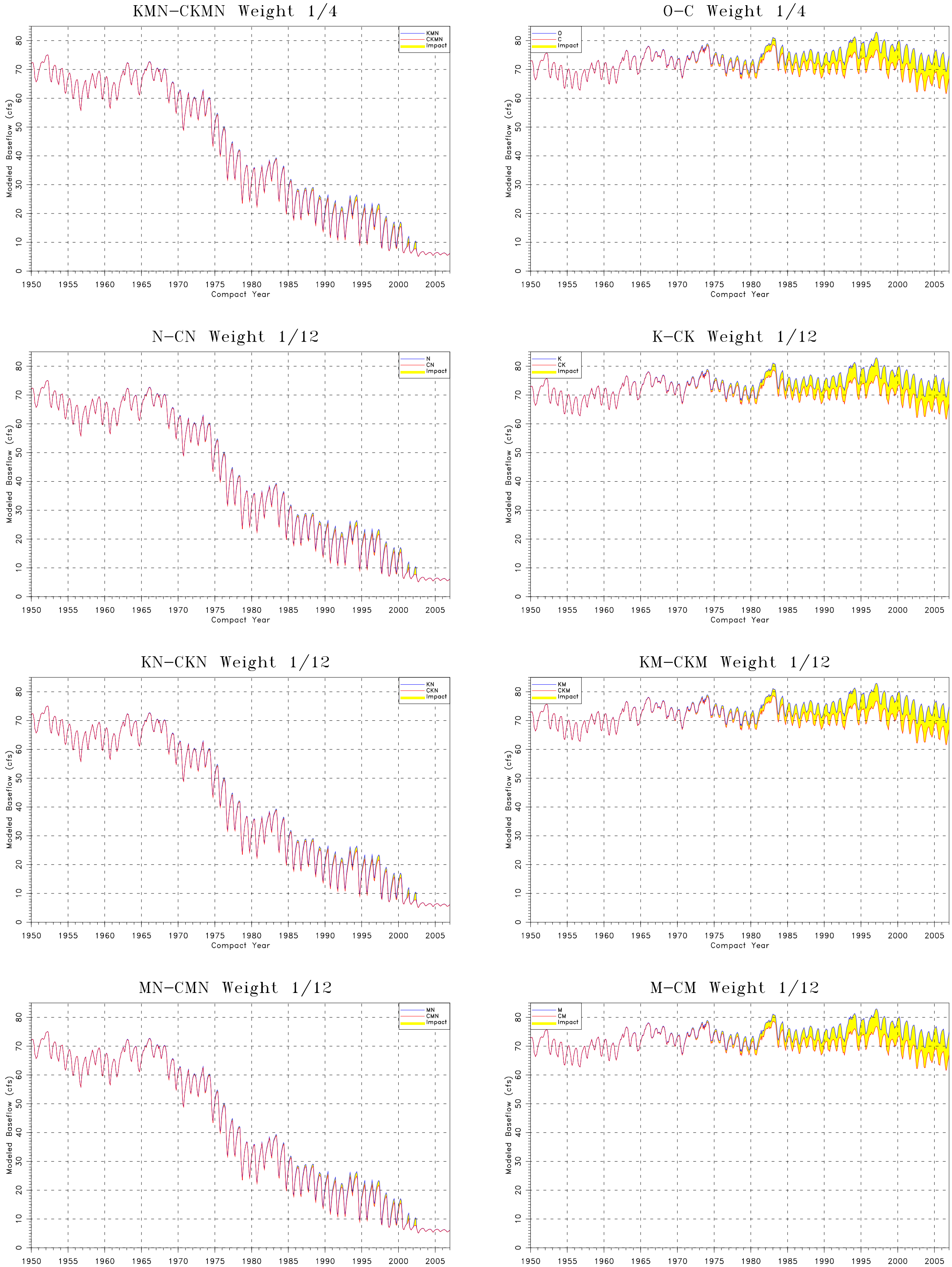
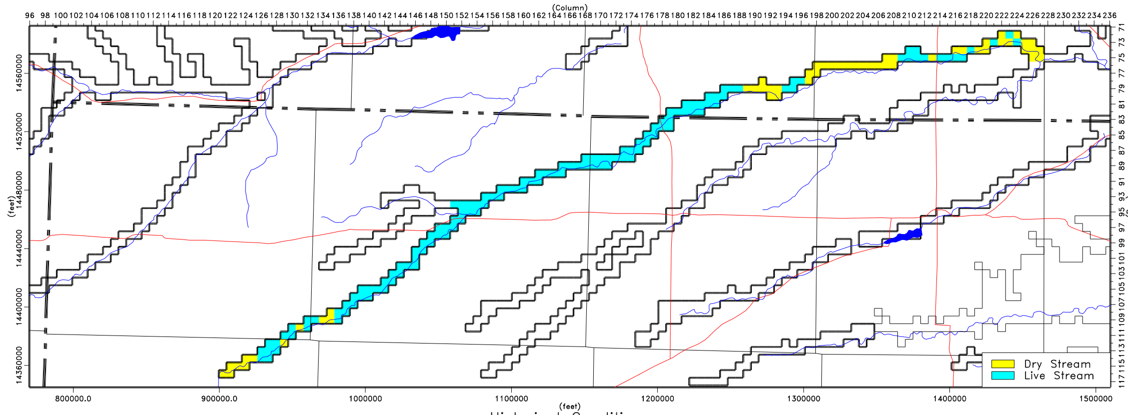


Figure 4.

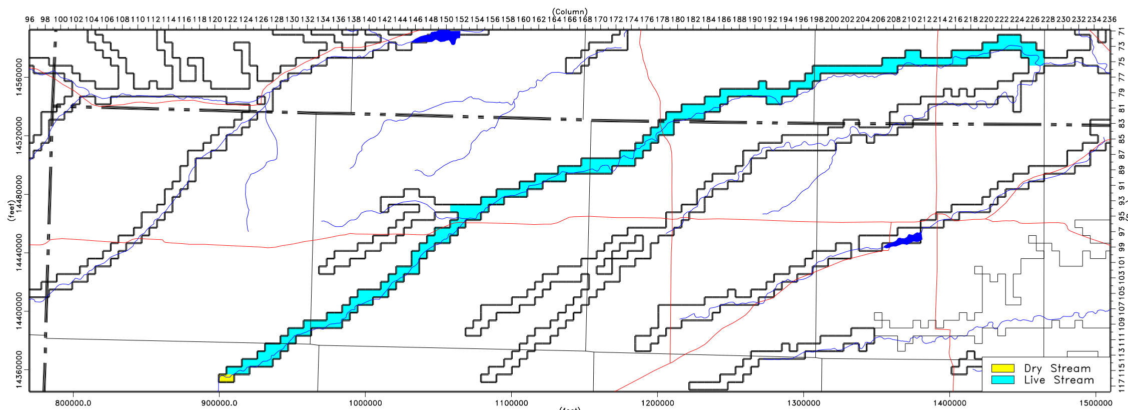
C-01

Beaver Creek as Modeled for June 2003

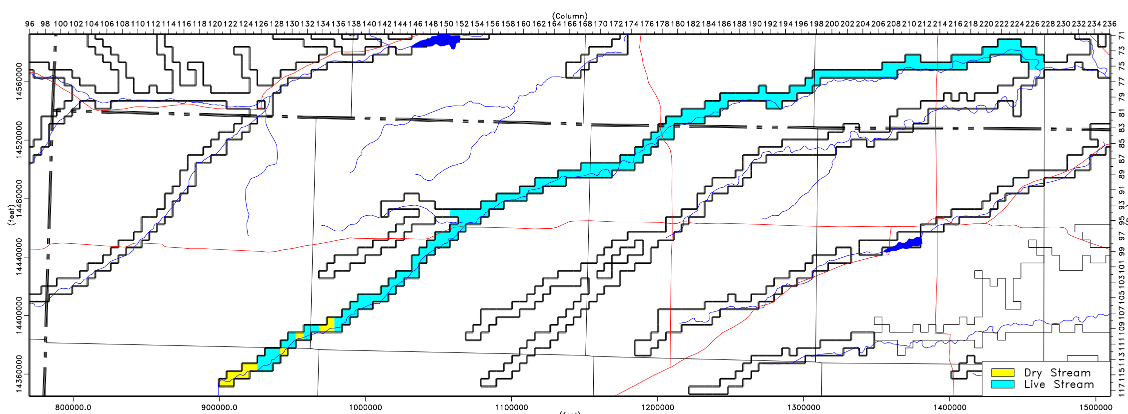
Republican River Compact Administration Groundwater Model



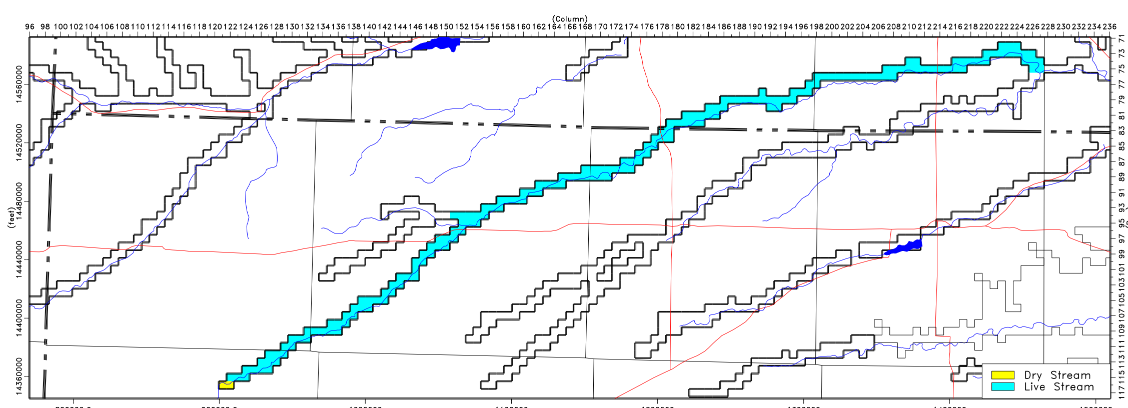
Historical Conditions



No Kansas Wells

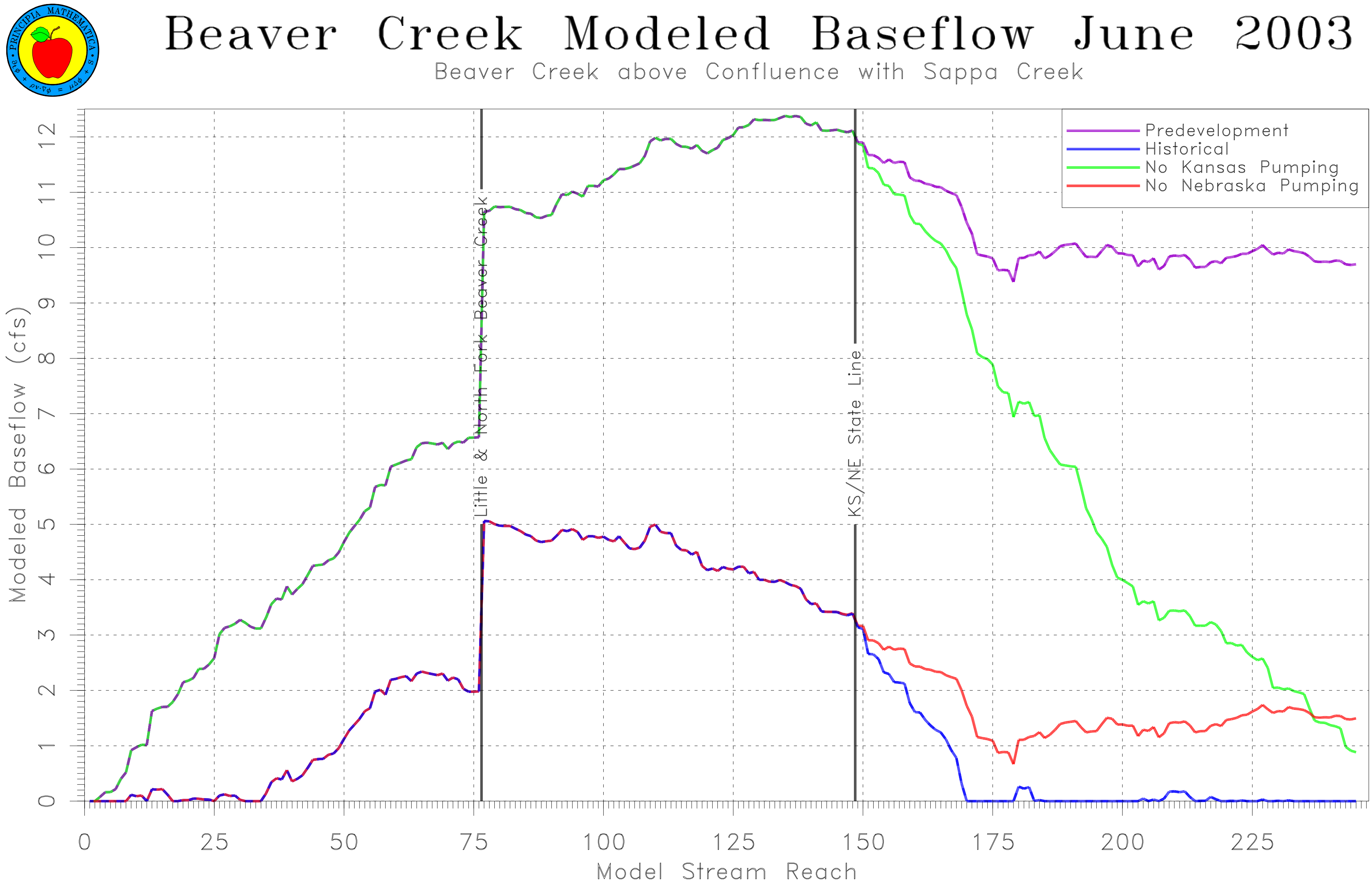


No Nebraska Wells



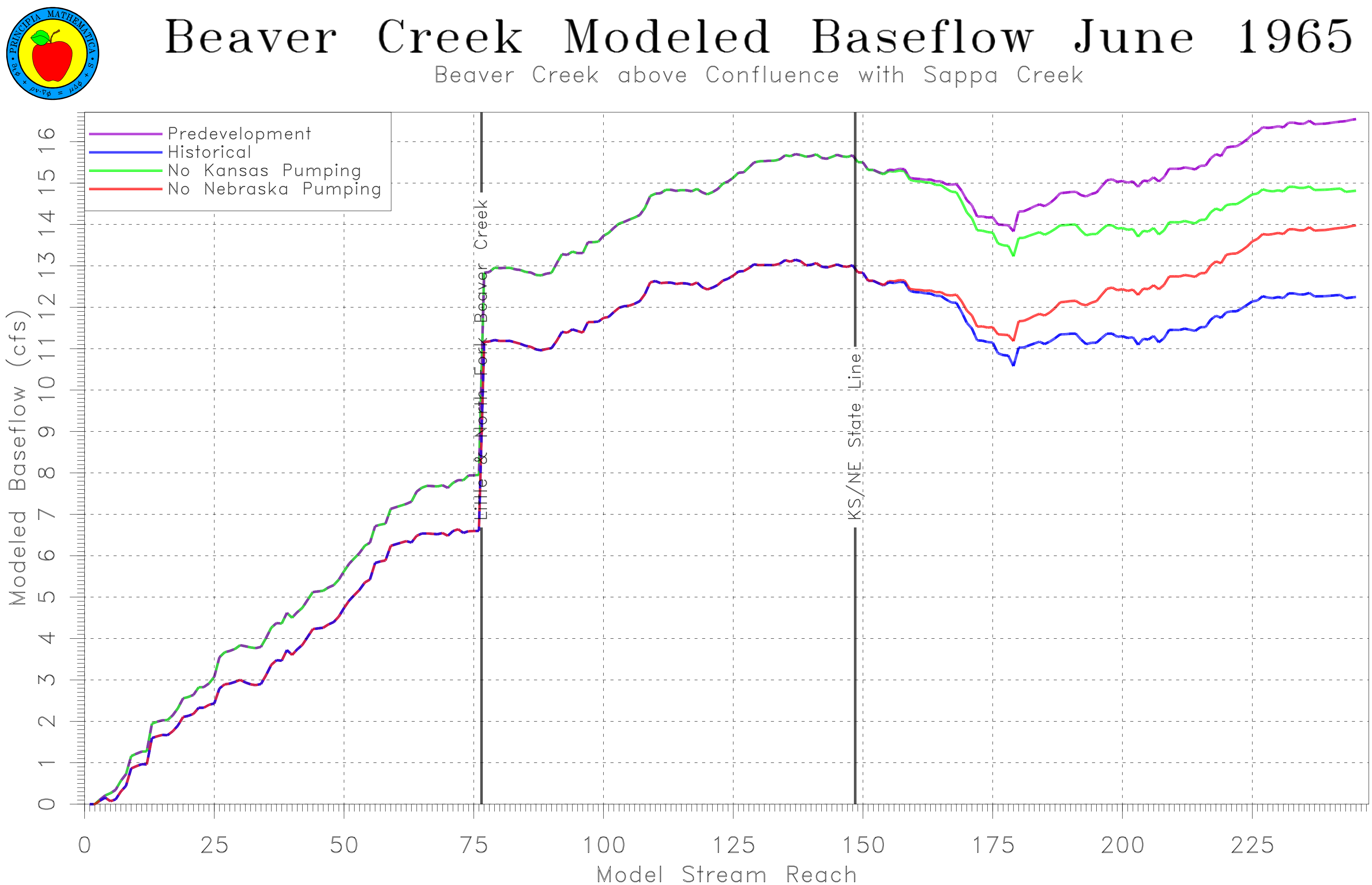
Predevelopment Conditions

Figure 5.



Beaver Creek Modeled Baseflow June 2003
Beaver Creek above Confluence with Sappa Creek
Predevelopment
Historical
No Kansas Pumping
No Nebraska Pumping
Little & North Fork Beaver Creek
KS/NE State Line
Modeled Baseflow (cfs)
0
1
2
3
4
5
6
7
8
9
10
11
12
0
25
50
75
100
125
150
175
200
225
Model Stream Reach

Figure 6.



Beaver Creek Modeled Baseflow June 1965
Beaver Creek above Confluence with Sappa Creek
Predevelopment
Historical
No Kansas Pumping
No Nebraska Pumping
Little & North Fork Beaver Creek
KS/NE State Line
Modeled Baseflow (cfs)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
0
25
50
75
100
125
150
175
200
225
Model Stream Reach

Figure 7.

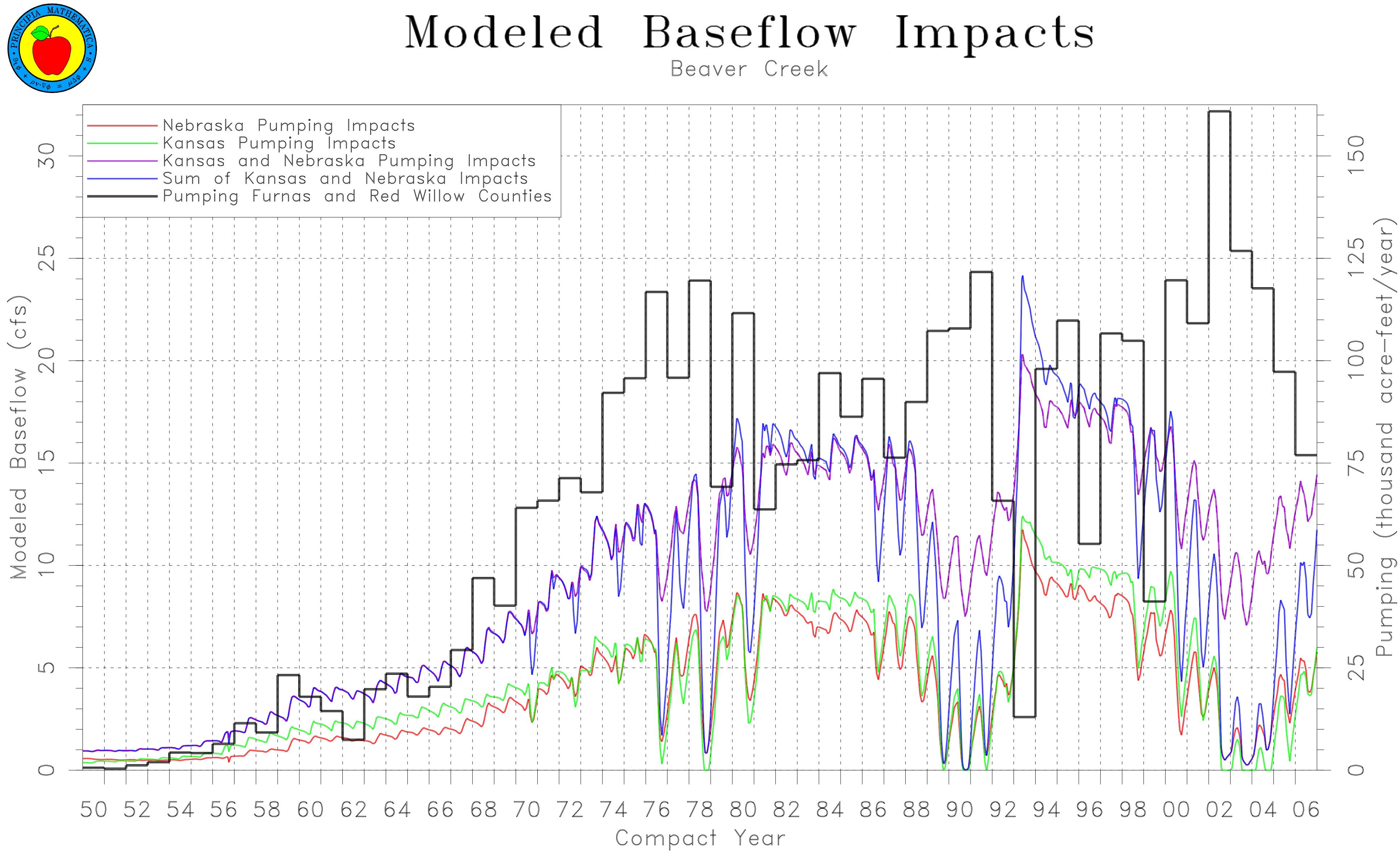

Modeled Baseflow Impacts
Beaver Creek
Nebraska Pumping Impacts
Kansas Pumping Impacts
Kansas and Nebraska Pumping Impacts
Sum of Kansas and Nebraska Impacts
Pumping Furnas and Red Willow Counties
Modeled Baseflow (cfs)
Pumping (thousand acre-feet/year)
Compact Year
0
5
10
15
20
25
30
0
25
50
75
100
125
150
50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80 82 84 86 88 90 92 94 96 98 00 02 04 06

Figure 8.

Pumping Impacts on Flow: Approved Method
Republican River above Harlan County Reservoir

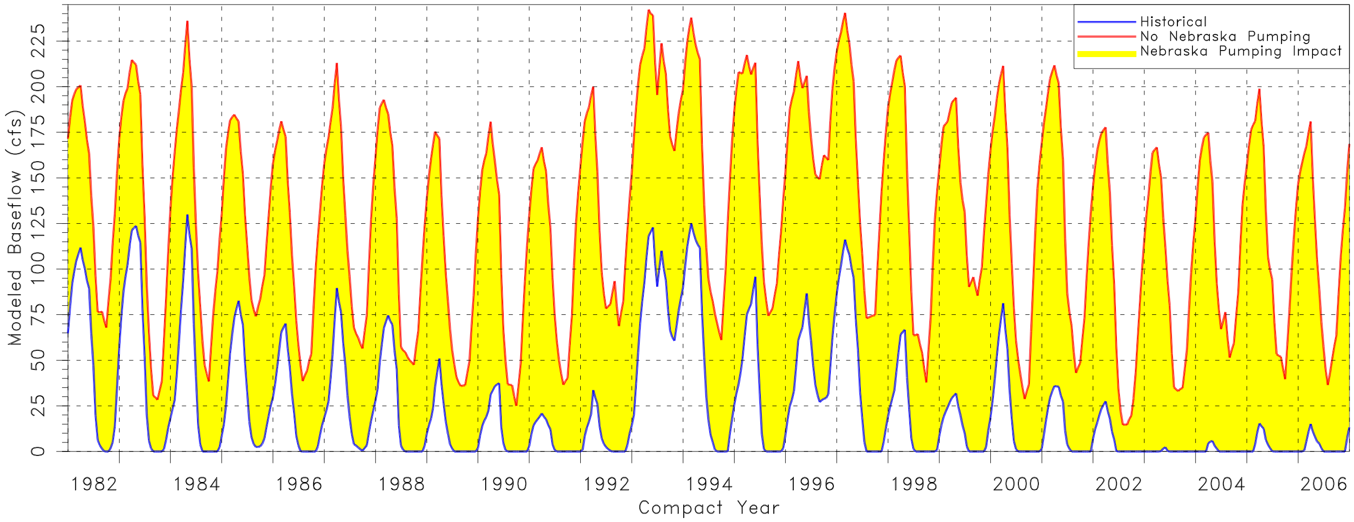


Figure 9a

Mound Impacts on Flow: Approved Method
Republican River above Harlan County Reservoir

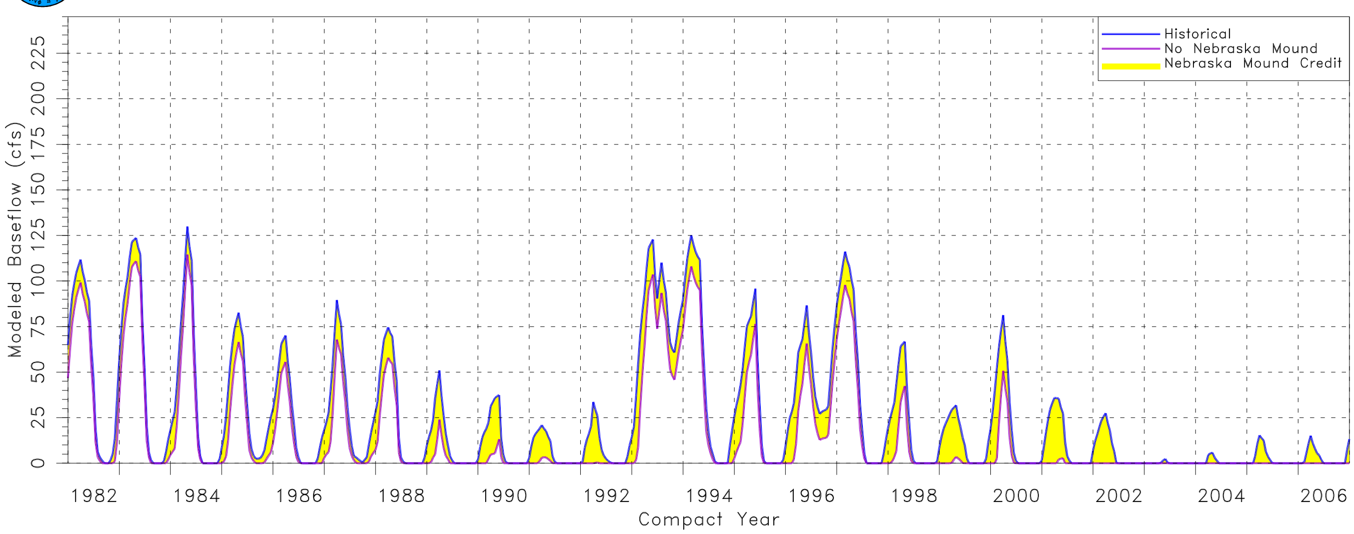


Figure 9b

Pumping Impacts on Flow: No Imported Water
Republican River above Harlan County Reservoir

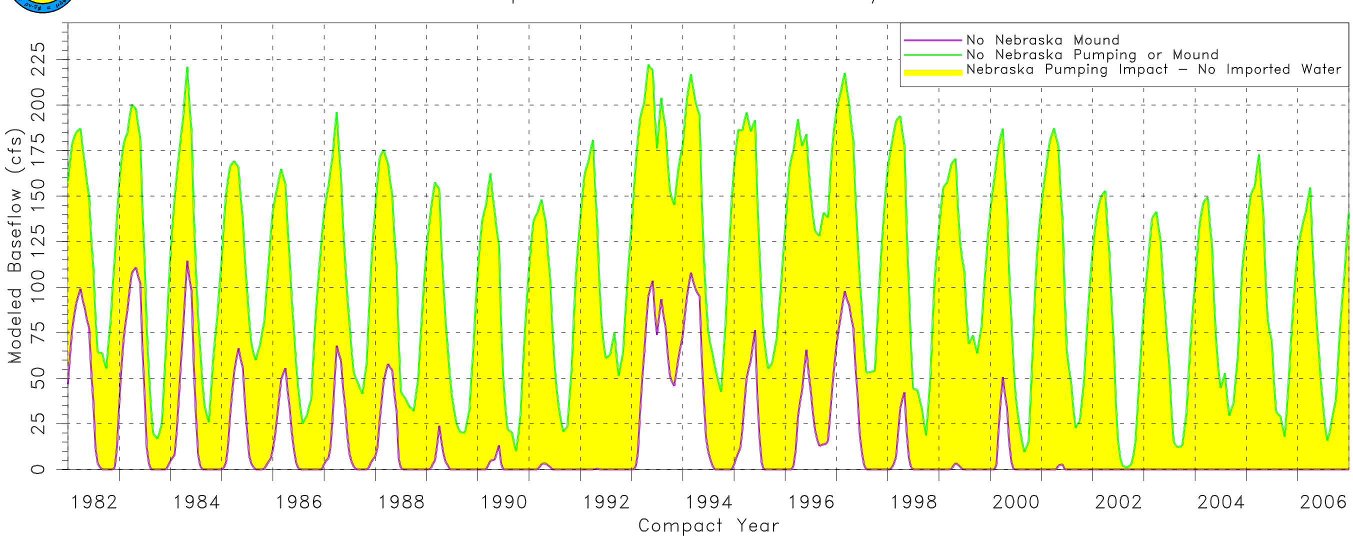


Figure 9c

Pumping Impacts: Approved Method **C-01**

Mainstem Impacts Swanson – Harlan

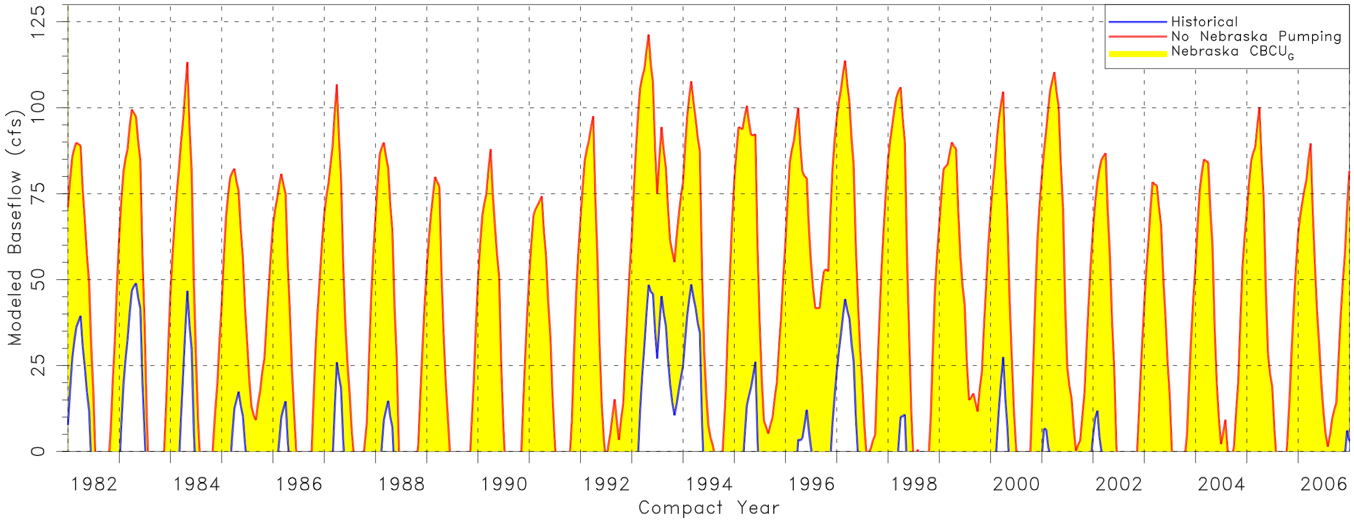


Figure 10a

Mound Credits: Approved Method

Mainstem Impacts Swanson – Harlan

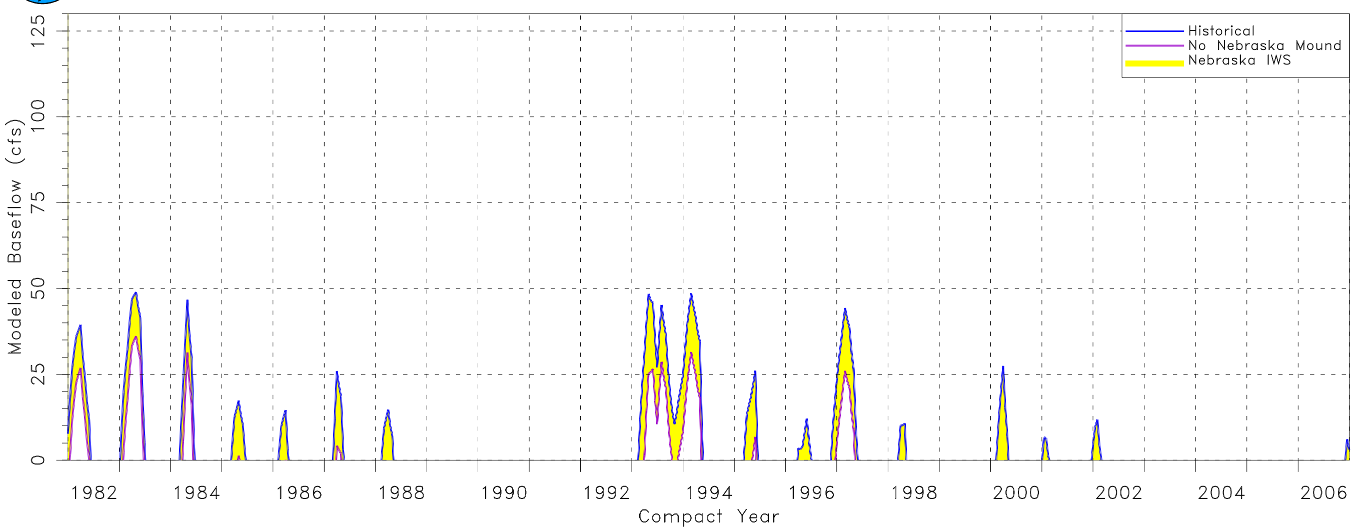


Figure 10b

Pumping Impacts without Imported Water

Mainstem Impacts Swanson – Harlan

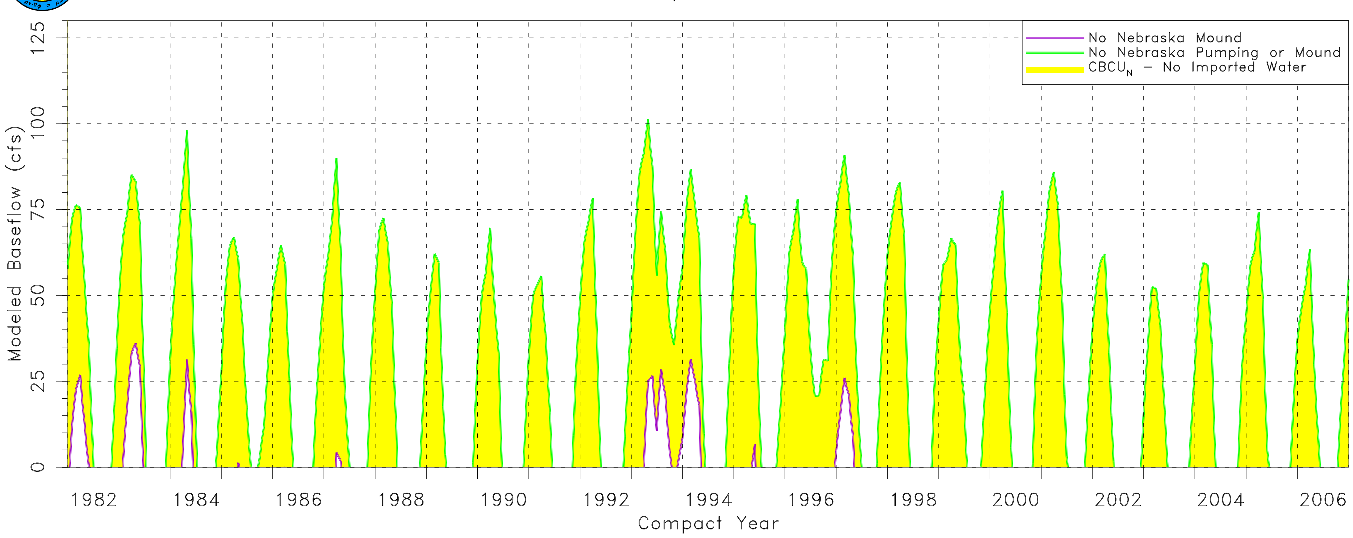


Figure 10c

Pumping Impacts: Approved Method **C-01**

Mainstem Impacts Swanson – Harlan

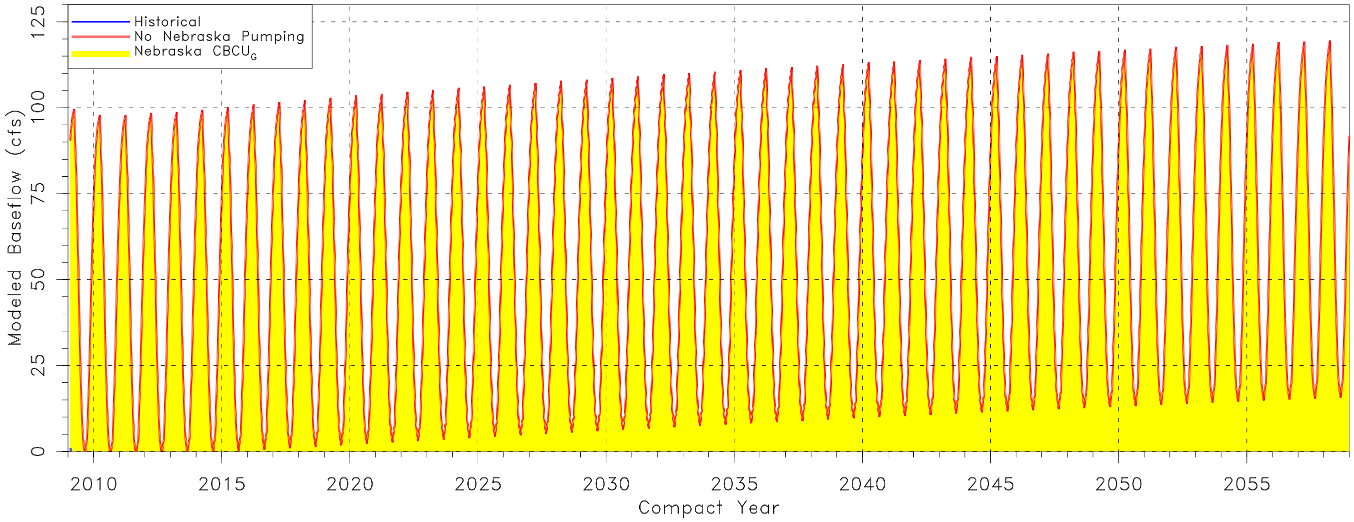


Figure 11a

Mound Credits: Approved Method

Mainstem Impacts Swanson – Harlan

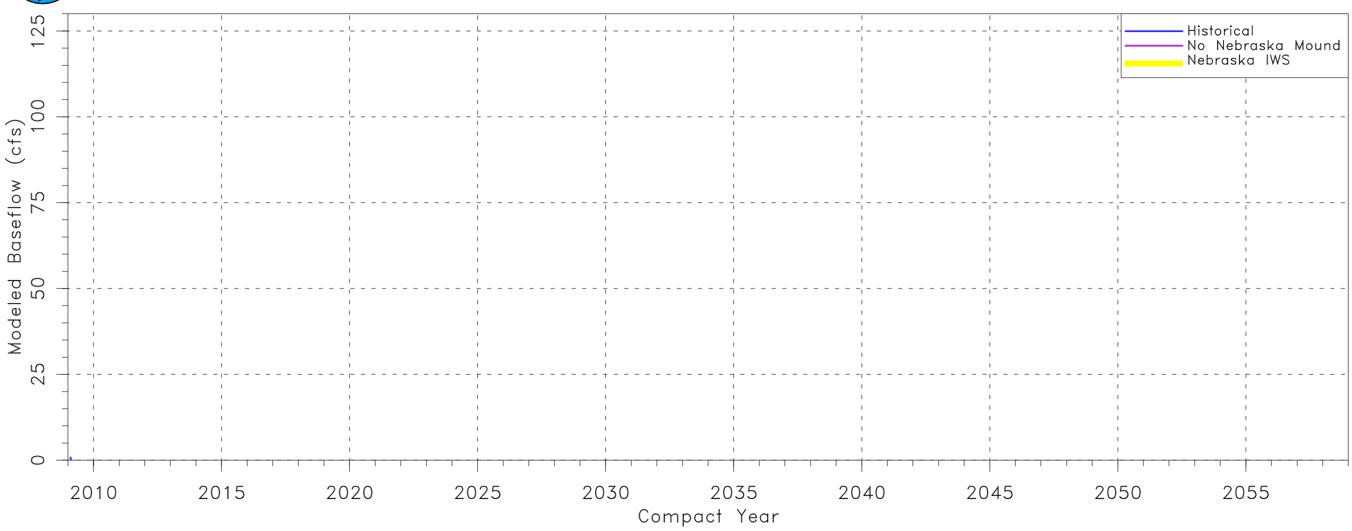


Figure 11b

Pumping Impacts without Imported Water

Mainstem Impacts Swanson – Harlan

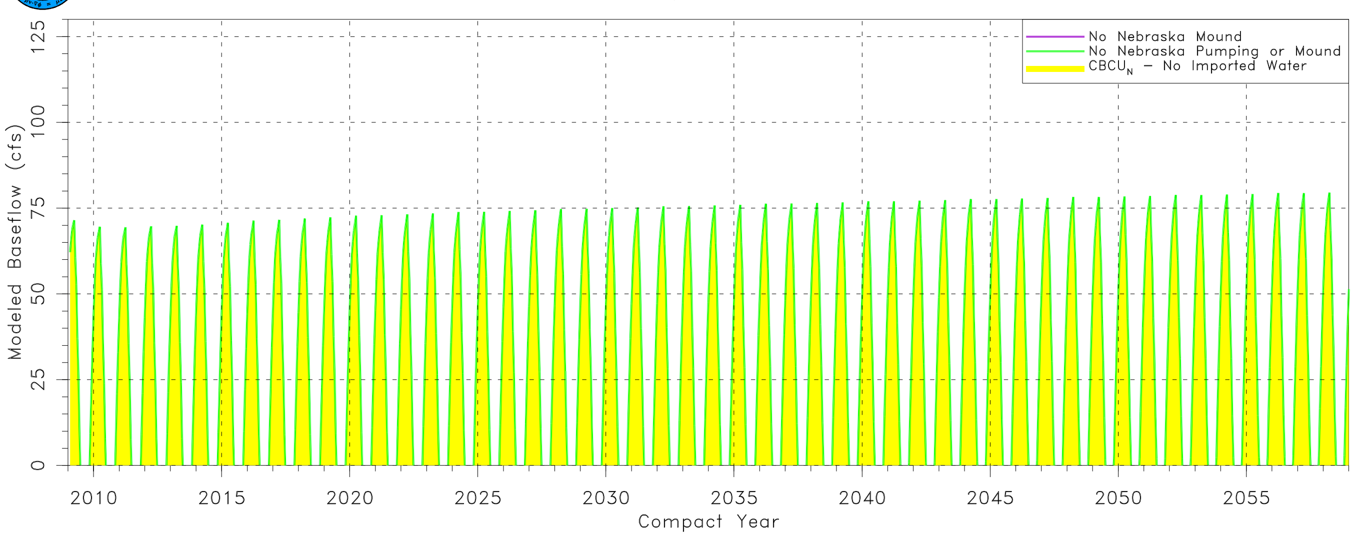


Figure 11c

CO000000431

Table 1a: 1981 (acre-feet/year)

Basin	$CBCU_C$			$CBCU_K$			$CBCU_N$			IWS			NE Residual			Basin Residual		
	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet
Arikaree	799	821	798	430	446	430	260	255	260	0	0	0	0	0	0	-32	0	-33
Beaver	0	0	0	5300	5275	5301	5444	5418	5443	0	0	0	0	-25	0	52	0	52
Buffalo	33	42	33	0	0	0	1400	1410	1400	0	0	0	0	0	0	-19	0	-19
Driftwood	0	0	0	0	0	0	835	835	835	0	0	0	0	0	0	0	0	0
Frenchman	243	858	240	0	0	0	50192	50798	50183	0	0	0	0	611	0	-1216	0	-1230
North Fork	7530	7528	7529	12	11	13	214	213	216	0	0	0	0	0	0	0	0	0
Above Swanson	-523	-641	-523	280	238	278	9721	9576	9736	14	0	14	-15	-150	0	295	0	308
Swanson - Harlan	0	-18	0	230	69	127	40486	40047	39857	8509	8838	8509	628	-140	0	940	0	207
Harlan - Guide Rock	0	0	0	0	0	0	12567	12558	12565	62	63	62	0	0	0	16	0	16
Guide Rock - Hardy	0	0	0	236	235	237	1456	1456	1469	12	0	12	-14	0	0	0	0	12
Medicine	0	0	0	0	0	0	9678	9612	9546	6624	6689	6624	132	0	0	130	0	0
Prairie Dog	0	0	0	4066	4067	4068	0	0	0	0	0	0	0	0	0	0	0	0
Red Willow	0	0	0	0	0	0	4046	4045	4044	11	12	11	0	0	0	0	0	0
Rock	0	0	0	0	0	0	1101	1101	1101	0	0	0	0	0	0	0	0	0
Sappa	0	0	0	-545	554	-551	1185	2287	1184	0	0	0	0	1101	0	-2198	0	-2205
South Fork	9683	9599	9681	10985	10818	10980	977	911	985	0	0	0	0	-67	0	311	0	311
Hugh Butler	0	0	0	0	0	0	839	839	839	0	0	0	0	0	0	0	0	0
Bonny	758	758	758	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Keith Sebelius	0	0	0	359	359	359	0	0	0	0	0	0	0	0	0	0	0	0
Enders	0	0	0	0	0	0	1695	1695	1694	0	0	0	0	0	0	0	0	0
Harlan	0	0	0	25	25	25	621	620	621	0	0	0	0	0	0	0	0	0
Harry Strunk	0	0	0	0	0	0	119	119	119	0	0	0	0	0	0	0	0	0
Swanson	0	0	0	0	0	0	141	139	141	0	0	0	0	0	0	0	0	0
Mainstem	**-531**	**-667**	**-532**	**743**	**536**	**640**	**64228**	**63637**	**63627**	**8596**	**8910**	**8596**	**601**	**-304**	**0**	**1247**	**0**	**542**
Total	**18524**	**18948**	**18514**	**21376**	**22087**	**21263**	**142975**	**143933**	**142239**	**15236**	**15611**	**15236**	**736**	**1319**	**0**	**-1718**	**0**	**-2577**

Table 1b: 1982 (acre-feet/year)

Basin	$CBCU_C$			$CBCU_K$			$CBCU_N$			IWS			NE Residual			Basin Residual		
	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet
Arikaree	2107	2141	2107	363	396	363	210	216	210	0	0	0	0	0	0	-73	0	-72
Beaver	0	0	0	5986	5692	5986	5707	5413	5706	0	0	0	0	-294	0	591	0	588
Buffalo	40	78	39	0	0	0	1475	1513	1475	0	0	0	0	38	0	-76	0	-76
Driftwood	0	0	0	0	0	0	830	829	829	0	0	0	0	0	0	0	0	0
Frenchman	288	972	286	0	0	0	51032	51710	51025	0	0	0	0	679	0	-1350	0	-1364
North Fork	7870	7867	7870	13	10	12	234	230	234	0	0	0	0	0	0	0	0	0
Above Swanson	-875	-908	-873	213	164	213	8702	8673	8690	-12	0	-12	11	-24	0	117	0	108
Swanson - Harlan	0	-15	0	-39	-61	-128	31110	29826	28515	6961	8281	6961	2595	0	0	2631	0	-54
Harlan - Guide Rock	0	0	0	0	0	0	12452	12436	12432	54	67	54	20	0	0	39	0	16
Guide Rock - Hardy	0	0	0	176	172	173	1424	1418	1421	0	0	0	0	0	0	16	0	11
Medicine	0	0	0	0	0	0	9461	9359	9258	6692	6794	6692	203	0	0	205	0	0
Prairie Dog	0	0	0	4544	4545	4543	0	0	0	0	0	0	0	0	0	0	0	0
Red Willow	0	0	0	0	0	0	3414	3413	3412	12	13	12	0	0	0	0	0	0
Rock	0	0	0	0	0	0	1281	1282	1281	0	0	0	0	0	0	0	0	0
Sappa	0	0	0	2128	2318	2128	2861	3052	2863	0	0	0	0	190	0	-381	0	-378
South Fork	8582	8774	8582	5887	6139	5889	596	673	589	0	0	0	0	83	0	-521	0	-526
Hugh Butler	0	0	0	0	0	0	882	882	882	0	0	0	0	0	0	0	0	0
Bonny	760	760	760	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Keith Sebelius	0	0	0	487	487	487	0	0	0	0	0	0	0	0	0	0	0	0
Enders	0	0	0	0	0	0	1802	1802	1802	0	0	0	0	0	0	0	0	0
Harlan	0	0	0	23	22	23	670	669	671	0	0	0	0	0	0	0	0	0
Harry Strunk	0	0	0	0	0	0	127	127	127	0	0	0	0	0	0	0	0	0
Swanson	0	0	0	0	0	0	135	133	135	0	0	0	0	0	0	0	0	0
Mainstem	**-887**	**-931**	**-885**	**353**	**272**	**258**	**53687**	**52354**	**51058**	**6998**	**8343**	**6998**	**2629**	**-49**	**0**	**2803**	**0**	**80**
Total	**18765**	**19665**	**18764**	**19789**	**19877**	**19690**	**134404**	**133657**	**131556**	**13695**	**15151**	**13695**	**2849**	**646**	**0**	**1214**	**0**	**-1734**

Table 1c: 1983 (acre-feet/year)

Basin	$CBCU_C$			$CBCU_K$			$CBCU_N$			IWS			NE Residual			Basin Residual		
	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet
Arikaree	1562	1554	1561	252	256	252	117	133	114	0	0	0	0	18	0	-11	0	-15
Beaver	0	0	0	5901	5755	5901	5217	5071	5216	0	0	0	0	-146	0	293	0	291
Buffalo	46	93	46	0	0	0	1498	1545	1498	0	0	0	0	47	0	-94	0	-94
Driftwood	0	0	0	0	0	0	922	922	922	0	0	0	0	0	0	0	0	0
Frenchman	353	1097	350	0	0	0	51342	52083	51338	0	0	0	0	744	0	-1480	0	-1487
North Fork	7959	7959	7958	13	17	13	299	302	300	0	0	0	0	0	0	0	0	0
Above Swanson	-1779	-1440	-1779	260	278	261	7135	7471	7133	0	0	0	0	340	0	-695	0	-696
Swanson - Harlan	0	-10	0	-136	-126	-283	21610	19945	18137	6364	8121	6364	3473	50	0	3421	0	-199
Harlan - Guide Rock	0	0	0	0	0	0	13864	13850	13844	65	76	65	21	0	0	28	0	0
Guide Rock - Hardy	0	0	0	198	197	198	1526	1523	1526	0	0	0	0	0	0	0	0	0
Medicine	0	0	0	0	0	0	9636	9477	9321	6676	6833	6676	315	0	0	317	0	0
Prairie Dog	0	0	0	4087	4088	4087	0	0	0	0	0	0	0	0	0	0	0	0
Red Willow	0	0	0	0	0	0	3131	3130	3130	13	13	13	0	0	0	0	0	0
Rock	0	0	0	0	0	0	1363	1364	1363	0	0	0	0	0	0	0	0	0
Sappa	0	0	0	2146	2277	2146	2820	2951	2820	0	0	0	0	131	0	-262	0	-261
South Fork	8224	8130	8225	4268	4214	4268	610	626	604	0	0	0	0	24	0	130	0	125
Hugh Butler	0	0	0	0	0	0	925	925	925	0	0	0	0	0	0	0	0	0
Bonny	780	780	780	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Keith Sebelius	0	0	0	454	454	454	0	0	0	0	0	0	0	0	0	0	0	0
Enders	0	0	0	0	0	0	1895	1895	1895	0	0	0	0	0	0	0	0	0
Harlan	0	0	0	20	20	20	680	679	680	0	0	0	0	0	0	0	0	0
Harry Strunk	0	0	0	0	0	0	134	134	134	0	0	0	0	0	0	0	0	0
Swanson	0	0	0	0	0	0	137	136	137	0	0	0	0	0	0	0	0	0
Mainstem	**-1781**	**-1454**	**-1781**	**322**	**347**	**176**	**44136**	**42788**	**40640**	**6431**	**8195**	**6431**	**3496**	**384**	**0**	**2761**	**0**	**-882**
Total	**17153**	**18167**	**17148**	**17465**	**17423**	**17318**	**124860**	**124159**	**121035**	**13118**	**15040**	**13118**	**3825**	**1202**	**0**	**1651**	**0**	**-2326**

Table 1d: 1984 (acre-feet/year)

Basin	$CBCU_C$			$CBCU_K$			$CBCU_N$			IWS			NE Residual			Basin Residual		
	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet
Arikaree	951	964	951	308	333	308	180	196	180	0	0	0	0	16	0	-55	0	-54
Beaver	0	0	0	6063	5949	6063	5197	5082	5196	0	0	0	0	-114	0	230	0	228
Buffalo	53	91	53	0	0	0	1550	1588	1550	0	0	0	0	38	0	-76	0	-76
Driftwood	0	0	0	0	0	0	1039	1039	1039	0	0	0	0	0	0	0	0	0
Frenchman	419	1221	418	0	-13	0	54338	55134	54326	0	0	0	12	801	0	-1582	0	-1593
North Fork	8394	8395	8393	18	27	18	330	337	330	0	0	0	0	0	0	-17	0	-18
Above Swanson	-1376	-1109	-1376	171	194	172	9567	9857	9565	0	0	0	0	292	0	-579	0	-580
Swanson - Harlan	0	0	0	-338	-257	-611	32922	31202	29072	6521	8489	6521	3850	161	0	3613	0	-509
Harlan - Guide Rock	0	0	0	0	0	0	14511	14494	14489	70	82	70	22	0	0	37	0	14
Guide Rock - Hardy	0	0	0	293	291	293	1362	1356	1360	0	0	0	0	0	0	14	0	13
Medicine	0	0	0	0	0	0	10608	10504	10404	7100	7202	7100	204	0	0	208	0	0
Prairie Dog	0	0	0	4056	4056	4057	0	0	0	0	0	0	0	0	0	0	0	0
Red Willow	0	0	0	0	0	0	3700	3699	3698	15	16	15	0	0	0	0	0	0
Rock	0	0	0	0	0	0	1426	1427	1426	0	0	0	0	0	0	0	0	0
Sappa	0	0	0	2375	2501	2373	2863	2990	2863	0	0	0	0	127	0	-254	0	-255
South Fork	7856	7985	7856	7710	7901	7710	665	755	665	0	0	0	0	90	0	-410	0	-410
Hugh Butler	0	0	0	0	0	0	994	993	994	0	0	0	0	0	0	0	0	0
Bonny	835	835	835	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Keith Sebelius	0	0	0	754	754	754	0	0	0	0	0	0	0	0	0	0	0	0
Enders	0	0	0	0	0	0	2036	2036	2036	0	0	0	0	0	0	0	0	0
Harlan	0	0	0	19	18	19	773	772	773	0	0	0	0	0	0	0	0	0
Harry Strunk	0	0	0	0	0	0	143	143	143	0	0	0	0	0	0	0	0	0
Swanson	0	0	0	0	0	0	149	147	149	0	0	0	0	0	0	0	0	0
Mainstem	**-1363**	**-1111**	**-1362**	**125**	**224**	**-146**	**58362**	**56909**	**54487**	**6587**	**8569**	**6587**	**3876**	**440**	**0**	**3084**	**0**	**-1062**
Total	**17159**	**18391**	**17157**	**21425**	**21750**	**21157**	**144353**	**143750**	**140256**	**13701**	**15794**	**13701**	**4097**	**1401**	**0**	**1138**	**0**	**-3229**

Table 1e: 1985 (acre-feet/year)

Basin	$CBCU_C$			$CBCU_K$			$CBCU_N$			IWS			NE Residual			Basin Residual		
	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet
Arikaree	345	363	346	294	312	294	191	194	191	0	0	0	0	0	0	-37	0	-37
Beaver	0	0	0	6049	5978	6049	5284	5212	5282	0	0	0	0	-72	0	144	0	142
Buffalo	61	90	61	0	0	0	1646	1676	1646	0	0	0	0	30	0	-59	0	-59
Driftwood	0	0	0	0	0	0	1052	1052	1052	0	0	0	0	0	0	0	0	0
Frenchman	455	1328	454	0	0	0	56303	57160	56286	0	0	0	17	869	0	-1719	0	-1740
North Fork	8687	8686	8687	20	26	20	367	370	366	0	0	0	0	0	0	0	0	0
Above Swanson	-1445	-1145	-1443	151	183	146	10054	10349	10047	0	0	0	0	303	0	-629	0	-639
Swanson - Harlan	0	0	0	186	99	416	36253	35313	34807	9442	10129	9442	1446	-181	0	1723	0	514
Harlan - Guide Rock	0	0	0	0	0	0	14564	14549	14545	78	89	78	18	0	0	27	0	0
Guide Rock - Hardy	0	0	0	220	219	219	1529	1526	1533	0	0	0	0	0	0	0	0	0
Medicine	0	0	0	0	0	0	11206	11106	11009	7197	7295	7197	198	0	0	201	0	0
Prairie Dog	0	0	0	3524	3524	3525	0	0	0	0	0	0	0	0	0	0	0	0
Red Willow	0	0	0	0	0	0	4168	4166	4165	16	17	16	0	0	0	0	0	0
Rock	0	0	0	0	0	0	1504	1504	1503	0	0	0	0	0	0	0	0	0
Sappa	0	0	0	2775	2748	2775	3200	3174	3203	0	0	0	0	-28	0	53	0	56
South Fork	9615	9710	9616	6635	6767	6634	719	787	712	0	0	0	0	75	0	-297	0	-303
Hugh Butler	0	0	0	0	0	0	1041	1041	1041	0	0	0	0	0	0	0	0	0
Bonny	841	841	841	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Keith Sebelius	0	0	0	655	655	655	0	0	0	0	0	0	0	0	0	0	0	0
Enders	0	0	0	0	0	0	2200	2200	2199	0	0	0	0	0	0	0	0	0
Harlan	0	0	0	18	18	18	712	711	712	0	0	0	0	0	0	0	0	0
Harry Strunk	0	0	0	0	0	0	154	154	154	0	0	0	0	0	0	0	0	0
Swanson	0	0	0	0	0	0	156	154	156	0	0	0	0	0	0	0	0	0
Mainstem	**-1443**	**-1153**	**-1434**	**556**	**499**	**780**	**62400**	**61737**	**60932**	**9510**	**10204**	**9510**	**1468**	**110**	**0**	**1124**	**0**	**-111**
Total	**18575**	**19876**	**18584**	**20527**	**20518**	**20748**	**152302**	**152397**	**150611**	**16715**	**17516**	**16715**	**1691**	**986**	**0**	**-587**	**0**	**-2048**

Table 1f: 1986 (acre-feet/year)

Basin	$CBCU_C$			$CBCU_K$			$CBCU_N$			IWS			NE Residual			Basin Residual		
	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet
Arikaree	311	336	311	246	279	246	177	192	177	0	0	0	0	14	0	-72	0	-72
Beaver	0	0	0	5081	5467	5081	4461	4847	4461	0	0	0	0	386	0	-770	0	-771
Buffalo	69	91	69	0	0	0	1728	1750	1728	0	0	0	0	22	0	-44	0	-44
Driftwood	0	0	0	0	0	0	1072	1072	1072	0	0	0	0	0	0	0	0	0
Frenchman	510	1445	511	0	-11	0	57359	58284	57351	0	0	0	0	930	0	-1854	0	-1859
North Fork	8823	8822	8825	16	20	18	375	376	376	0	0	0	0	0	0	0	0	0
Above Swanson	-1582	-1302	-1579	186	191	193	9132	9412	9134	0	0	0	0	280	0	-567	0	-554
Swanson - Harlan	-14	-20	-18	-232	-201	-570	28896	26415	23578	5863	8576	5863	5318	125	0	5168	0	-492
Harlan - Guide Rock	0	0	0	0	0	0	14795	14779	14770	88	99	88	25	0	0	21	0	0
Guide Rock - Hardy	0	0	0	247	251	249	1339	1339	1340	0	0	0	0	0	0	0	0	0
Medicine	0	0	0	0	0	0	11709	11563	11421	7165	7309	7165	288	0	0	291	0	0
Prairie Dog	0	0	0	2195	2195	2195	0	0	0	0	0	0	0	0	0	0	0	0
Red Willow	0	0	0	0	0	0	4039	4037	4036	15	16	15	0	0	0	0	0	0
Rock	0	11	0	0	0	0	1590	1591	1590	0	0	0	0	0	0	0	0	0
Sappa	0	0	0	948	1442	944	2099	2595	2099	0	0	0	0	495	0	-989	0	-993
South Fork	7576	7643	7578	6011	6091	6014	715	749	711	0	0	0	0	38	0	-181	0	-180
Hugh Butler	0	0	0	0	0	0	1108	1108	1109	0	0	0	0	0	0	0	0	0
Bonny	860	860	860	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Keith Sebelius	0	0	0	616	617	616	0	0	0	0	0	0	0	0	0	0	0	0
Enders	0	0	0	0	0	0	2341	2341	2341	0	0	0	0	0	0	0	0	0
Harlan	0	0	0	18	17	18	789	788	789	0	0	0	0	0	0	0	0	0
Harry Strunk	0	0	0	0	0	0	164	165	165	0	0	0	0	0	0	0	0	0
Swanson	0	0	0	0	0	0	154	153	154	0	0	0	0	0	0	0	0	0
Mainstem	**-1602**	**-1329**	**-1597**	**197**	**244**	**-127**	**54162**	**51945**	**48822**	**5948**	**8668**	**5948**	**5340**	**403**	**0**	**4617**	**0**	**-1042**
Total	**16564**	**17882**	**16573**	**15323**	**16361**	**15003**	**144043**	**143557**	**138402**	**13132**	**16002**	**13132**	**5642**	**2285**	**0**	**1001**	**0**	**-4952**

Table 1g: 1987 (acre-feet/year)

Basin	$CBCU_C$			$CBCU_K$			$CBCU_N$			IWS			NE Residual			Basin Residual		
	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet
Arikaree	343	369	343	310	335	310	190	199	190	0	0	0	0	0	0	-60	0	-60
Beaver	0	0	0	5259	5574	5260	4648	4963	4648	0	0	0	0	315	0	-629	0	-629
Buffalo	79	98	79	0	0	0	1798	1817	1798	0	0	0	0	20	0	-39	0	-39
Driftwood	0	0	0	0	0	0	1103	1103	1103	0	0	0	0	0	0	0	0	0
Frenchman	584	1569	582	-10	-19	0	58479	59467	58454	-17	0	-17	25	1000	0	-1952	0	-1973
North Fork	9328	9326	9328	21	24	21	433	433	428	0	0	0	0	0	0	0	0	0
Above Swanson	-1694	-1312	-1691	148	199	155	9257	9647	9233	-20	-12	-20	24	405	0	-816	0	-828
Swanson - Harlan	-19	-12	-20	39	0	157	35066	33715	32596	9180	10401	9180	2469	-103	0	2600	0	246
Harlan - Guide Rock	0	0	0	0	0	0	15641	15624	15613	88	105	88	28	0	0	38	0	11
Guide Rock - Hardy	0	0	0	223	223	224	1378	1376	1377	-12	-10	-12	0	0	0	0	0	0
Medicine	0	0	0	0	0	0	12154	12012	11873	7412	7552	7412	281	0	0	285	0	0
Prairie Dog	0	0	0	4495	4496	4496	0	0	0	0	0	0	0	0	0	0	0	0
Red Willow	0	0	0	0	0	0	4227	4224	4223	17	19	17	0	0	0	0	0	0
Rock	10	12	10	0	0	0	1705	1706	1705	0	0	0	0	0	0	0	0	0
Sappa	0	0	0	300	1159	293	1445	2305	1442	0	0	0	0	861	0	-1716	0	-1726
South Fork	9818	9943	9822	8061	8199	8074	716	782	709	0	0	0	0	71	0	-328	0	-318
Hugh Butler	0	0	0	0	0	0	1122	1122	1122	0	0	0	0	0	0	0	0	0
Bonny	900	900	900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Keith Sebelius	0	0	0	551	551	551	0	0	0	0	0	0	0	0	0	0	0	0
Enders	0	0	0	0	0	0	2440	2440	2440	0	0	0	0	0	0	0	0	0
Harlan	0	0	0	17	16	17	714	713	714	0	0	0	0	0	0	0	0	0
Harry Strunk	0	0	0	0	0	0	173	173	174	0	0	0	0	0	0	0	0	0
Swanson	0	0	0	0	0	0	154	151	153	0	0	0	0	0	0	0	0	0
Mainstem	**-1717**	**-1333**	**-1715**	**408**	**424**	**534**	**61341**	**60361**	**58819**	**9236**	**10484**	**9236**	**2522**	**293**	**0**	**1828**	**0**	**-565**
Total	**19349**	**20886**	**19355**	**19413**	**20758**	**19552**	**152841**	**153974**	**149994**	**16637**	**18048**	**16637**	**2847**	**2569**	**0**	**-2604**	**0**	**-5306**

Table 1h: 1988 (acre-feet/year)

Basin	$CBCU_C$			$CBCU_K$			$CBCU_N$			IWS			NE Residual			Basin Residual		
	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet
Arikaree	782	811	782	289	323	289	169	176	169	0	0	0	0	0	0	-68	0	-67
Beaver	0	0	0	4658	5272	4658	4009	4624	4010	0	0	0	0	613	0	-1227	0	-1227
Buffalo	89	113	89	0	0	0	1873	1897	1873	0	0	0	0	24	0	-48	0	-48
Driftwood	0	0	0	0	0	0	1098	1098	1098	0	0	0	0	0	0	0	0	0
Frenchman	653	1708	651	0	0	0	59737	60792	59730	0	0	0	0	1057	0	-2102	0	-2113
North Fork	9762	9765	9764	18	26	19	483	489	483	0	0	0	0	0	0	-17	0	-14
Above Swanson	-1974	-1524	-1967	256	276	261	9342	9791	9343	0	0	0	0	450	0	-921	0	-908
Swanson - Harlan	12	0	14	-342	-283	-763	30381	27736	24494	6073	9086	6073	5886	229	0	5613	0	-692
Harlan - Guide Rock	0	0	11	0	0	0	18164	18147	18135	106	116	106	28	0	0	22	0	0
Guide Rock - Hardy	0	0	10	291	291	291	1538	1538	1540	0	0	0	0	0	0	0	0	0
Medicine	0	0	0	0	0	0	12460	12326	12195	7578	7711	7578	265	0	0	268	0	0
Prairie Dog	0	0	0	2498	2499	2498	0	0	0	0	0	0	0	0	0	0	0	0
Red Willow	0	0	0	0	0	0	4174	4172	4170	19	21	19	0	0	0	0	0	0
Rock	12	14	12	0	0	0	1833	1834	1833	0	0	0	0	0	0	0	0	0
Sappa	0	0	0	-83	691	-91	1247	2024	1245	0	0	0	0	777	0	-1548	0	-1558
South Fork	7813	7858	7817	7193	7274	7192	725	804	723	0	0	0	0	82	0	-205	0	-204
Hugh Butler	0	0	0	0	0	0	1171	1171	1171	0	0	0	0	0	0	0	0	0
Bonny	950	950	950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Keith Sebelius	0	0	0	613	613	612	0	0	0	0	0	0	0	0	0	0	0	0
Enders	0	0	0	0	0	0	2547	2547	2547	0	0	0	0	0	0	0	0	0
Harlan	0	0	0	16	15	16	820	820	820	0	0	0	0	0	0	0	0	0
Harry Strunk	0	0	0	0	0	0	181	181	181	0	0	0	0	0	0	0	0	0
Swanson	0	0	0	0	0	0	160	156	160	0	0	0	0	0	0	0	0	0
Mainstem	**-1963**	**-1520**	**-1932**	**205**	**285**	**-210**	**59424**	**57213**	**53512**	**6173**	**9190**	**6173**	**5912**	**684**	**0**	**4705**	**0**	**-1591**
Total	**18107**	**19700**	**18143**	**15406**	**16991**	**14981**	**152112**	**152324**	**145920**	**13773**	**16934**	**13773**	**6192**	**3242**	**0**	**-229**	**0**	**-6810**

Table 1i: 1989 (acre-feet/year)

Basin	$CBCU_C$			$CBCU_K$			$CBCU_N$			IWS			NE Residual			Basin Residual		
	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet
Arikaree	107	120	107	295	319	295	164	183	164	0	0	0	0	19	0	-55	0	-55
Beaver	0	0	0	2404	4103	2404	2072	3771	2072	0	0	0	0	1699	0	-3398	0	-3398
Buffalo	99	117	98	0	0	0	1939	1957	1939	0	0	0	0	18	0	-36	0	-36
Driftwood	0	0	0	0	0	0	1101	1101	1101	0	0	0	0	0	0	0	0	0
Frenchman	711	1806	709	0	0	0	60370	61459	60352	0	0	0	18	1099	0	-2171	0	-2187
North Fork	9841	9839	9841	32	33	32	515	515	516	0	0	0	0	0	0	0	0	0
Above Swanson	-1958	-1492	-1956	169	196	174	9017	9503	9016	0	0	0	0	489	0	-981	0	-976
Swanson - Harlan	0	0	0	180	97	418	28414	25237	22438	6177	9124	6177	5976	-149	0	6220	0	474
Harlan - Guide Rock	0	0	0	0	0	0	17744	17722	17708	113	130	113	36	0	0	44	0	10
Guide Rock - Hardy	0	0	0	234	234	236	1674	1671	1676	0	0	0	0	0	0	0	0	12
Medicine	0	0	0	0	0	0	13019	12839	12660	7506	7686	7506	359	0	0	362	0	0
Prairie Dog	0	0	0	752	752	751	0	0	0	0	0	0	0	0	0	0	0	0
Red Willow	0	0	0	0	0	0	4152	4150	4148	18	21	18	0	0	0	0	0	0
Rock	13	15	13	0	0	0	1915	1917	1915	0	0	0	0	0	0	0	0	0
Sappa	0	0	0	-823	-189	-829	688	1323	685	0	0	0	0	635	0	-1266	0	-1275
South Fork	8588	8962	8589	6640	7030	6645	418	663	420	0	0	0	0	247	0	-1012	0	-1004
Hugh Butler	0	0	0	0	0	0	1263	1263	1263	0	0	0	0	0	0	0	0	0
Bonny	968	968	968	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Keith Sebelius	0	0	0	682	682	682	0	0	0	0	0	0	0	0	0	0	0	0
Enders	0	0	0	0	0	0	2660	2661	2661	0	0	0	0	0	0	0	0	0
Harlan	0	0	0	16	16	16	895	895	896	0	0	0	0	0	0	0	0	0
Harry Strunk	0	0	0	0	0	0	189	189	190	0	0	0	0	0	0	0	0	0
Swanson	0	0	0	0	0	0	159	158	160	0	0	0	0	0	0	0	0	0
Mainstem	**-1946**	**-1502**	**-1950**	**585**	**529**	**831**	**56849**	**54132**	**50838**	**6287**	**9247**	**6287**	**6010**	**334**	**0**	**5289**	**0**	**-480**
Total	**18388**	**20328**	**18382**	**10588**	**13271**	**10836**	**148368**	**149177**	**141979**	**13813**	**16961**	**13813**	**6389**	**4051**	**0**	**-2284**	**0**	**-8431**

Table 1j: 1990 (acre-feet/year)

Basin	$CBCU_C$			$CBCU_K$			$CBCU_N$			IWS			NE Residual			Basin Residual		
	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet
Arikaree	400	437	401	359	403	359	203	232	203	0	0	0	0	29	0	-110	0	-110
Beaver	0	0	0	1217	3546	1217	1054	3383	1054	0	0	0	0	2329	0	-4657	0	-4657
Buffalo	110	139	110	0	0	0	2055	2084	2055	0	0	0	0	29	0	-58	0	-58
Driftwood	0	0	0	0	0	0	1121	1121	1121	0	0	0	0	0	0	0	0	0
Frenchman	693	1871	691	0	-12	0	63990	65162	63974	0	0	0	16	1180	0	-2334	0	-2355
North Fork	10508	10503	10507	29	35	27	597	600	598	0	0	0	0	0	0	0	0	0
Above Swanson	-2095	-1556	-2096	-32	108	-41	10904	11513	10905	0	0	0	0	606	0	-1285	0	-1293
Swanson - Harlan	0	-11	0	118	0	78	32829	29973	27295	7018	9793	7018	5535	-96	0	5756	0	183
Harlan - Guide Rock	0	0	0	0	0	0	18122	18092	18070	117	146	117	52	0	0	75	0	12
Guide Rock - Hardy	0	0	0	252	243	243	1571	1567	1574	0	0	0	0	0	0	20	0	14
Medicine	0	0	0	0	0	0	13983	13760	13540	7634	7855	7634	443	0	0	447	0	0
Prairie Dog	0	0	0	779	780	779	0	0	0	0	0	0	0	0	0	0	0	0
Red Willow	0	0	0	0	0	0	4549	4546	4543	19	22	19	0	0	0	0	0	0
Rock	15	17	14	0	0	0	2037	2039	2037	0	0	0	0	0	0	0	0	0
Sappa	0	0	0	-780	-372	-789	616	1026	612	0	0	0	0	410	0	-815	0	-827
South Fork	9853	10041	9854	9616	9942	9607	787	966	783	0	0	0	0	179	0	-690	0	-702
Hugh Butler	0	0	0	0	0	0	1335	1335	1335	0	0	0	0	0	0	0	0	0
Bonny	985	985	985	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Keith Sebelius	0	0	0	641	642	641	0	0	0	0	0	0	0	0	0	0	0	0
Enders	0	0	0	0	0	0	2795	2796	2795	0	0	0	0	0	0	0	0	0
Harlan	0	0	0	15	17	15	906	908	907	0	0	0	0	0	0	0	0	0
Harry Strunk	0	0	0	0	0	0	199	201	200	0	0	0	0	0	0	0	0	0
Swanson	0	0	0	0	0	0	171	168	171	0	0	0	0	0	0	0	0	0
Mainstem	**-2089**	**-1575**	**-2090**	**340**	**351**	**273**	**63427**	**61145**	**57844**	**7135**	**9944**	**7135**	**5583**	**492**	**0**	**4567**	**0**	**-1085**
Total	**20480**	**22420**	**20476**	**12216**	**15331**	**12123**	**159823**	**161471**	**153773**	**14788**	**17834**	**14788**	**6050**	**4652**	**0**	**-3657**	**0**	**-9804**

Table 1k: 1991 (acre-feet/year)

Basin	$CBCU_C$			$CBCU_K$			$CBCU_N$			IWS			NE Residual			Basin Residual		
	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet
Arikaree	1216	1256	1216	447	489	446	298	308	298	0	0	0	0	0	0	-93	0	-92
Beaver	0	0	0	1321	3787	1321	1354	3819	1354	0	0	0	0	2465	0	-4931	0	-4930
Buffalo	122	189	121	0	0	0	2219	2286	2218	0	0	0	0	67	0	-134	0	-135
Driftwood	0	0	0	0	0	0	1150	1150	1150	0	0	0	0	0	0	0	0	0
Frenchman	713	1980	711	0	0	-11	67072	68336	67059	0	15	0	13	1268	0	-2511	0	-2539
North Fork	10923	10913	10923	46	29	46	595	576	594	0	0	0	0	-18	0	46	0	45
Above Swanson	-1168	-1127	-1173	139	197	127	12258	12301	12265	0	0	0	0	37	0	-142	0	-153
Swanson - Harlan	0	-18	0	0	-60	-136	38381	34176	29970	4504	8736	4504	8411	-26	0	8523	0	-26
Harlan - Guide Rock	0	0	0	0	0	0	20750	20726	20700	123	147	123	50	0	0	47	0	0
Guide Rock - Hardy	0	0	0	364	363	363	1865	1878	1886	0	0	0	-21	0	0	-25	0	0
Medicine	0	0	0	0	0	0	15201	15034	14870	8018	8184	8018	332	0	0	337	0	0
Prairie Dog	0	0	0	2179	2179	2179	0	0	0	0	0	0	0	0	0	0	0	0
Red Willow	0	0	0	0	0	0	5184	5179	5175	20	25	20	0	0	0	11	0	0
Rock	16	20	16	0	0	0	2224	2228	2224	0	0	0	0	0	0	0	0	0
Sappa	0	0	0	-1079	-483	-1088	578	1177	575	0	0	0	0	599	0	-1191	0	-1203
South Fork	10667	10702	10668	10620	10691	10615	965	1040	973	0	0	0	0	71	0	-183	0	-180
Hugh Butler	0	0	0	0	0	0	1420	1420	1420	0	0	0	0	0	0	0	0	0
Bonny	975	975	975	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Keith Sebelius	0	0	0	658	658	658	0	0	0	0	0	0	0	0	0	0	0	0
Enders	0	0	0	0	0	0	2933	2933	2932	0	0	0	0	0	0	0	0	0
Harlan	0	0	0	18	18	18	994	995	995	0	0	0	0	0	0	0	0	0
Harry Strunk	0	0	0	0	0	0	212	212	212	0	0	0	0	0	0	0	0	0
Swanson	0	0	0	0	0	0	165	160	165	0	0	0	0	0	0	10	0	0
Mainstem	**-1167**	**-1146**	**-1171**	**506**	**499**	**352**	**73255**	**69082**	**64821**	**4637**	**8881**	**4637**	**8434**	**17**	**0**	**8403**	**0**	**-188**
Total	**23474**	**24891**	**23468**	**14722**	**17858**	**14539**	**175819**	**175935**	**167035**	**12690**	**17114**	**12690**	**8784**	**4477**	**0**	**-246**	**0**	**-9218**

Table 1l: 1992 (acre-feet/year)

Basin	$CBCU_C$			$CBCU_K$			$CBCU_N$			IWS			NE Residual			Basin Residual		
	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet
Arikaree	2048	2061	2046	388	410	388	207	226	206	0	0	0	0	19	0	-52	0	-55
Beaver	0	0	0	3008	4657	3009	3021	4669	3021	0	0	0	0	1648	0	-3295	0	-3295
Buffalo	135	219	135	0	0	0	2294	2378	2294	0	0	0	0	84	0	-168	0	-168
Driftwood	0	0	0	0	0	0	1153	1153	1153	0	0	0	0	0	0	0	0	0
Frenchman	733	2070	707	0	0	0	64283	65623	64266	0	15	0	17	1345	0	-2662	0	-2703
North Fork	11295	11287	11292	23	16	23	586	581	587	0	0	0	0	0	0	20	0	18
Above Swanson	-1039	-1112	-1060	404	326	407	10265	10186	10275	10	0	10	-10	-86	0	227	0	219
Swanson - Harlan	-11	-20	17	-52	-229	-1075	49746	46460	42537	6148	9925	6148	7209	147	0	7247	0	-956
Harlan - Guide Rock	0	0	0	0	0	0	18840	18786	18745	106	155	106	95	0	0	119	0	15
Guide Rock - Hardy	0	0	0	107	103	110	1658	1655	1666	0	0	0	0	0	0	13	0	16
Medicine	0	0	0	0	0	0	14920	14808	14698	8354	8466	8354	222	0	0	228	0	0
Prairie Dog	0	0	0	4454	4455	4454	0	0	0	0	0	0	0	0	0	0	0	0
Red Willow	0	0	0	0	0	0	5475	5470	5466	24	28	24	0	0	0	11	0	0
Rock	19	23	19	0	0	0	2373	2377	2373	0	0	0	0	0	0	0	0	0
Sappa	0	0	0	-1714	-247	-1740	711	2189	707	0	0	0	0	1475	0	-2939	0	-2968
South Fork	10407	10467	10402	6550	6639	6551	925	913	930	0	0	0	0	-14	0	-141	0	-140
Hugh Butler	0	0	0	0	0	0	1307	1307	1306	0	0	0	0	0	0	0	0	0
Bonny	994	994	994	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Keith Sebelius	0	0	0	425	425	425	0	0	0	0	0	0	0	0	0	0	0	0
Enders	0	0	0	0	0	0	3040	3040	3040	0	0	0	0	0	0	0	0	0
Harlan	0	0	0	16	18	16	842	845	843	0	0	0	0	0	0	0	0	0
Harry Strunk	0	0	0	0	0	0	219	219	220	0	0	0	0	0	0	0	0	0
Swanson	0	0	0	0	0	0	145	142	145	0	0	0	0	0	0	0	0	0
Mainstem	**-1037**	**-1140**	**-1050**	**459**	**196**	**-555**	**80509**	**77087**	**73224**	**6270**	**10088**	**6270**	**7285**	**45**	**0**	**7607**	**0**	**-706**
Total	**24603**	**25982**	**24549**	**13613**	**16567**	**12577**	**182010**	**183026**	**174480**	**14665**	**18613**	**14665**	**7530**	**4598**	**0**	**-1401**	**0**	**-10021**

Table 1m: 1993 (acre-feet/year)

Basin	$CBCU_C$			$CBCU_K$			$CBCU_N$			IWS			NE Residual			Basin Residual		
	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet
Arikaree	1802	1799	1801	448	441	449	190	189	189	0	0	0	0	0	0	12	0	0
Beaver	0	0	0	7720	6992	7719	7008	6280	7007	0	0	0	0	-728	0	1458	0	1455
Buffalo	147	244	147	0	0	0	2284	2381	2283	0	0	0	0	97	0	-195	0	-195
Driftwood	0	0	0	0	0	0	1076	1076	1076	0	0	0	0	0	0	0	0	0
Frenchman	980	2324	974	0	0	0	63480	64827	63449	0	11	0	31	1360	0	-2665	0	-2704
North Fork	11493	11488	11492	14	11	14	592	591	592	0	0	0	0	0	0	11	0	10
Above Swanson	-1061	-1070	-1066	210	210	209	8532	8529	8527	0	0	0	0	0	0	19	0	0
Swanson - Harlan	0	-17	-46	127	165	818	45635	45928	46817	15495	14795	15495	-1182	-189	0	-1012	0	813
Harlan - Guide Rock	0	0	0	-14	0	-14	16855	16836	16816	189	206	189	39	0	0	26	0	-15
Guide Rock - Hardy	0	0	0	47	53	47	1360	1359	1356	0	0	0	0	0	0	0	0	-16
Medicine	0	0	0	0	0	0	13281	13229	13174	8878	8932	8878	107	0	0	108	0	0
Prairie Dog	0	0	0	14165	14167	14165	0	0	0	0	0	0	0	0	0	0	0	0
Red Willow	0	0	0	0	0	0	5082	5083	5083	39	39	39	0	0	0	0	0	0
Rock	21	25	21	0	0	0	2501	2505	2500	0	0	0	0	0	0	0	0	0
Sappa	0	0	0	2897	2936	2894	4252	4297	4262	13	0	13	0	39	0	-88	0	-81
South Fork	9566	9480	9546	8322	8196	8322	805	784	803	0	0	0	0	-26	0	240	0	219
Hugh Butler	0	0	0	0	0	0	1113	1113	1113	0	0	0	0	0	0	0	0	0
Bonny	1005	1005	1005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Keith Sebelius	0	0	0	404	404	404	0	0	0	0	0	0	0	0	0	0	0	0
Enders	0	0	0	0	0	0	3080	3081	3080	0	0	0	0	0	0	0	0	0
Harlan	0	0	0	57	62	57	637	642	635	0	0	0	0	0	0	-10	0	-12
Harry Strunk	0	0	0	0	0	0	215	215	215	0	0	0	0	0	0	0	0	0
Swanson	0	0	0	0	0	0	129	128	129	0	0	0	0	0	0	0	0	0
Mainstem	**-1063**	**-1082**	**-1120**	**371**	**421**	**1061**	**72381**	**72652**	**73516**	**15672**	**14997**	**15672**	**-1135**	**-189**	**0**	**-977**	**0**	**791**
Total	**23956**	**25285**	**23866**	**34403**	**33627**	**35089**	**178101**	**179065**	**179099**	**24596**	**24001**	**24596**	**-999**	**561**	**0**	**-2112**	**0**	**-518**

Table 1n: 1994 (acre-feet/year)

Basin	$CBCU_C$			$CBCU_K$			$CBCU_N$			IWS			NE Residual			Basin Residual		
	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet
Arikaree	1029	1057	1030	206	250	207	116	144	116	0	0	0	0	28	0	-99	0	-99
Beaver	0	0	0	7665	6914	7664	6636	5885	6634	0	0	0	0	-750	0	1502	0	1500
Buffalo	159	259	159	0	0	0	2293	2394	2293	0	0	0	0	101	0	-201	0	-202
Driftwood	0	0	0	0	0	0	1043	1043	1043	0	0	0	0	0	0	0	0	0
Frenchman	890	2353	892	0	0	0	67828	69286	67809	0	12	0	19	1469	0	-2909	0	-2923
North Fork	11698	11699	11698	12	17	12	694	695	694	0	0	0	0	0	0	0	0	0
Above Swanson	-2725	-2038	-2721	224	196	225	9131	9843	9134	0	0	0	0	710	0	-1372	0	-1363
Swanson - Harlan	0	0	17	-229	-190	-495	28354	24926	21154	7277	10915	7277	7200	134	0	7040	0	-415
Harlan - Guide Rock	0	0	11	0	12	0	18748	18719	18703	189	209	189	45	0	0	47	0	11
Guide Rock - Hardy	0	0	10	268	271	271	1305	1301	1307	0	0	0	0	0	0	0	0	0
Medicine	0	0	0	0	0	0	13342	13197	13053	8434	8578	8434	289	0	0	291	0	0
Prairie Dog	0	0	0	6358	6363	6359	0	0	0	0	0	0	0	0	0	0	0	0
Red Willow	0	0	0	0	0	0	4382	4379	4377	30	33	30	0	0	0	0	0	0
Rock	23	28	23	0	0	0	2563	2568	2563	0	0	0	0	0	0	-10	0	-11
Sappa	0	0	0	3873	3269	3880	4806	4205	4819	16	0	16	-13	-606	0	1197	0	1216
South Fork	9034	9064	9041	3279	3399	3286	591	696	596	0	0	0	0	103	0	-259	0	-239
Hugh Butler	0	0	0	0	0	0	1349	1348	1348	0	0	0	0	0	0	0	0	0
Bonny	1044	1044	1044	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Keith Sebelius	0	0	0	476	476	476	0	0	0	0	0	0	0	0	0	0	0	0
Enders	0	0	0	0	0	0	3164	3164	3164	0	0	0	0	0	0	0	0	0
Harlan	0	0	0	112	101	112	869	858	869	0	0	0	0	-11	0	21	0	22
Harry Strunk	0	0	0	0	0	0	214	214	214	0	0	0	0	0	0	0	0	0
Swanson	0	0	0	0	0	0	156	154	156	0	0	0	0	0	0	0	0	0
Mainstem	**-2710**	**-2041**	**-2683**	**271**	**289**	**11**	**57537**	**54790**	**50299**	**7458**	**11111**	**7458**	**7239**	**838**	**0**	**5713**	**0**	**-1758**
Total	**21174**	**23469**	**21210**	**22255**	**21075**	**22012**	**167581**	**165022**	**160046**	**15951**	**19749**	**15951**	**7535**	**1179**	**0**	**5242**	**0**	**-2500**

Table 1o: 1995 (acre-feet/year)

Basin	$CBCU_C$			$CBCU_K$			$CBCU_N$			IWS			NE Residual			Basin Residual		
	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet
Arikaree	1656	1682	1656	378	399	379	232	239	230	0	0	0	0	0	0	-53	0	-54
Beaver	0	0	0	6973	6636	6973	6313	5976	6312	0	0	0	0	-337	0	676	0	674
Buffalo	172	276	172	0	0	0	2410	2514	2410	0	0	0	0	104	0	-208	0	-208
Driftwood	0	0	0	0	0	0	1117	1117	1117	0	0	0	0	0	0	0	0	0
Frenchman	791	2377	789	0	0	0	70334	71903	70297	0	14	0	37	1590	0	-3139	0	-3171
North Fork	12100	12098	12100	28	40	28	746	753	742	0	0	0	0	0	0	-15	0	-19
Above Swanson	-2046	-1635	-2047	0	140	0	10636	11065	10626	0	0	0	10	436	0	-976	0	-985
Swanson - Harlan	-10	0	0	-396	-311	-883	41743	39097	35765	8943	12007	8943	5978	268	0	5621	0	-831
Harlan - Guide Rock	0	0	0	0	0	0	22103	22066	22028	189	224	189	75	0	0	70	0	0
Guide Rock - Hardy	0	0	0	362	363	363	1754	1751	1749	0	0	0	0	0	0	0	0	0
Medicine	0	0	0	0	0	0	14966	14833	14699	8750	8882	8750	267	0	0	268	0	0
Prairie Dog	0	0	0	3689	3689	3689	0	0	0	0	0	0	0	0	0	0	0	0
Red Willow	0	0	0	0	0	0	5470	5467	5464	35	38	35	0	0	0	0	0	0
Rock	25	31	25	0	0	0	2642	2648	2642	0	0	0	0	0	0	-11	0	-12
Sappa	0	0	0	2256	2371	2253	3476	3595	3481	0	0	0	0	116	0	-236	0	-234
South Fork	12098	12230	12099	8872	9082	8875	876	981	865	0	0	0	11	112	0	-444	0	-450
Hugh Butler	0	0	0	0	0	0	1448	1448	1448	0	0	0	0	0	0	0	0	0
Bonny	1053	1053	1053	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Keith Sebelius	0	0	0	485	485	485	0	0	0	0	0	0	0	0	0	0	0	0
Enders	0	0	0	0	0	0	3299	3300	3299	0	0	0	0	0	0	0	0	0
Harlan	0	0	0	82	69	82	956	944	957	0	0	0	0	-12	0	24	0	24
Harry Strunk	0	0	0	0	0	0	225	225	226	0	0	0	0	0	0	0	0	0
Swanson	0	0	0	0	0	0	154	150	154	0	0	0	0	0	0	0	0	0
Mainstem	**-2058**	**-1642**	**-2044**	**-31**	**196**	**-514**	**76236**	**73978**	**70168**	**9127**	**12229**	**9127**	**6068**	**709**	**0**	**4717**	**0**	**-1820**
Total	**25843**	**28107**	**25855**	**22734**	**22965**	**22259**	**190899**	**190069**	**184508**	**17927**	**21186**	**17927**	**6391**	**2301**	**0**	**1594**	**0**	**-5259**

Table 1p: 1996 (acre-feet/year)

Basin	$CBCU_C$			$CBCU_K$			$CBCU_N$			IWS			NE Residual			Basin Residual		
	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet
Arikaree	1569	1593	1569	406	434	406	237	247	236	0	0	0	0	10	0	-62	0	-63
Beaver	0	0	0	7098	6796	7098	6178	5875	6175	0	0	0	0	-301	0	607	0	603
Buffalo	186	307	186	0	0	0	2500	2621	2499	0	0	0	0	121	0	-242	0	-243
Driftwood	0	0	0	0	0	0	1146	1146	1146	0	0	0	0	0	0	0	0	0
Frenchman	936	2600	937	0	0	0	70585	72235	70536	0	17	0	49	1677	0	-3287	0	-3331
North Fork	12354	12341	12354	31	20	31	755	743	753	0	0	0	0	-11	0	36	0	34
Above Swanson	-829	-1010	-829	305	240	304	11071	10880	11072	0	0	0	0	-195	0	440	0	440
Swanson - Harlan	22	0	14	345	232	889	52755	51993	51996	14929	15218	14929	758	-293	0	1195	0	973
Harlan - Guide Rock	0	0	0	0	0	0	20692	20659	20629	216	248	216	63	0	0	67	0	0
Guide Rock - Hardy	0	0	0	318	318	318	1763	1760	1759	0	0	0	0	0	0	0	0	0
Medicine	0	0	0	0	0	0	15006	14943	14882	9144	9206	9144	124	0	0	130	0	0
Prairie Dog	0	0	0	5918	5918	5918	0	0	0	0	0	0	0	0	0	0	0	0
Red Willow	0	0	0	0	0	0	5933	5929	5926	38	42	38	0	0	0	0	0	0
Rock	28	35	28	0	0	0	2775	2782	2774	0	0	0	0	0	0	-13	0	-14
Sappa	0	0	0	3084	2821	3086	4048	3787	4056	15	0	15	0	-264	0	519	0	530
South Fork	11061	11147	11060	7485	7609	7484	919	950	916	0	0	0	0	31	0	-239	0	-244
Hugh Butler	0	0	0	0	0	0	1362	1362	1362	0	0	0	0	0	0	0	0	0
Bonny	1054	1054	1054	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Keith Sebelius	0	0	0	334	334	334	0	0	0	0	0	0	0	0	0	0	0	0
Enders	0	0	0	0	0	0	3385	3385	3384	0	0	0	0	0	0	0	0	0
Harlan	0	0	0	63	51	64	771	758	771	0	0	0	0	-12	0	25	0	25
Harry Strunk	0	0	0	0	0	0	232	232	232	0	0	0	0	0	0	0	0	0
Swanson	0	0	0	0	0	0	142	139	142	0	0	0	0	0	0	0	0	0
Mainstem	**-802**	**-1016**	**-811**	**969**	**789**	**1513**	**86280**	**85291**	**85457**	**15133**	**15457**	**15133**	**823**	**-490**	**0**	**1706**	**0**	**1418**
Total	**26392**	**28061**	**26382**	**25389**	**24766**	**25940**	**202252**	**202420**	**201241**	**24331**	**24746**	**24331**	**1010**	**764**	**0**	**-801**	**0**	**-1270**

Table 1q: 1997 (acre-feet/year)

Basin	$CBCU_C$			$CBCU_K$			$CBCU_N$			IWS			NE Residual			Basin Residual		
	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet
Arikaree	1549	1567	1549	282	312	282	165	194	163	0	0	0	0	31	0	-77	0	-78
Beaver	0	0	0	6908	6723	6908	5873	5686	5869	0	0	0	0	-185	0	374	0	371
Buffalo	198	312	198	0	0	0	2564	2677	2563	0	0	0	0	114	0	-227	0	-227
Driftwood	0	0	0	0	0	0	1150	1150	1150	0	0	0	0	0	0	0	0	0
Frenchman	960	2678	959	0	0	0	72886	74584	72842	0	19	0	44	1722	0	-3389	0	-3428
North Fork	12406	12406	12406	22	26	22	865	867	861	0	0	0	0	0	0	0	0	0
Above Swanson	-2575	-1944	-2572	222	218	226	10961	11604	10948	0	0	0	14	653	0	-1267	0	-1273
Swanson - Harlan	-15	-14	-11	-415	-372	-1159	34424	30549	25796	7167	11601	7167	8628	319	0	8266	0	-1102
Harlan - Guide Rock	0	0	0	0	0	0	22493	22439	22389	199	250	199	104	0	0	107	0	0
Guide Rock - Hardy	0	0	0	308	307	309	1693	1690	1690	0	0	0	0	0	0	0	0	0
Medicine	0	0	0	0	0	0	15220	15084	14947	8994	9129	8994	273	0	0	273	0	0
Prairie Dog	0	0	0	4121	4122	4122	0	0	0	0	0	0	0	0	0	0	0	0
Red Willow	0	0	0	0	0	0	5312	5307	5302	39	43	39	0	0	0	0	0	0
Rock	31	39	31	0	0	0	2839	2846	2838	0	0	0	0	0	0	-15	0	-15
Sappa	0	0	0	2542	2506	2538	3432	3399	3433	0	0	0	0	-34	0	69	0	66
South Fork	9177	9203	9181	5863	5924	5869	858	945	845	0	0	0	12	98	0	-173	0	-175
Hugh Butler	0	0	0	0	0	0	1479	1479	1479	0	0	0	0	0	0	0	0	0
Bonny	1079	1078	1079	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Keith Sebelius	0	0	0	427	427	427	0	0	0	0	0	0	0	0	0	0	0	0
Enders	0	0	0	0	0	0	3464	3464	3463	0	0	0	0	0	0	0	0	0
Harlan	0	0	0	53	41	53	963	952	964	0	0	0	0	-11	0	22	0	23
Harry Strunk	0	0	0	0	0	0	237	237	238	0	0	0	0	0	0	0	0	0
Swanson	0	0	0	0	0	0	161	158	161	0	0	0	0	0	0	0	0	0
Mainstem	**-2589**	**-1959**	**-2581**	**118**	**153**	**-622**	**69571**	**66282**	**60822**	**7358**	**11848**	**7358**	**8749**	**970**	**0**	**7114**	**0**	**-2367**
Total	**22818**	**25324**	**22830**	**20338**	**20229**	**19608**	**187039**	**185312**	**177942**	**16406**	**21061**	**16406**	**9097**	**2715**	**0**	**3985**	**0**	**-5831**

Table 1r: 1998 (acre-feet/year)

Basin	$CBCU_C$			$CBCU_K$			$CBCU_N$			IWS			NE Residual			Basin Residual		
	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet
Arikaree	1088	1116	1088	286	323	287	205	220	205	0	0	0	0	15	0	-79	0	-79
Beaver	0	0	0	5710	6152	5711	4890	5330	4888	0	0	0	0	442	0	-881	0	-882
Buffalo	210	302	209	0	0	0	2686	2779	2686	0	0	0	0	92	0	-185	0	-185
Driftwood	0	0	0	0	0	0	1196	1196	1196	0	0	0	0	0	0	0	0	0
Frenchman	704	2577	703	0	-15	0	73757	75617	73733	11	23	11	24	1872	0	-3707	0	-3728
North Fork	12621	12625	12621	20	29	21	936	941	936	0	0	0	0	0	0	-16	0	-16
Above Swanson	-3332	-2375	-3333	30	160	34	10164	11154	10167	0	0	0	0	987	0	-2077	0	-2071
Swanson - Harlan	0	-29	0	-419	-332	-756	35089	31746	27875	8605	12272	8605	7214	204	0	6946	0	-606
Harlan - Guide Rock	0	0	0	0	0	0	21878	21800	21734	176	250	176	145	0	0	160	0	16
Guide Rock - Hardy	0	0	0	268	263	268	1598	1597	1606	0	0	0	0	0	0	0	0	13
Medicine	0	0	0	0	0	0	15926	15726	15531	8864	9060	8864	394	0	0	401	0	0
Prairie Dog	0	0	0	2543	2543	2544	0	0	0	0	0	0	0	0	0	0	0	0
Red Willow	0	0	0	0	0	0	5337	5330	5325	34	41	34	12	0	0	15	0	0
Rock	34	43	34	0	0	0	2894	2902	2894	0	0	0	0	0	0	-16	0	-17
Sappa	0	0	0	892	1449	883	2383	2947	2388	0	0	0	0	560	0	-1120	0	-1125
South Fork	11331	11539	11334	7707	7963	7711	799	941	803	0	0	0	0	140	0	-609	0	-597
Hugh Butler	0	0	0	0	0	0	1548	1548	1548	0	0	0	0	0	0	0	0	0
Bonny	1121	1121	1121	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Keith Sebelius	0	0	0	404	404	404	0	0	0	0	0	0	0	0	0	0	0	0
Enders	0	0	0	0	0	0	3606	3606	3605	0	0	0	0	0	0	0	0	0
Harlan	0	0	0	47	37	47	949	940	949	0	0	0	0	0	0	19	0	20
Harry Strunk	0	0	0	0	0	0	248	248	248	0	0	0	0	0	0	0	0	0
Swanson	0	0	0	0	0	0	179	176	179	0	0	0	0	0	0	0	0	0
Mainstem	**-3337**	**-2410**	**-3339**	**-120**	**89**	**-452**	**68729**	**66298**	**61382**	**8788**	**12525**	**8788**	**7346**	**1178**	**0**	**5033**	**0**	**-2648**
Total	**23781**	**26913**	**23780**	**17496**	**18972**	**17166**	**186266**	**186744**	**178495**	**17724**	**21677**	**17724**	**7771**	**4297**	**0**	**-1134**	**0**	**-9237**

Table 1s: 1999 (acre-feet/year)

Basin	$CBCU_C$			$CBCU_K$			$CBCU_N$			IWS			NE Residual			Basin Residual		
	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet
Arikaree	758	790	758	423	468	423	313	324	313	0	0	0	0	12	0	-88	0	-88
Beaver	0	0	0	5781	6147	5781	4779	5144	4778	0	0	0	0	366	0	-729	0	-730
Buffalo	222	321	222	0	0	0	2794	2893	2794	0	0	0	0	98	0	-197	0	-197
Driftwood	0	0	0	0	0	0	1171	1171	1171	0	0	0	0	0	0	0	0	0
Frenchman	997	2824	994	0	0	0	75095	76899	75068	17	33	17	28	1815	0	-3598	0	-3630
North Fork	13111	13104	13111	25	21	25	915	907	915	0	0	0	0	0	0	19	0	19
Above Swanson	-736	-983	-736	324	269	322	12820	12547	12831	0	0	0	-12	-277	0	567	0	577
Swanson - Harlan	0	-22	0	-34	-236	-1070	49587	46049	41900	8746	12772	8746	7687	122	0	7784	0	-939
Harlan - Guide Rock	0	0	0	0	0	0	21925	21837	21756	175	262	175	169	0	0	177	0	0
Guide Rock - Hardy	0	0	0	310	309	310	1679	1680	1687	0	0	0	0	0	0	0	0	0
Medicine	0	0	0	0	0	0	15287	15239	15197	9480	9525	9480	90	0	0	98	0	0
Prairie Dog	0	0	0	2481	2480	2480	0	0	0	0	0	0	0	0	0	0	0	0
Red Willow	0	0	0	0	0	0	6345	6335	6327	33	42	33	19	0	0	21	0	0
Rock	38	47	38	0	0	0	3023	3032	3023	0	0	0	0	0	0	-18	0	-19
Sappa	0	0	0	-135	978	-160	1123	2246	1118	0	0	0	0	1121	0	-2228	0	-2257
South Fork	12488	12684	12488	8793	9067	8788	1040	1162	1044	0	0	0	0	123	0	-597	0	-597
Hugh Butler	0	0	0	0	0	0	1344	1344	1344	0	0	0	0	0	0	0	0	0
Bonny	1117	1116	1117	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Keith Sebelius	0	0	0	356	356	356	0	0	0	0	0	0	0	0	0	0	0	0
Enders	0	0	0	0	0	0	3711	3711	3710	0	0	0	0	0	0	0	0	0
Harlan	0	0	0	43	34	44	863	854	864	0	0	0	0	0	0	17	0	19
Harry Strunk	0	0	0	0	0	0	249	249	250	0	0	0	0	0	0	0	0	0
Swanson	14	0	14	0	0	0	178	172	179	0	0	0	0	0	0	15	0	15
Mainstem	**-736**	**-1002**	**-736**	**601**	**340**	**-437**	**86011**	**82113**	**78175**	**8932**	**13035**	**8932**	**7836**	**-164**	**0**	**8527**	**0**	**-347**
Total	**28010**	**29889**	**28006**	**18384**	**19884**	**17317**	**204242**	**203794**	**196269**	**18482**	**22657**	**18482**	**7973**	**3350**	**0**	**1245**	**0**	**-7800**

Table 1t: 2000 (acre-feet/year)

Basin	$CBCU_C$			$CBCU_K$			$CBCU_N$			IWS			NE Residual			Basin Residual		
	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet
Arikaree	1794	1823	1794	245	294	246	195	234	194	0	0	0	0	40	0	-116	0	-118
Beaver	0	0	0	4650	5600	4650	3483	4432	3481	0	0	0	0	949	0	-1897	0	-1898
Buffalo	237	330	237	0	0	0	2907	3000	2907	0	0	0	0	93	0	-186	0	-187
Driftwood	0	0	0	0	0	0	1153	1153	1153	0	0	0	0	0	0	0	0	0
Frenchman	599	2689	588	0	0	0	74874	76944	74830	0	25	0	44	2090	0	-4127	0	-4187
North Fork	13288	13285	13287	23	24	22	1039	1038	1038	0	0	0	0	0	0	0	0	0
Above Swanson	-4279	-3109	-4284	148	216	146	10282	11450	10275	0	0	0	0	1172	0	-2403	0	-2416
Swanson - Harlan	13	0	0	-245	-51	431	30875	27220	23853	9460	12864	9460	7022	-38	0	6873	0	506
Harlan - Guide Rock	0	0	0	0	0	0	25303	25195	25093	155	261	155	210	0	0	221	0	0
Guide Rock - Hardy	0	0	0	411	407	408	1764	1762	1765	0	0	0	0	0	0	0	0	0
Medicine	0	0	0	0	0	0	15926	15699	15476	9028	9252	9028	450	0	0	454	0	0
Prairie Dog	0	0	0	1392	1392	1391	0	0	0	0	0	0	0	0	0	0	0	0
Red Willow	0	0	0	0	0	0	5178	5169	5161	31	40	31	17	0	0	19	0	0
Rock	42	52	42	0	0	0	3125	3135	3125	0	0	0	0	10	0	-20	0	-21
Sappa	0	0	0	-641	354	-664	766	1770	762	0	0	0	0	1002	0	-1991	0	-2019
South Fork	9339	9283	9336	6277	6315	6273	975	1029	970	0	0	0	0	57	0	-34	0	-46
Hugh Butler	0	0	0	0	0	0	1600	1600	1600	0	0	0	0	0	0	0	0	0
Bonny	1170	1170	1170	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Keith Sebelius	0	0	0	407	407	407	0	0	0	0	0	0	0	0	0	0	0	0
Enders	0	0	0	0	0	0	3847	3848	3847	0	0	0	0	0	0	0	0	0
Harlan	0	0	0	41	32	41	987	981	989	0	0	0	0	0	0	16	0	16
Harry Strunk	0	0	0	0	0	0	251	253	252	0	0	0	0	0	0	0	0	0
Swanson	12	10	11	0	0	0	219	217	218	0	0	0	0	0	0	0	0	0
Mainstem	**-4260**	**-3104**	**-4293**	**318**	**573**	**986**	**68224**	**65627**	**60986**	**9612**	**13126**	**9612**	**7238**	**1127**	**0**	**4701**	**0**	**-1902**
Total	**22222**	**25536**	**22170**	**12724**	**14990**	**13360**	**184749**	**186129**	**176987**	**18689**	**22473**	**18689**	**7761**	**5358**	**0**	**-3176**	**0**	**-10354**

Table 1u: 2001 (acre-feet/year)

Basin	$CBCU_C$			$CBCU_K$			$CBCU_N$			IWS			NE Residual			Basin Residual		
	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet
Arikaree	1098	1148	1097	320	370	320	340	382	339	0	0	0	0	42	0	-143	0	-143
Beaver	0	0	0	3645	5081	3645	2988	4423	2986	0	0	0	0	1436	0	-2870	0	-2871
Buffalo	250	326	250	0	0	0	3094	3170	3094	0	0	0	0	76	0	-151	0	-152
Driftwood	0	0	0	0	0	0	1221	1221	1221	0	0	0	0	0	0	0	0	0
Frenchman	559	2734	554	0	0	0	78272	80437	78229	0	23	0	43	2186	0	-4316	0	-4368
North Fork	13656	13654	13655	23	29	23	1548	1552	1546	0	0	0	0	0	0	0	0	0
Above Swanson	-4192	-2801	-4189	-118	154	-119	11698	13124	11701	0	0	0	0	1427	0	-3094	0	-3089
Swanson - Harlan	0	11	0	143	-84	-672	41297	37473	33266	8839	12983	8839	8031	63	0	8180	0	-663
Harlan - Guide Rock	0	0	0	0	0	0	24310	24201	24089	170	281	170	221	0	0	220	0	0
Guide Rock - Hardy	0	0	0	217	216	218	1832	1836	1837	0	0	0	0	0	0	0	0	0
Medicine	0	0	0	0	0	0	17330	17137	16944	9303	9495	9303	386	0	0	385	0	0
Prairie Dog	0	0	0	3028	3027	3027	0	0	0	0	0	0	0	0	0	0	0	0
Red Willow	0	0	0	0	0	0	6173	6162	6150	29	41	29	23	0	0	24	0	0
Rock	46	57	46	0	0	0	3216	3227	3216	0	0	0	0	11	0	-22	0	-23
Sappa	0	0	0	-939	182	-969	873	2007	869	0	0	0	0	1131	0	-2246	0	-2281
South Fork	9769	10385	9767	7398	8296	7397	637	1114	637	0	0	0	0	479	0	-1993	0	-1996
Hugh Butler	0	0	0	0	0	0	1593	1593	1593	0	0	0	0	0	0	0	0	0
Bonny	1217	1217	1217	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Keith Sebelius	0	0	0	378	378	378	0	0	0	0	0	0	0	0	0	0	0	0
Enders	0	0	0	0	0	0	3995	3996	3995	0	0	0	0	0	0	0	0	0
Harlan	0	0	0	41	32	40	826	820	827	0	0	0	0	0	0	15	0	16
Harry Strunk	0	0	0	0	0	0	262	263	263	0	0	0	0	0	0	0	0	0
Swanson	11	11	11	0	0	0	244	244	244	0	0	0	0	0	0	0	0	0
Mainstem	**-4201**	**-2794**	**-4192**	**245**	**289**	**-570**	**79137**	**76634**	**70894**	**9009**	**13257**	**9009**	**8243**	**1493**	**0**	**5300**	**0**	**-3750**
Total	**22407**	**26735**	**22406**	**14149**	**17689**	**13299**	**201749**	**204381**	**193046**	**18355**	**22837**	**18355**	**8702**	**6853**	**0**	**-6018**	**0**	**-15571**

Table 1v: 2002 (acre-feet/year)

Basin	$CBCU_C$			$CBCU_K$			$CBCU_N$			IWS			NE Residual			Basin Residual		
	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet
Arikaree	261	280	261	226	257	226	349	374	349	0	0	0	0	25	0	-75	0	-75
Beaver	0	0	0	1739	3768	1739	1791	3820	1791	0	0	0	0	2029	0	-4057	0	-4057
Buffalo	247	310	247	0	0	0	3221	3284	3220	0	0	0	0	63	0	-126	0	-126
Driftwood	0	0	0	0	0	0	1272	1272	1272	0	0	0	0	0	0	0	0	0
Frenchman	603	2795	604	0	0	0	74126	76303	74084	0	24	0	42	2198	0	-4344	0	-4381
North Fork	13691	13685	13691	25	22	25	1801	1796	1801	0	0	0	0	0	0	14	0	14
Above Swanson	-6193	-4424	-6195	362	236	366	10148	11934	10148	0	0	0	0	1787	0	-3431	0	-3428
Swanson - Harlan	0	0	0	194	0	-219	21705	16327	10950	5425	10874	5425	10755	-72	0	11027	0	-139
Harlan - Guide Rock	0	0	0	0	0	0	26236	26121	26003	172	288	172	233	0	0	230	0	0
Guide Rock - Hardy	0	0	0	276	275	277	1611	1615	1614	0	0	0	0	0	0	0	0	0
Medicine	0	0	0	0	0	0	18405	17857	17310	8373	8920	8373	1095	0	0	1096	0	0
Prairie Dog	0	0	0	2292	2294	2292	0	0	0	0	0	0	0	0	0	0	0	0
Red Willow	0	0	0	0	0	0	5192	5180	5169	24	35	24	23	0	0	24	0	0
Rock	53	63	53	0	0	0	3297	3307	3296	0	0	0	0	11	0	-21	0	-21
Sappa	0	0	0	-422	85	-435	695	1206	690	0	0	0	0	511	0	-1014	0	-1032
South Fork	9563	9554	9561	4854	4810	4855	1259	1463	1260	0	0	0	0	204	0	-153	0	-153
Hugh Butler	0	0	0	0	0	0	1746	1746	1746	0	0	0	0	0	0	0	0	0
Bonny	1268	1267	1268	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Keith Sebelius	0	0	0	512	512	512	0	0	0	0	0	0	0	0	0	0	0	0
Enders	0	0	0	0	0	0	4128	4129	4128	0	0	0	0	0	0	0	0	0
Harlan	0	0	0	39	32	40	892	887	894	11	10	11	0	0	0	11	0	13
Harry Strunk	0	0	0	0	0	0	271	273	273	0	0	0	0	0	0	0	0	0
Swanson	0	0	0	0	0	0	283	283	283	0	0	0	0	0	0	0	0	0
Mainstem	**-6197**	**-4428**	**-6196**	**836**	**512**	**429**	**59699**	**55998**	**48715**	**5590**	**11152**	**5590**	**10984**	**1721**	**0**	**7818**	**0**	**-3572**
Total	**19489**	**23531**	**19489**	**10107**	**12292**	**9692**	**178423**	**179175**	**166278**	**14007**	**20150**	**14007**	**12146**	**6754**	**0**	**-836**	**0**	**-13397**

Table 1w: 2003 (acre-feet/year)

Basin	$CBCU_C$			$CBCU_K$			$CBCU_N$			IWS			NE Residual			Basin Residual		
	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet
Arikaree	125	159	125	226	284	226	502	568	502	0	0	0	0	66	0	-159	0	-159
Beaver	0	0	0	323	3021	323	727	3425	727	0	0	0	0	2698	0	-5394	0	-5395
Buffalo	268	309	268	0	0	0	3332	3374	3332	0	0	0	0	41	0	-82	0	-82
Driftwood	0	0	0	0	0	0	1391	1391	1391	0	0	0	0	0	0	0	0	0
Frenchman	19	2562	21	0	0	0	81188	83704	81143	0	26	0	46	2539	0	-5028	0	-5071
North Fork	14155	14149	14154	33	29	33	1257	1248	1257	0	0	0	0	0	0	19	0	18
Above Swanson	117	-642	117	-58	75	-58	18003	17250	18005	0	0	0	0	-755	0	1379	0	1381
Swanson - Harlan	11	0	10	53	-22	0	27253	18629	10077	140	8735	140	17176	-43	0	17301	0	71
Harlan - Guide Rock	0	0	0	0	0	0	27700	27576	27449	182	307	182	251	0	0	250	0	0
Guide Rock - Hardy	0	0	0	359	357	359	2251	2256	2257	0	0	0	0	0	0	0	0	0
Medicine	0	0	0	0	0	0	19809	19574	19339	9439	9674	9439	470	0	0	470	0	0
Prairie Dog	0	0	0	1136	1137	1136	0	0	0	0	0	0	0	0	0	0	0	0
Red Willow	0	0	0	0	0	0	6055	6035	6017	20	39	20	38	0	0	39	0	0
Rock	58	69	58	0	0	0	3419	3430	3419	0	0	0	0	11	0	-22	0	-22
Sappa	0	0	0	-323	-173	-323	500	648	495	0	0	0	0	150	0	-295	0	-300
South Fork	10842	11209	10842	5284	5833	5285	1331	1672	1331	0	0	0	0	343	0	-1259	0	-1258
Hugh Butler	0	0	0	0	0	0	1758	1758	1758	0	0	0	0	0	0	0	0	0
Bonny	1326	1326	1326	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Keith Sebelius	0	0	0	542	542	542	0	0	0	0	0	0	0	0	0	0	0	0
Enders	0	0	0	0	0	0	4436	4438	4436	0	0	0	0	0	0	0	0	0
Harlan	0	0	0	36	31	36	882	878	884	12	11	12	0	0	0	0	0	10
Harry Strunk	0	0	0	0	0	0	412	413	413	0	0	0	0	0	0	0	0	0
Swanson	20	15	20	0	0	0	483	477	483	0	0	0	0	0	0	14	0	14
Mainstem	**120**	**-642**	**119**	**357**	**411**	**304**	**75207**	**65711**	**57789**	**315**	**9033**	**315**	**17418**	**-795**	**0**	**18921**	**0**	**1449**
Total	**26930**	**29156**	**26930**	**7625**	**11113**	**7574**	**202689**	**198745**	**184714**	**9797**	**18791**	**9797**	**17975**	**5037**	**0**	**7224**	**0**	**-10802**

Table 1x: 2004 (acre-feet/year)

Basin	$CBCU_C$			$CBCU_K$			$CBCU_N$			IWS			NE Residual			Basin Residual		
	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet
Arikaree	161	166	161	311	291	311	427	405	427	0	0	0	0	-22	0	37	0	37
Beaver	0	0	0	272	3233	272	1182	4143	1182	0	0	0	0	2961	0	-5921	0	-5921
Buffalo	294	341	293	0	0	0	3327	3375	3327	0	0	0	0	48	0	-96	0	-96
Driftwood	0	0	0	0	0	0	1479	1479	1479	0	0	0	0	0	0	0	0	0
Frenchman	39	2682	39	0	0	0	85179	87801	85123	0	28	0	56	2651	0	-5233	0	-5289
North Fork	14501	14499	14501	31	33	31	1302	1300	1302	0	0	0	0	0	0	0	0	0
Above Swanson	-1251	-1295	-1251	166	160	167	13837	13829	13834	0	0	0	0	0	0	57	0	55
Swanson - Harlan	0	0	0	96	0	0	33892	25370	16914	613	9117	613	16977	-48	0	17112	0	43
Harlan - Guide Rock	0	0	0	0	0	0	29142	29011	28873	198	331	198	269	0	0	268	0	0
Guide Rock - Hardy	0	0	0	177	174	178	2268	2273	2270	0	0	0	0	0	0	0	0	0
Medicine	0	0	0	0	0	0	20243	19986	19728	9533	9790	9533	514	0	0	514	0	0
Prairie Dog	0	0	0	1327	1327	1327	0	0	0	0	0	0	0	0	0	0	0	0
Red Willow	0	0	0	0	0	0	6446	6429	6412	25	42	25	34	0	0	34	0	0
Rock	57	72	57	0	0	0	3581	3597	3581	0	0	0	0	15	0	-30	0	-30
Sappa	0	0	0	-272	-133	-272	558	694	553	0	0	0	0	138	0	-271	0	-276
South Fork	11586	11839	11586	5723	5973	5724	1188	1316	1190	0	0	0	0	128	0	-632	0	-629
Hugh Butler	0	0	0	0	0	0	1772	1772	1772	0	0	0	0	0	0	0	0	0
Bonny	1343	1342	1343	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Keith Sebelius	0	0	0	496	496	496	0	0	0	0	0	0	0	0	0	0	0	0
Enders	0	0	0	0	0	0	4527	4529	4527	0	0	0	0	0	0	0	0	0
Harlan	0	0	0	34	30	35	778	775	781	15	13	15	0	0	0	0	0	0
Harry Strunk	0	0	0	0	0	0	359	361	360	0	0	0	0	0	0	0	0	0
Swanson	18	12	18	0	0	0	486	480	486	0	0	0	0	0	0	15	0	15
Mainstem	**-1261**	**-1307**	**-1259**	**441**	**343**	**350**	**79139**	**70482**	**61891**	**806**	**9440**	**806**	**17247**	**-43**	**0**	**17435**	**0**	**98**
Total	**26737**	**29645**	**26738**	**8372**	**11590**	**8283**	**211974**	**208924**	**194123**	**10386**	**19319**	**10386**	**17851**	**5868**	**0**	**5856**	**0**	**-12082**

Table 1y: 2005 (acre-feet/year)

Basin	CBCU_C			CBCU_K			CBCU_N			IWS			NE Residual			Basin Residual		
	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet
Arikaree	632	658	632	250	266	250	245	234	245	0	0	0	0	-11	0	-31	0	-31
Beaver	0	0	0	1633	3950	1633	2588	4906	2588	0	0	0	0	2318	0	-4634	0	-4634
Buffalo	309	384	309	0	0	0	3351	3426	3351	0	0	0	0	75	0	-149	0	-150
Driftwood	0	0	0	0	0	0	1481	1481	1481	0	0	0	0	0	0	0	0	0
Frenchman	52	2770	38	0	0	0	78056	80761	77999	0	28	0	58	2734	0	-5385	0	-5456
North Fork	14485	14479	14484	30	33	30	1303	1302	1303	0	0	0	0	0	0	0	0	0
Above Swanson	-1966	-1644	-1974	100	156	99	11005	11345	11003	0	0	0	0	342	0	-717	0	-729
Swanson - Harlan	-20	-21	0	53	-27	-51	39778	31914	24107	2055	9905	2055	15672	-43	0	15795	0	34
Harlan - Guide Rock	0	0	0	0	0	0	29037	28900	28763	216	351	216	274	0	0	287	0	0
Guide Rock - Hardy	11	0	0	212	205	211	2800	2801	2801	0	-11	0	0	0	0	13	0	0
Medicine	0	0	0	0	0	0	19884	19625	19365	9644	9902	9644	518	0	0	519	0	0
Prairie Dog	0	0	0	5263	5265	5264	0	0	0	0	0	0	0	0	0	0	0	0
Red Willow	0	0	0	0	0	0	6595	6581	6568	34	48	34	27	0	0	28	0	0
Rock	60	77	60	0	0	0	3745	3762	3745	0	0	0	0	17	0	-34	0	-35
Sappa	0	0	0	-1540	-193	-1583	703	2069	698	0	0	0	0	1361	0	-2703	0	-2751
South Fork	13755	13712	13753	7162	7091	7164	1348	1289	1349	0	0	0	0	-56	0	170	0	170
Hugh Butler	0	0	0	0	0	0	1708	1708	1708	0	0	0	0	0	0	0	0	0
Bonny	1274	1273	1274	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Keith Sebelius	0	0	0	510	510	510	0	0	0	0	0	0	0	0	0	0	0	0
Enders	0	0	0	0	0	0	4649	4650	4649	0	0	0	0	0	0	0	0	0
Harlan	0	0	0	32	30	33	858	857	863	17	14	17	0	0	0	0	0	0
Harry Strunk	0	0	0	0	0	0	316	316	317	0	0	0	0	0	0	0	0	0
Swanson	13	0	13	0	0	0	421	415	421	0	0	0	0	0	0	10	0	10
Mainstem	**-1966**	**-1662**	**-1979**	**371**	**333**	**266**	**82621**	**74960**	**66675**	**2261**	**10244**	**2261**	**15947**	**302**	**0**	**15379**	**0**	**-687**
Total	**28616**	**31700**	**28585**	**13722**	**17282**	**13577**	**209873**	**208344**	**193324**	**11962**	**20248**	**11962**	**16549**	**6734**	**0**	**3172**	**0**	**-13553**

Table 1z: 2006 (acre-feet/year)

Basin	CBCU_C			CBCU_K			CBCU_N			IWS			NE Residual			Basin Residual		
	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet
Arikaree	1018	1047	1019	141	164	141	122	120	122	0	0	0	0	0	0	-51	0	-50
Beaver	0	0	0	3127	4629	3127	3431	4933	3430	0	0	0	0	1502	0	-3004	0	-3004
Buffalo	323	399	322	0	0	0	3329	3405	3328	0	0	0	0	76	0	-152	0	-153
Driftwood	0	0	0	0	0	0	1422	1422	1421	0	0	0	0	0	0	0	0	0
Frenchman	35	2839	38	0	0	0	73667	76441	73612	0	31	0	55	2803	0	-5549	0	-5601
North Fork	14427	14424	14427	19	17	19	1233	1230	1233	0	0	0	0	0	0	0	0	0
Above Swanson	-3042	-2454	-3043	212	202	211	8945	9533	8944	0	0	0	0	589	0	-1167	0	-1169
Swanson - Harlan	0	-13	0	-109	-256	-1149	37549	30174	22061	2523	10421	2523	15488	215	0	15429	0	-1098
Harlan - Guide Rock	0	0	-18	0	0	0	26639	26500	26350	224	370	224	289	0	0	287	0	-16
Guide Rock - Hardy	0	0	-14	116	115	116	2341	2345	2339	-13	-11	-13	0	0	0	0	0	-12
Medicine	0	0	0	0	0	0	19116	18767	18418	9405	9754	9405	698	0	0	699	0	0
Prairie Dog	0	0	0	4978	4980	4979	0	0	0	0	0	0	0	0	0	0	0	0
Red Willow	0	0	0	0	0	0	6098	6080	6063	25	42	25	35	0	0	35	0	0
Rock	63	82	63	0	0	0	3845	3864	3845	0	0	0	0	19	0	-38	0	-38
Sappa	0	0	0	-1828	-59	-1979	1028	2871	1023	0	28	0	0	1820	0	-3584	0	-3739
South Fork	10560	10585	10555	4340	4350	4340	1023	1028	1026	0	0	0	0	0	0	-41	0	-43
Hugh Butler	0	0	0	0	0	0	1647	1647	1646	0	0	0	0	0	0	0	0	0
Bonny	1263	1262	1263	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Keith Sebelius	0	0	0	531	531	531	0	0	0	0	0	0	0	0	0	0	0	0
Enders	0	0	0	0	0	0	4624	4625	4624	0	0	0	0	0	0	0	0	0
Harlan	0	0	0	31	30	31	813	814	818	18	16	18	0	0	0	0	0	0
Harry Strunk	0	0	0	0	0	0	293	294	294	0	0	0	0	0	0	0	0	0
Swanson	14	12	14	0	0	0	373	370	373	0	0	0	0	0	0	0	0	0
Mainstem	**-3059**	**-2477**	**-3080**	**225**	**65**	**-816**	**75474**	**68551**	**59694**	**2733**	**10779**	**2733**	**15780**	**812**	**0**	**14547**	**0**	**-2295**
Total	**24648**	**28172**	**24623**	**11572**	**14712**	**10383**	**197536**	**196462**	**180973**	**12193**	**20654**	**12193**	**16564**	**7028**	**0**	**2871**	**0**	**-14907**

Table 2a: Average 1981- 2000 (acre-feet/year)

Basin	$CBCU_C$			$CBCU_K$			$CBCU_N$			IWS			NE Residual			Basin Residual		
	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet
Arikaree	1111	1133	1111	333	361	333	201	215	200	0	0	0	0	14	0	-64	0	-65
Beaver	0	0	0	5238	5651	5238	4631	5044	4630	0	0	0	0	413	0	-824	0	-826
Buffalo	123	186	123	0	0	0	2096	2158	2095	0	0	0	0	62	0	-125	0	-125
Driftwood	0	0	0	0	0	0	1076	1076	1076	0	0	0	0	0	0	0	0	0
Frenchman	661	1917	657	0	0	0	63167	64415	63145	0	0	0	21	1259	0	-2488	0	-2512
North Fork	10500	10497	10499	22	23	22	578	578	578	0	0	0	0	0	0	0	0	0
Above Swanson	-1755	-1442	-1755	190	210	191	9948	10268	9946	0	0	0	0	321	0	-652	0	-654
Swanson - Harlan	0	-12	0	-82	-102	-230	36228	33878	31423	8169	10597	8169	4805	27	0	4808	0	-145
Harlan - Guide Rock	0	0	0	0	0	0	18101	18066	18038	128	159	128	62	0	0	69	0	0
Guide Rock - Hardy	0	0	0	257	256	257	1562	1560	1564	0	0	0	0	0	0	0	0	0
Medicine	0	0	0	0	0	0	13150	13017	12888	7976	8107	7976	262	0	0	265	0	0
Prairie Dog	0	0	0	3915	3916	3915	0	0	0	0	0	0	0	0	0	0	0	0
Red Willow	0	0	0	0	0	0	4665	4661	4659	24	27	24	0	0	0	0	0	0
Rock	19	22	19	0	0	0	2136	2140	2135	0	0	0	0	0	0	0	0	0
Sappa	0	0	0	1021	1454	1014	2230	2667	2231	0	0	0	0	435	0	-869	0	-875
South Fork	9639	9722	9639	7339	7463	7339	784	858	782	0	0	0	0	76	0	-282	0	-283
Hugh Butler	0	0	0	0	0	0	1232	1232	1232	0	0	0	0	0	0	0	0	0
Bonny	962	962	962	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Keith Sebelius	0	0	0	509	509	509	0	0	0	0	0	0	0	0	0	0	0	0
Enders	0	0	0	0	0	0	2797	2797	2797	0	0	0	0	0	0	0	0	0
Harlan	0	0	0	36	32	36	821	817	821	0	0	0	0	0	0	0	0	0
Harry Strunk	0	0	0	0	0	0	194	195	195	0	0	0	0	0	0	0	0	0
Swanson	0	0	0	0	0	0	157	155	157	0	0	0	0	0	0	0	0	0
Mainstem	**-1754**	**-1456**	**-1755**	**365**	**363**	**217**	**65838**	**63771**	**60971**	**8294**	**10753**	**8294**	**4866**	**341**	**0**	**4228**	**0**	**-786**
Total	**21267**	**22986**	**21261**	**18779**	**19765**	**18627**	**165752**	**165796**	**160593**	**16303**	**18908**	**16303**	**5159**	**2598**	**0**	**-144**	**0**	**-5461**

Table 2b: Average 2001- 2006 (acre-feet/year)

Basin	$CBCU_C$			$CBCU_K$			$CBCU_N$			IWS			NE Residual			Basin Residual		
	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet
Arikaree	549	576	549	246	272	246	331	347	331	0	0	0	0	16	0	-70	0	-70
Beaver	0	0	0	1790	3947	1790	2118	4275	2117	0	0	0	0	2157	0	-4313	0	-4314
Buffalo	282	345	282	0	0	0	3276	3339	3275	0	0	0	0	63	0	-126	0	-126
Driftwood	0	0	0	0	0	0	1377	1378	1377	0	0	0	0	0	0	0	0	0
Frenchman	218	2730	216	0	0	0	78415	80908	78365	0	27	0	50	2519	0	-4976	0	-5028
North Fork	14152	14148	14152	27	27	27	1407	1405	1407	0	0	0	0	0	0	0	0	0
Above Swanson	-2754	-2210	-2756	110	164	111	12273	12836	12273	0	0	0	0	564	0	-1162	0	-1163
Swanson - Harlan	0	0	0	72	-64	-348	33579	26648	19563	3266	10339	3266	14016	12	0	14141	0	-292
Harlan - Guide Rock	0	0	0	0	0	0	27177	27051	26921	194	321	194	256	0	0	257	0	0
Guide Rock - Hardy	0	0	0	226	224	226	2184	2188	2187	0	0	0	0	0	0	0	0	0
Medicine	0	0	0	0	0	0	19131	18824	18517	9283	9589	9283	614	0	0	614	0	0
Prairie Dog	0	0	0	3004	3005	3004	0	0	0	0	0	0	0	0	0	0	0	0
Red Willow	0	0	0	0	0	0	6093	6078	6063	26	41	26	30	0	0	31	0	0
Rock	56	70	56	0	0	0	3517	3531	3517	0	0	0	0	14	0	-28	0	-28
Sappa	0	0	0	-887	-48	-927	726	1582	722	0	0	0	0	852	0	-1686	0	-1730
South Fork	11012	11214	11011	5794	6059	5794	1131	1314	1132	0	0	0	0	183	0	-651	0	-651
Hugh Butler	0	0	0	0	0	0	1704	1704	1704	0	0	0	0	0	0	0	0	0
Bonny	1282	1281	1282	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Keith Sebelius	0	0	0	495	495	495	0	0	0	0	0	0	0	0	0	0	0	0
Enders	0	0	0	0	0	0	4393	4394	4393	0	0	0	0	0	0	0	0	0
Harlan	0	0	0	36	31	36	842	839	845	14	12	14	0	0	0	0	0	0
Harry Strunk	0	0	0	0	0	0	319	320	320	0	0	0	0	0	0	0	0	0
Swanson	14	11	14	0	0	0	382	378	382	0	0	0	0	0	0	0	0	0
Mainstem	**-2761**	**-2218**	**-2765**	**413**	**326**	**0**	**75213**	**68723**	**60943**	**3452**	**10651**	**3452**	**14270**	**581**	**0**	**13233**	**0**	**-1459**
Total	**24805**	**28156**	**24795**	**10925**	**14113**	**10468**	**200374**	**199338**	**185409**	**12784**	**20333**	**12784**	**14964**	**6379**	**0**	**2045**	**0**	**-13385**

Table 2c: Average 1981- 2006 (acre-feet/year)

Basin	$CBCU_C$			$CBCU_K$			$CBCU_N$			IWS			NE Residual			Basin Residual		
	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet	RRCA	Jan09	NEnet
Arikaree	981	1005	981	313	341	313	231	246	230	0	0	0	0	15	0	-65	0	-66
Beaver	0	0	0	4442	5258	4442	4051	4866	4050	0	0	0	0	816	0	-1630	0	-1631
Buffalo	160	222	160	0	0	0	2368	2430	2368	0	0	0	0	63	0	-125	0	-125
Driftwood	0	0	0	0	0	0	1146	1146	1146	0	0	0	0	0	0	0	0	0
Frenchman	558	2105	555	0	0	0	66685	68221	66658	0	14	0	28	1550	0	-3062	0	-3093
North Fork	11343	11340	11342	23	24	23	770	769	769	0	0	0	0	0	0	0	0	0
Above Swanson	-1985	-1619	-1986	172	199	172	10484	10860	10483	0	0	0	0	377	0	-770	0	-771
Swanson - Harlan	0	-11	0	-47	-93	-257	35617	32209	28686	7038	10538	7038	6931	23	0	6962	0	-179
Harlan - Guide Rock	0	0	0	0	0	0	20195	20139	20088	143	197	143	107	0	0	113	0	0
Guide Rock - Hardy	0	0	0	250	248	250	1705	1705	1708	0	0	0	0	0	0	0	0	0
Medicine	0	0	0	0	0	0	14530	14358	14187	8278	8449	8278	343	0	0	346	0	0
Prairie Dog	0	0	0	3705	3705	3705	0	0	0	0	0	0	0	0	0	0	0	0
Red Willow	0	0	0	0	0	0	4995	4988	4983	24	30	24	12	0	0	13	0	0
Rock	27	33	27	0	0	0	2454	2461	2454	0	0	0	0	0	0	-12	0	-13
Sappa	0	0	0	580	1107	566	1883	2417	1883	0	0	0	0	531	0	-1058	0	-1072
South Fork	9956	10067	9955	6982	7139	6983	864	963	863	0	0	0	0	101	0	-367	0	-368
Hugh Butler	0	0	0	0	0	0	1341	1341	1341	0	0	0	0	0	0	0	0	0
Bonny	1036	1036	1036	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Keith Sebelius	0	0	0	506	506	506	0	0	0	0	0	0	0	0	0	0	0	0
Enders	0	0	0	0	0	0	3165	3166	3165	0	0	0	0	0	0	0	0	0
Harlan	0	0	0	36	32	36	825	822	826	0	0	0	0	0	0	0	0	0
Harry Strunk	0	0	0	0	0	0	223	223	224	0	0	0	0	0	0	0	0	0
Swanson	0	0	0	0	0	0	209	206	209	0	0	0	0	0	0	0	0	0
Mainstem	**-1986**	**-1632**	**-1988**	**376**	**354**	**166**	**68001**	**64914**	**60965**	**7177**	**10729**	**7177**	**7036**	**397**	**0**	**6306**	**0**	**-942**
Total	**22083**	**24179**	**22076**	**16967**	**18461**	**16744**	**173742**	**173536**	**166320**	**15491**	**19237**	**15491**	**7421**	**3470**	**0**	**361**	**0**	**-7290**