Engineering Committee Report

Republican River Compact Administration

August 24, 2016

EXECUTIVE SUMMARY

The Engineering Committee (EC) met four times since last August's Republican River Compact Administration (RRCA) Annual Meeting. Over the past year, the EC completed these assignments: 1) holding quarterly meetings and 2) exchanging information listed in Section V of the RRCA Accounting Procedures and Reporting Requirements, including all required data and documentation and 3) drafting a letter to the USGS to discuss finalized gage data by April 15 of each year.

Ongoing assignments include 1) continuing efforts to resolve concerns related to varying methods of estimating ground and surface water recharge and return flows and related issues, 2) continuing to finalize accounting for 2006-2015, 3) working to resolve issues preventing agreement on final accounting for 2006-2014, 4) discussing developing an application and approval process for future augmentation plans, 5) exploring options for sharing evaporation charges for Harlan County Lake, 6) Assign responsibility for collecting specific fields of data collected for the annual data exchange, 7) create a document memorializing when RRCA Accounting Procedures have changed over the years and incorporated it into the Accounting Procedures.

The EC recommends discussion by the RRCA on the exchange of data and documentation and the modeling runs completed by Principia Mathematica for 2015, discussion of Nebraska's proposal to revise the RRCA Accounting Procedures and Reporting Requirements, and the recommended EC assignments for the following year.

Details of the various EC tasks are described further in the remainder of this report, including as attachments, the EC meeting notes.

COMMITTEE ASSIGNMENTS AND WORK ACTIVITIES RELATED TO THESE ASSIGNMENTS

1. Meet quarterly to review the tasks assigned to the committee.
    a. Assignment completed.
    b. The EC held four meetings since the August 2015 RRCA Annual Meeting. Notes from the four EC meetings are attached: November 16, 2015 (Attachment 1), February 18, 2016 (Attachment 2), April 28, 2016 (Attachment 3), and July 7, 2016 (Attachment 4).
2. Exchange by April 15, 2016, the information listed in Section V of the RRCA Accounting Procedures and Reporting Requirements, and other data required by that

document, including all necessary documentation. By July 15, 2016, the states will exchange any updates to these data.

a. Assignment completed.

b. Kansas, Nebraska, and Colorado posted preliminary data by April 15, 2016. The status and details of the preliminary data exchange was discussed at the April 28 and July 7, 2016, EC meetings (Attachments 3 and 4). Nebraska posted final data on April 15, May 26, and July 7, 2016, and Kansas posted final data on June 8, 2016. The Colorado procedure for 2015 uses the metered pumping for those wells covered by the Metering Rules with acreage data from 2010. Wells without meter records in parts of two counties use average application rates from Kit Carson County along with the acreage associated with each well. Due to data availability issues Colorado's CIR based estimate of pumping was not distributed. The pumping estimate will be distributed when it is complete.

c. In advance of the July 2016 meeting, Willem Schreüder of Principia Mathematica executed the most recent model run for 2015 using full-year temperature and precipitation data, river data, and pipeline information. He also executed a preliminary model run for 2016 using temperature data, long-term average precipitation data, 2015 evaporation data, river data, and pipeline information. This information has been posted to the RRCA website.

d. The Committee continued to discuss updating documentation of the modeling processes. Principia Mathematica will continue to update the modeling process documentation. The write-up for the update will have two versions of the processing programs: 2001 to 2006 and 2007 skipping intermediate steps and describing the current version of the model (5 run).

3. When possible, continue efforts to resolve concerns related to varying methods of estimating ground and surface water irrigation recharge and return flows within the Republican River Basin and related issues.

    a. Assignment ongoing.

    b. Kansas is working on a scope and needs document for this task regarding changes in irrigation efficiency through time.

4. When possible, continue efforts to finalize accounting for 2006-2015.

    a. Assignment ongoing.

    b. The EC discussed and analyzed Schreüder's "SWinputs Spreadsheet" in order to determine the most suitable inputs for the years 1996-2015.

5. Work to resolve issues preventing agreement on final accounting for 2006-2015, as identified in the 2015 EC Report. These issues include:

    a. Kansas's request for beginning and ending meter data from other states.

        i. Assignment ongoing.

ii. Kansas is reviewing Colorado's annual meter data for 2015. Colorado's 2012, 2013, and 2014 meter data are now available on the RRCA website. As Colorado has no meter data older than 2012, Kansas is examining how the 2012-2015 data correspond with the 75 percent Crop Irrigation Requirement assumption.

b. Reaching consensus about how to model Bonny Reservoir.

i. Assignment ongoing.

ii. Kansas and Colorado discussed this issue in ongoing confidential conversations, the EC deferred discussion of this assignment.

6. Discuss any accounting changes that may be needed for surface water diversions for the purpose of recharging groundwater, as data become available from Nebraska projects.

a. Assignment ongoing.

b. Nebraska submitted a proposal for changes to the RRCA Accounting Procedures and Reporting Requirements document, which included changes to Attachment 7 of the document for Percent Field and Canal Loss that Returns to Stream for the Non-Irrigation Season. This proposal is available as Attachment A to the July 7 EC Minutes (Attachment 5). The EC discussed this proposal briefly at the July 7, 2016 meeting.

7. When possible, discuss developing an application and approval process for future augmentation plans.

a. Assignment not completed.

b. Due to ongoing consideration of this topic at Three-States meetings throughout the year, the EC deferred discussion of this assignment.

8. Continue to explore options for sharing evaporation charges for Harlan County Lake when accounts exist separate from the project water supplies of Bostwick Irrigation District and explore potential means to adjust the compact accounting of Harlan County Lake for the mutual benefit of the States.

a. Assignment not completed.

b. Kansas and Nebraska have discussed the issues related to calculating the incremental increase in reservoir arears, and they are close to being resolved. Discussion of these issues will continue at Three-States meetings.

9. Assign responsibility for collecting specific fields of data collected for the annual data exchange by determining who has the best available data and assigning them the responsibility of populating those fields in order to avoid confusion between multiple datasets.

a. Assignment ongoing.

b. The EC is utilizing the SWInputs Spreadsheet to collaborate and agree upon which source/state has the responsibility of populating data fields.

10. Draft a letter to the USGS to discuss how the RRCA can get finalized gage data by April 15 of each year.

a. Assignment complete.

b. The RRCA Chair drafted a letter dated February 24, 2016 to the USGS requesting timely gage data. A phone conversation took place on April 6, 2016 between RRCA staff and the USGS to field questions related to the request. A letter dated April 13, 2016 was received from USGS acknowledging their understanding of the request and agreeing to provide support. The RRCA chair replied by letter dated May 16, 2016 acknowledging the understanding that was reached and thanking the USGS. All letters are included with this report as Attachment 6.

11. Create a document memorializing when RRCA Accounting Procedures have changed over the years and incorporated it into the Accounting Procedures

    a. Assignment ongoing.

    b. Kansas is spearheading this document and the work has yielded a draft document that was presented to the EC during the July 7 meeting. The draft document is broken out into Accounting Procedure changes, Model Update and Resolution Action, and how the document is kept current.

OTHER COMMITTEE ACTIVITIES

1. Updates on the status of the development and review of RRCA annual reports for 2014, and 2015 were given by the states at each quarterly EC meeting.
2. Nebraska reminded the EC that moving forward only the Medicine Creek gage data would be maintained by Nebraska. The Beaver and Guide Rock gages were formerly maintained by Nebraska and will now be managed by the USGS.
3. The EC discussed Nebraska's 2016 water administration during each quarterly meeting. This is a Compact Call Year, but the N-CORPE and Rock Creek augmentation projects will provide water for the forecasted water shortage quantity.
4. Kansas suggested that the RRCA develop an administrative website that would be an informational page for the general public. Kansas has developed a draft to share with the EC for discussion and requested feedback from other states.
5. Nebraska has developed a new method for tracking non-federal reservoirs. The new method was described in a write-up prepared by Nebraska, dated November 13, 2015, and was discussed at the February 18th EC meeting. Kansas and Colorado agreed that the new methodology was suitable for use and Nebraska will continue to use the methodology for years 2013-present. This is included as Attachment #7.
6. The EC elected to form an ad hoc subcommittee between members of each state to discuss details surrounding the SWInputs spreadsheet and the origins of data populating said spreadsheet.

ITEMS FOR RRCA DISCUSSION & ACTION

Based upon the EC discussions and information presented in this report, the EC recommends RRCA discussion and potential action on the following items:

1. Agreement that the Data Exchange & Modeling Results for 2015 were performed. The EC has examined the data exchanged and the results from Principia Mathematica and agrees that the 2015 modeling runs are complete.
2. Discussion and direction on the specific modeling and data tasks to be assigned to Principia Mathematica for 2016.
3. Discussion of Nebraska's proposal to revise the RRCA Accounting Procedures and Reporting Requirements as well as Attachment 7 to account for non-irrigation season canal diversions intended for aquifer recharge purposes.
4. Discuss the continuation of efforts to draft and develop and RRCA administrative website that would be an informational page for the general public.
5. Discussion of the recommended EC assignments and other potential assignments for the next year and agreement on a final set of assignments. The EC presents the list of 12 items in this report as recommended assignments to report on at the 2017 annual meeting of the RRCA.

RECOMMENDED ASSIGNMENTS FOR THE COMING YEAR

The Engineering Committee recommends that the Republican River Compact Administration assign the following tasks:

1. Meet quarterly to review the tasks assigned to the committee.
2. Exchange by April 15, 2017, the information listed in Section V of the RRCA Accounting Procedures and Reporting Requirements, and other data required by that document, including all necessary documentation. By July 15, 2017, the states will exchange any updates to these data.
3. When possible, continue efforts to resolve concerns related to varying methods of estimating ground and surface water irrigation recharge and return flows within the Republican River Basin and related issues.
4. Continue efforts to finalize all accounting for years since 2006. Issues between the states currently include:
    a. Kansas's request for beginning and ending meter data from other states.
    b. Agreement on appropriate Surface Water Inputs.
    c. Reaching consensus on how to model Bonny Reservoir.
5. Continue work to assign responsibility for collecting specific fields of data collected for the annual data exchange by determining who has the best available data and assigning them the responsibility of populating those fields in order to avoid confusion between multiple datasets.

6. Continue work on creating a document memorializing when RRCA Accounting Procedures have changed over the years and incorporate it into the Accounting Procedures.
7. When possible discuss developing an application and approval process for future augmentation plans.
8. Continue to explore options for sharing evaporation charges for Harlan County Lake when accounts exist separate from the project water supplies of Bostwick Division and explore potential means to adjust the compact accounting of Harlan County Lake for the mutual benefit of the States.
9. Continue efforts to develop and publish an administrative website that would be an informational page for the general public.
10. By December 31, 2016 unify accounting procedures and reporting requirements approved by all RRCA resolutions including determining the appropriate model run or runs to be performed by Principia Mathmatica.
11. Continue work and provide future update on improving accounting tools developed by the Engineering Committee.

The Engineering Committee Report and the exchanged data will be posted on the web at www.republicanrivercompact.org.

SIGNED BY

Ivan Franco
Chair, Engineering Committee Member for Colorado

Jennifer J. Schellpeper
Engineering Committee Member for Nebraska

Chris Beightel
Engineering Committee Member for Kansas

Attachment 1

Final Meeting Notes for the
QUARTERLY MEETING of the
ENGINEERING COMMITTEE of the
REPUBLICAN RIVER COMPACT ADMINISTRATION
November 16th, 2015, 12:30 PM Mountain, 1:30 PM Central

Attendees:

Ivan Franco	Colorado	Chris Beightel	Kansas
Willem Schreuder	Principia Mathematica	Chelsea Erickson	Kansas
Jesse Bradley	Nebraska		
Michael Ou	Nebraska		
Carol Flaute	Nebraska		
Jennifer Schellpeper	Nebraska		
David Kracman	The Flatwater Group		
Chance Thayer	The Flatwater Group		

1. Introductions
2. Review/Modify Agenda
    a. No changes to the agenda
3. Publication of RRCA Annual Reports
    a. 2014 Reports (Nebraska)
        i. December 2013 Special - Documents under review with Colorado
        ii. August 2014 Annual – Documents under review with Colorado
    b. 2015 Reports (Nebraska)
        i. October 2014 – Documents under review with Kansas
        ii. November 2014 – Documents under review with Kansas
        iii. March 2015 – Being prepared by Nebraska
        iv. August 2015 Annual - Being prepared by Nebraska
4. Modeling and Data Tasks for Principia Mathematica
    a. Documentation
        i. No additional progress from Schreuder on this issue.
5. Non-Federal Reservoir Tracking (Nebraska)
    a. Previously Nebraska proposed to prepare a write-up of the methodology utilized in their quantification of Non-Federal Reservoirs. Bradley plans on distributing the methodology write up after the meeting.
6. Data Exchange
    a. 2014 Accounting
        i. Bradley noted that gross M&I pumping totals were included in the data exchange instead of net pumping. The updated net pumping numbers were submitted to Schreuder and were incorporated into a model update done October 20th.

b. 2015 Accounting
    i. Nebraska will continue to provide monthly updates moving forward. One more update likely before year's end. Schreuder noted that he is repeating pumping for 2014 in the 2015 and 2016 projections. Schreuder stated that if anyone has a suggestion for what they think is a better a way of making pumping estimates for 2015 and 2016, he is interested in hearing about it. Also, Schreuder noted that he runs preliminary accounting scenarios (html) on his website and inquired as to whether this would be of value to the other states.
    ii. Plan to make a request to USGS to report annual gage flow on calendar year rather than water year.
c. 2016 Accounting
    i. Schreuder would like to see a streamlined process considered.
d. Finalization of 2015 and previous years accounting
    i. List of issues preventing finalization of accounting – no change here
    ii. 1995-2014 accounting spreadsheet from Schreuder –
        1. Beightel noted that Kansas has looked at the data and staff has prepared follow up questions regarding some minor discrepancies.
        2. Bradley noted that Nebraska gauge data (Medicine Creek, Beaver Creek, Guide Rock), are all complete and final through 2013. Any discrepancies may be the result of confusion between older data and the finalized data.
        3. Moving forward Medicine Creek will be the only gauge Nebraska is operating (Bradley). The USGS will be operating the other two gauges (Beaver Creek, Guide Rock). The Nebraska data moving forward will be available on Nebraska's website. Schreuder asked whether he could automate the process of grabbing the data from the website. Bradley replied that it would be possible, but Schreuder would have to wait until Nebraska notified him that the data had been worked, so it would probably be easier for Nebraska to just send him the data.
        4. KS & NE staff are considering dividing the responsibility of data entry into the accounting spreadsheet. Schreuder will upload the latest version of the spreadsheet to the restricted part of the website so that the states can look at it while considering this suggestion.

7. Estimating Ground and Surface Water Irrigation Recharge and Return Flows
    a. Draft scope and needs document regarding changes in irrigation efficiency (Kansas)
        i. Kansas reports no further progress on this issue at this time.

8. Accounting changes for Nebraska Groundwater Recharge Project - Non-Irrigation Season Diversions
    a. Accounting change proposal (Nebraska)
        i. Nebraska plans on drafting new redlines for this proposal given the accounting procedure changes.
        ii. Beightel reiterated Kansas's concern that 18% of the canal loss may not be entirely due to evaporation. Some of it may be a timing issue related to leaky

canals. Kansas is seeking Nebraska staff's comments on the observation.

9. Future Augmentation Plans
    a. Ongoing discussions at Three-States Meetings
        i. This continues to be an item for discussion at the 3 states meeting.
        ii. Bradley provided an update on the N-CORPE project and noted that the project pumped 17,600 acre-feet for 2015. The projection is to pump 30,000 to 32,000 acre-feet for 2016 prior to June 1st. If the forecast holds, the total for 2016 will be close to 50,000 acre-feet.
        iii. Franco provided the CCP pumping goal of 11,000 acre-feet.

10. Harlan County Lake–Evaporation Charges and Compact Accounting Adjustments
    a. Examples for calculating the incremental increase in reservoir areas
        i. This issue has evolved out of the Engineering Committee, but may come into play later if there is a permanent Kansas account. Recommended to leave on the agenda for further discussion.
    b. Ongoing discussions at Three-States Meetings
        i. Bradley plans to distribute the Harlan County Lake agreements and provide Harlan County Lake split spreadsheet to Willem Schreuder. Schreuder noted that typically at the beginning of each month, precipitation data is updated and this is when the model is run. If Schreuder can get surface water projection updates from Nebraska at the same time, a more complete model run can be produced. Bradley and Schreuder agreed to work together to streamline the model updates.

11. Beginning and Ending Meter Data
    a. Review of Colorado Data (Kansas)
        i. Schreuder sent a comparison to Sam Perkins earlier in the year with Colorado's analysis and comparison of the meter data. Kansas will bring a proposal to the EC outlining Kansas's views on the 2012-2014 Colorado meter data.

12. Modeling Bonny Reservoir
    a. Kansas and Colorado discussions
        i. 3-States discussing – no update at this time.

13. Creating a New RRCA-oriented Website
    a. Draft administrative website (Kansas)
        i. Schreuder informed the group that had discussions with David Barfield and Chelsea Erickson regarding the structure of the public webpage and whether using Word Press to produce the page would be a viable option.
        ii. Beightel reminded the group that Kansas staff are producing the draft copy using WIX because they are less familiar with Word Press.
        iii. Erickson plans on recirculating a link to the draft website, and the issue will be considered further at the next meeting of the Engineering Committee.

14. Discuss annual data exchange and who has the best available data.
    a. Procedure for populating current year Surface Water inputs

i. Schreuder will circulate his stab at who he thinks should be providing surface water data sets. The group will review and discuss at a future meeting of the Engineering Committee.

15. Draft letter to the USGS to discuss finalization of gage data by April 15 of each year (Nebraska).
    a. Bradley has discussed this issue with Jason Lambrect (USGS). Lambrect indicated that finalizing the data sooner and working it throughout the year is not likely to be a problem; however, as the changes discussed have not yet been implemented, Bradley will reach out to Lambrect again to discuss this informally. In addition, Bradley will draft a letter to the USGS and circulate to the states for review. The group felt it would be most impactful if the letter were signed by the RRCA commissioners.
    b. Discuss assigning the USGS to provide gage flows by month (Willem)
        i. This issue is tied to the letter to the USGS.

16. Draft a document memorializing when and how RRCA Accounting Procedures have changed
    a. Erickson will review the background of this assignment for discussion at future Engineering Committee meetings.

17. Summary of Meeting Actions/Assignments
    a. Bradley will draft a letter to the USGS addressing the RRCA's need for a timely finalization of annual gauge data.
    b. Nebraska will provide a write-up on methodology of Non-Federal Reservoir Tracking.
    c. Kansas will provide a proposal on how 2012-2014 Colorado meter data should be used in the model runs for those years.
    d. Schreuder will distribute a version of his Surface Water spreadsheet with his opinion on who should be providing certain data.
    e. Schreuder will post a copy of the draft accounting spreadsheet to the website so everyone can evaluate whether the states want to start doing it as part of the model update process.
    f. Erickson will distribute the draft copy of the website prepared by Kansas.
    g. Erickson will review the background for memorializing how RRCA Accounting Procedures have changed in recent years.
    h. Kansas will provide a response to Nebraska's proposal to adjust the canal loss factor for winter operations.

18. Future Meeting Schedule
    a. The next meeting of the RRCA Engineering Committee is scheduled for Thursday February 18th, 2016, at 12:30 p.m. Mountain Time by telephone conference.

19. Adjournment
    a. The meeting adjourned at 1:50 p.m.

Attachment 2

Final Meeting Notes for the
QUARTERLY MEETING of the
ENGINEERING COMMITTEE of the
REPUBLICAN RIVER COMPACT ADMINISTRATION
February 18th, 2016, 12:30 PM Mountain, 1:30 PM Central

Attendees:

Ivan Franco	Colorado	Chance Thayer	The Flatwater Group
Willem Schreuder	Principia Mathematica	Chelsea Erickson	Kansas
Jesse Bradley	Nebraska	Chris Beightel	Kansas
Mahesh Pun	Nebraska		
Zablon Adane	Nebraska		
Kari Burgert	Nebraska		
Jennifer Schellpeper	Nebraska		
Kathy Benson	Nebraska		
David Kracman	The Flatwater Group		

1. Introductions
2. Review/Modify Agenda
    a. No changes to the agenda
3. Publication of RRCA Annual Reports
    a. 2014 Reports (Nebraska)
        i. December 2013 Special - Review complete by all states
        ii. August 2014 Annual – Review complete by all states
    b. 2015 Reports (Nebraska)
        i. October 2014 – Review complete by all states
        ii. November 2014 – Review complete by all states
        iii. March 2015 – transcripts out for review/ waiting on Colorado
        iv. August 2015 Annual - transcript sent out/ minutes going out soon
4. Modeling and Data Tasks for Principia Mathematica
    a. Documentation
        i. Willem made some progress since the last meeting and had the following question: In the re-run of the model from 2007 onward, Willem used the latest version of the processing program (5 run). He pointed out that interim versions of the model exist in which the North Fork accounting point was changed or the Rock creek gage was changed (etc.). He asked if it would be appropriate to document the 2007 version and current versions only, skipping the intermediate steps. It was requested that Willem send an email with his question for consideration by each state.
5. Non-Federal Reservoir Tracking (Nebraska)

a. Both Colorado and Kansas reviewed the documentation provided by Nebraska regarding the above topic and are comfortable with the methodology that is in place. Bradley, in response to a question, informed the group that this methodology was in place for the years 2014-2015 and likely 2013 as well. The issue is considered resolved.

6. Data Exchange
    a. 2014 Accounting – No pending issues/Resolved
    b. 2015 Accounting
        i. Schreuder pointed out that a recent 2015 preliminary run is posted to the website. He plans another run around the beginning of March.
    c. 2016 Accounting
        i. Schreuder is using data projections for the 2016 runs. It was noted that these projections will become more informative in the coming months. Nebraska will have more preliminary accounting data as the 2016 year progresses and will continue to provide monthly updates. Schreuder noted that he is interested in receiving Nebraska's next projection as soon as it is available.
        ii. Schreuder had a question about how Lovewell Reservoirs contribution is calculated in the accounting for Republican River versus White Rock Creek sources. Kansas will consider the question and provide information.
    d. Finalization of 2015 and previous years accounting
        i. List of issues preventing finalization of accounting
            1. No updates.
        ii. 1995-2014 accounting spreadsheet from Schreuder
            1. Kansas is fine with inputs through 2014 meaning that all states are now in agreement with 1995-2014 inputs. The states will discuss at a future meeting how to best formally approve the inputs.

7. Estimating Ground and Surface Water Irrigation Recharge and Return Flows
    a. Draft scope and needs document regarding changes in irrigation efficiency (Kansas)
        i. Kansas reports no further progress on this issue at this time. Beightel did indicate that Kansas has planned an internal meeting in early March to discuss this issue and others.

8. Accounting changes for Nebraska Groundwater Recharge Project - Non-Irrigation Season Diversions
    a. Accounting change proposal (Nebraska)
        i. Beightel inquired as to the volume of water Nebraska is considering each year. Bradley did not have an exact volume, but he did indicate that the diversions would only apply in years when Harlan County Lake is full so volumes might not be too great. An estimate of the recharge volume was approximately 2,000 acre-feet, with 10,000 acre-feet as a likely maximum. These volumes are the amounts estimated to infiltrating into the ground. Bradley noted that there aren't more than 120 days to operate recharge projects during the winter months.
        ii. Bradley suggested looking to the basin study for volumes that may have been projected as a possible reference.

iii. Beightel indicated that more direction on this topic from Kansas may be forthcoming after the March internal meeting.

9. Future Augmentation Plans
    a. Ongoing discussions at Three-States Meetings
        i. N-CORPE pumping totaled a little over 10,000 acre-feet during 2015 for 2016 compliance. The forecast is 46,000 in the red for 2016 with an understanding that 31,000 needs to be provided, including the carryover from 2015. The 31,000 will be provided by end of April. This forecast will be reassessed in the fall to see if additional pumping is required.
        ii. The plan for Colorado is to have a normal spring with regards to the CCP. A minimum of 4,000 acre-feet is expected by April 1st. As an early projection for 2016, Franco expects a total of 7,000 to be pumped.
        iii. Bradley provided a comment that the Platte River project is in the feasibility phase.
        iv. Beightel asked if the Rock Creek Augmentation project would be pumping in 2016. Bradley informed the group that the project would not operate during the spring of 2016 and it would depend on compliance requirements to determine if fall pumping was required.

10. Harlan County Lake–Evaporation Charges and Compact Accounting Adjustments
    a. Examples for calculating the incremental increase in reservoir areas
    b. Ongoing discussions at Three-States Meetings
        i. Both of these issues are part of the three state discussions and have evolved out of the Engineering Committee. The two issues may come into play later if there is a permanent Kansas account in Harlan County Lake. Recommended to leave on the agenda.

11. Beginning and Ending Meter Data
    a. Review of Colorado Data (Kansas)
        i. Colorado informed the group that 2015 meter data is in the process of being finalized and is expected to be available for release to the other states by the April 15th data exchange. Furthermore, the effort to amend the Republican River Measurement Rules has produced a result in that the new rules should go into effect April 1, 2016. This will bring about 350 well into the metering boundary.
        ii. Colorado is working internally to incorporate 2015 meter data into the ground water pumping estimates for Colorado. It is unclear at this time if that effort will be completed prior to the April 15th data exchange.

12. Modeling Bonny Reservoir
    a. Kansas and Colorado discussions
        i. This is part of the three state discussions with no update at this time.

13. Creating a New RRCA-oriented Website
    a. Draft administrative website (Kansas)
        i. Nebraska informed the group they were unable to fully review the draft but were planning on meeting internally with new staff members in the near future.

ii. Erickson will likely use GoDaddy software to build a polished draft for circulation. GoDaddy was utilized to build the Arkansas River Website and it seemed reasonable to continue its use, if possible. As a reminder it was pointed out that the previous draft was built using WIX.

14. Discuss annual data exchange and who has the best available data.
    a. Procedure for populating current year Surface Water inputs
        i. Schreuder color coded the spreadsheet for Surface Water Inputs, indicating each states responsibility. The three states will review and discuss at the next meeting.

15. Draft letter to the USGS to discuss finalization of gage data by April 15 of each year (Nebraska).
    a. Discuss assigning the USGS to provide gage flows by month (Willem)
        i. It was agreed that Franco would coordinate the final draft of the letter with Colorado's commissioner for discussion at the next three state meeting.

16. Draft a document memorializing when and how RRCA Accounting Procedures have changed
    a. A number of changes have taken place to both the approved accounting and model versions since 2010. These changes have been approved both with and without RRCA resolutions. Erickson is taking the lead on drafting a document noting the chain of events which lead to the current version of each.

17. Summary of Meeting Actions/Assignments
    a. Schreuder will email his question regarding model versions from 2007-2015 to the group for consideration.
    b. Beightel will provide an estimate of Lovewell operations for 2016.
    c. Erickson will work on putting together a draft document explaining accounting and modeling changes of the past few years.
    d. Erickson will put together a draft copy of the GoDaddy website.
    e. Franco will coordinate the finalization of the USGS letter.
    f. Kansas will provide a proposal on how 2012-2014 Colorado meter data should be used in the model runs for those years.
    g. Kansas will provide direction to Nebraska regarding what supplemental information would be helpful regarding the Ground Water Recharge Project.
    h. Franco will complete Colorado's review on the March 2015 meeting transcripts.

18. Future Meeting Schedule
    The next meeting of the RRCA Engineering Committee is scheduled for Thursday April 28th 2016, at 12:30 p.m. Mountain Time by telephone conference.
19. Adjournment
    a. The meeting adjourned at 1:36 p.m. MST.

Attachment 3

Final Meeting Notes for
QUARTERLY MEETING of the
ENGINEERING COMMITTEE of the
REPUBLICAN RIVER COMPACT ADMINISTRATION
April 28th, 2016, 12:30 PM Mountain, 1:30 PM Central

Attendees:

Ivan Franco	Colorado	Chance Thayer	The Flatwater Group
Willem Schreuder	Principia Mathematica	Jesse Bradley	The Flatwater Group
Jennifer Schellpeper	Nebraska	Chris Beightel	Kansas
Carol Flaute	Nebraska	Sam Perkins	Kansas
Kari Burgert	Nebraska	Honsheng Cho	Kansas
Kathy Benson	Nebraska	Chelsea Erickson	Kansas
Zablon Adane	Nebraska		
Mahesh Pun	Nebraska		

1. Introductions
2. Review/Modify Agenda
    a. One item added to the agenda:
        i. Discussion on how address issues caused by incorporating the 2016 Harlan County Lake Resolution into existing accounting.

3. Publication of RRCA Annual Reports
    a. 2015 Reports (Nebraska)
        i. October 2014 – Review complete by all states
        ii. November 2014 - Review complete by all states
        iii. March 2015 – transcript review complete by all states / minutes going out soon
        iv. August 2015 Annual – transcript sent out/ minutes going out soon

4. Modeling and Data Tasks for Principia Mathematica
    a. Documentation
        i. Schreuder continues to work on this task. No additional progress to report at this time.
        ii. Beightel requested that a new model run take the place of Dry Bonny/Kansas Method 3. The new model run will be Small Bonny/Kansas Method 3. Beightel requested that the new model run be applied moving forward and be retroactively applied to previous years runs.

5. Data Exchange
    a. 2015 Accounting
        i. Schreuder noted that he continues to have questions on Kansas and Nebraska surface water inputs that were provided in the April 15th data exchange. Schreuder noted that the data was in a different format and it was difficult to understand.

ii. In response to Beightel's question Bradley noted that surface and groundwater commingled acreage that were reported previously were no longer necessary, and this could account for some of the confusion. Additionally, a different method was used for acres primarily outside of the basin. It was agreed that a subcommittee, with a member from each state, would be formed to address these and other questions.

iii. Schreuder informed the group the 2010 acreage data was applied to the 2015 meter pumping. Colorado is working on putting together a 2015 acreage data set to apply to meter pumping. Schreuder also informed the group that the model calculates meter totals by cell, and the cells do not exactly line up to county boundaries. These results in county totals that do not exactly match the county geographic boundaries, however the totals are still useful for comparison purposes. Beightel noted that the acreage was higher by some 48,000 acres than in the previous year. Schreuder noted that an updated acreage for 2015 is being compiled and Colorado has taken steps to avoid double counting acres in the 2010 data set and is unsure the source of the additional acres.

b. 2016 Accounting

i. Schreuder believes he has the data necessary from each state for these calculations. However, he intends to discuss with the surface water subcommittee.

c. Finalization of 2015 and previous years accounting

i. List of issues preventing finalization of accounting

ii. 1995-2014 accounting spreadsheet from Schreuder

1. The group collectively discussed the appropriate method for formally accepting the Surface Water Input spreadsheet. It was agreed that attaching the Surface Water Spreadsheet to the Engineering Report prepared for the 2016 annual meeting would likely be sufficient.

6. Estimating Ground and Surface Water Irrigation Recharge and Return Flows

a. Draft scope and needs document regarding changes in irrigation efficiency (Kansas)

i. Beightel informed the group that work continues on this topic but did not have any further progress to report at this time.

7. Accounting changes for Nebraska Groundwater Recharge Project - Non-Irrigation Season Diversions

a. Accounting change proposal (Nebraska)

i. Kansas has revisited this issue and believes that the proposal is acceptable. However, Kansas would like to see an upper limit of 10,000 acre-feet on these types of projects incorporated into any resolution.

ii. Nebraska agreed to consider this limitation and respond at the following Engineering Committee meeting.

iii. Beightel mentioned that the 10,000 acre-foot number was included in the Republican Basin Study as an anticipated upper limit.

8. Future Augmentation Plans

a. Ongoing discussions at Three-States Meetings

i. The group did not feel the need to discuss this issue as an update on augmentation plan operations was recently provided by each state.

9. Harlan County Lake–Evaporation Charges and Compact Accounting Adjustments
    a. Examples for calculating the incremental increase in reservoir areas
    b. Ongoing discussions at Three-States Meetings
        i. Both of these issues are part of the three state discussions and have evolved out to of the Engineering Committee. The two issues may come into play later if there is a permanent Kansas account in Harlan County Lake. Recommended to leave on the agenda.

10. Beginning and Ending Meter Data
    a. Review of Colorado Data (Kansas)
        i. Franco noted that annual meter data for 2015 was distributed as part of the April 15th data exchange and that the meter data was incorporated into the model run.
        ii. Beightel indicated that Kansas is still working on reviewing the meter data for 2015.
        iii. Schreuder made the point that the pumping per acre was less than originally estimated but overall CIR vs Meter data has been pretty close for the years where meter data has been compiled. Specifically, the amount of pumping per acre in the CIR methodology and the applied meter data. Schreuder also noted that in the counties where meter data was not collected, an acre-foot per acre estimate was applied based on the nearest county.
        iv. Beightel pointed out that the acre-foot/acre estimate may be lower than actual values if the overall acreage needs to be reduced.

11. Modeling Bonny Reservoir
    a. Kansas and Colorado discussions
    b. This is part of the three state discussions with no update at this time.

12. Creating a New RRCA-oriented Website
    a. Draft administrative website (Kansas)
        i. Erickson notified the group that Kansas has created a GoDaddy account and discovered that additional software (website builder) is required at a cost. Kansas intends to purchase the software and work with each state in the development of the draft website. Erickson had a question about securing the domain name and it seemed likely that regardless of the domain name secured, Schreuder could route the address through the existing website.
        ii. Franco agreed to work with Erickson along with an, as of yet unnamed, representative from Nebraska on producing a polished draft of the website
        iii. Beightel noted that this initial work will have to lead to a discussion of operation cost and cost sharing among the states.

13. Discuss annual data exchange and who has the best available data.
    a. Procedure for populating current year Surface Water inputs
        i. Schreuder suggested discussing this topic with the subcommittee at a later date.

14. Draft letter to the USGS to discuss finalization of gage data by April 15 of each year (Nebraska).

a. Discuss assigning the USGS to provide gage flows by month (Willem)
    i. Franco informed the group that a phone conversation took place on April 6th with USGS staff to answer questions regarding the February 24, 2016 RRCA request letter. The USGS agreed to deliver data on a provisional level by the 5th of each month and final annual data by April 1st of each year. The USGS sent a letter dated April 13, 2016 confirming their understanding.
    ii. Beightel commented that the USGS response was unclear.
    iii. Franco will draft a letter in response, explicitly stating what the USGS would be providing, closing the loop on the matter.

15. Draft a document memorializing when and how RRCA Accounting Procedures have changed
    a. Erickson has completed a large portion of this work and is preparing to distribute to the group. Erickson had a question on how small of a change was too small to be included in the document. The group collectively agreed that including the data in question was appropriate but changes to preprocessors were too small of an issue to include.

16. Discussion on how address issues caused by incorporating the 2016 Harlan County Lake Resolution into existing accounting
    a. Schellpeper distributed two draft spread sheets showing the potential effects of implementing the 2016 HCL Resolution. It was noted that pumping intended to be credited towards the 2016 calendar year could take place in 2015 or 2017. The accounting sheets are designed to account for all pumping in each calendar year, thus requiring some change.
    b. Bradley noted that the group needed to come to an agreement on the proper way to account for Nebraska's augmentation pumping such that the accounting balance for 2015/2017 is unaffected by pumping during that year intended for 2016 use.
    c. Beightel asked if the depletions are accounted for in the actual year of pumping. Bradley confirmed that they did and no amendment to the depletions was being proposed.
    d. The group agreed to discuss the issue in further detail following the next three states meeting at the end of May.

17. Summary of Meeting Actions/Assignments
    a. Kansas and Nebraska will designate one or more people to participate in a subcommittee to discuss surface water data exchange issues (and other issues).
    b. Schreuder will work on incorporating a Small Bonny/Kansas Method 3 run to replace No Bonny/Kansas Method 3.
    c. Franco will draft a response letter to the USGS.
    d. Franco will investigate a meeting location for discussion after the three state meeting
    e. Nebraska will consider the 10,000 acre-foot limitation for Groundwater Recharge projects.
    f. Erickson will work with website subcommittee to produce in initial draft RRCA website.
    g. Erickson will distribute for review/input the draft document memorializing the RRCA Accounting changes.

18. Future Meeting Schedule

- The next meeting of the RRCA Engineering Committee is scheduled for July 7, 2016, at 12:30 P.M. MST by telephone conference.

19. Adjournment
    a. Adjourned at 1:45 p.m. MST

ATTACHMENT 4

Final Meeting Notes for
QUARTERLY MEETING of the
ENGINEERING COMMITTEE of the
REPUBLICAN RIVER COMPACT ADMINISTRATION
July 7th, 2016, 12:30 PM Mountain, 1:30 PM Central

Attendees:

Ivan Franco	Colorado	Chance Thayer	The Flatwater Group
Willem Schreuder	Principia Mathematica	Jesse Bradley	The Flatwater Group
Jennifer Schellpeper	Nebraska	Chris Beightel	Kansas
Mahesh Pun	Nebraska	Sam Perkins	Kansas
Kari Burgert	Nebraska	Chelsea Erickson	Kansas
Kathy Benson	Nebraska	David Barfield	Kansas
Zablon Adane	Nebraska	Craig Scott	USBR

1. Introductions
2. Review/Modify Agenda
    a. No changes to the agenda
3. Publication of RRCA Annual Reports
    a. 2015 Reports (Nebraska)
        i. October 2014 – Review complete by all states
        ii. November 2014 – Review complete by all states
        iii. March 2015 – transcripts reviewed by all states/ Minutes in preparation
        iv. August 2015 Annual – transcripts sent out/ minutes going out soon
4. Modeling and Data Tasks for Principia Mathematica
    a. Documentation
        i. Schreuder continues to work on this task. No additional progress to report at this time. Schreuder mentioned the likelihood of a final decision on modeling by the RRCA and the benefit of clearer direction for this task.
        ii. Beightel noted that his request for a Small Bonny/Kansas Method 3 model run had been completed by Schreuder. Beightel asked if the model files associated with those runs were available on the website. Schreuder informed Beightel that the model run files were located on the website under the data section for each year.
5. Data Exchange
    a. 2015 Accounting
        i. Schreuder acknowledged that the preliminary accounting on the website is not accurately calculating Canal Return per August 2015 revision to Attachment 7 for spills.

ii. Schreuder thanked Nebraska staff for providing input on the SWInputs spreadsheet by way of email on July 7, 2016. Schreuder asked if the notes referencing the data source for each column would be static. The consensus was that these notes would likely change somewhat from year to year.

iii. The group agreed that 2015 data was very close to being completely finalized but not quite there yet. For example, the stream gage data has some provisional data still being finalized by the USGS.

b. 2016 Accounting

i. Schreuder sent out his July 6, 2016 update with predicted 2016 model runs. The 2015 data is being used per the norm. The 2016 CCP pumping estimate will be refined in the coming months.

c. Finalization of 2015 and previous years accounting

i. List of issues preventing finalization of accounting

ii. 1995-2014 accounting spreadsheet from Schreuder

1. Franco discussed a number of points regarding the SWInputs spreadsheet. The intent of the spreadsheet is to create one source for accepted surface water inputs to the accounting. The extensive amount of data and recent input from each state has warranted another review of the data for acceptability. It was agreed that each state would continue to review the SWInputs spreadsheet for discussion at the annual meeting.
    a. Colorado, Nebraska and Kansas all anticipated having slight changes to the current version of the SWInputs spreadsheet. Schreuder committed to implementing the July 7, 2016 update and sending out another version to prevent confusion on which version is being reviewed.
2. Schreuder acknowledged that Sam Perkins provided an extensive number of spreadsheets as part of the subcommittee discussions. Schreuder is still considering what data acquisition changes might be helpful after reviewing the spreadsheets.
3. The group discussed previous years approved accounting and updating the SWInputs spreadsheet for these years. It was agreed that 2006 accounting had been approved and 2007 model inputs had been approved but not the accounting. The 5-run decision will necessitate an amended 2007 model run. The group did not come to a conclusion on updating the SWInput spreadsheet for the years with approved accounting.
4. Beightel asked how the data in the SWInputs spreadsheet was compiled by Schreuder. The methodology of creating the accounting page revolves around data base files which are created based on the individual variable names assigned in the SWInput spreadsheet. This allows the model to be run and the accounting to be updated in a streamlined process. Schreuder will be supplying the program on the website with the SWInput spreadsheet.

6. Estimating Ground and Surface Water Irrigation Recharge and Return Flows

   a. Draft scope and needs document regarding changes in irrigation efficiency (Kansas)
      i. Beightel informed the group that work continues on this topic but did not have any further progress to report at this time.

7. Accounting changes for Nebraska Groundwater Recharge Project - Non-Irrigation Season Diversions
   a. Accounting change proposal (Nebraska)
      i. On July 7, 2016 Nebraska emailed to each state a memorandum and attachments regarding the proposed changes to the Accounting Procedures for non-irrigation season canal recharge diversions. Given the group had not had any time to review the documents, it was agreed that this issue would be discussed at the Engineering Committee workshop at the annual meeting.

8. Future Augmentation Plans
   a. Ongoing discussions at Three-States Meetings
      i. The group did not feel the need to discuss at this time as the issue is ongoing at the Three-States meeting.

9. Harlan County Lake–Evaporation Charges and Compact Accounting Adjustments
   a. Examples for calculating the incremental increase in reservoir areas
   b. Ongoing discussions at Three-States Meetings
      i. Both of these issues are part of the Three-States discussions and have evolved out of the Engineering Committee. The two issues may come into play later if there is a permanent Kansas accounting for Harlan County Lake. This is recommended to leave on the agenda.

10. Beginning and Ending Meter Data
   a. Review of Colorado Data (Kansas)
      i. Kansas is still working on reviewing and proposing a potential use for the meter data for years where it is available.

11. Modeling Bonny Reservoir
   a. Kansas and Colorado discussions
      i. This is part of the Three-States discussions with no update at this time.

12. Creating a New RRCA-oriented Website
   a. Draft administrative website (Kansas)
      i. The domain name was purchased by Kansas and a preliminary draft, using Go Daddy software, was presented digitally. Erickson narrated a walkthrough of the draft for the benefit of Nebraska and Colorado. It was agreed that the draft site should not go live as of yet and Kansas would work on a way to allow each state to view the pages for comment.

13. Discuss annual data exchange and who has the best available data.
   a. Procedure for populating current year Surface Water inputs

i. Schreuder and the Surface Water subcommittee met on May 9, 2016 and have had no subsequent meetings. Schreuder pointed out that he received a large amount of data from the other states as a result of this meeting and is still sorting through it. The goal was to find a definitive source for all the data that was provided.

14. Draft letter to the USGS to discuss finalization of gage data by April 15 of each year (Nebraska).
    a. Agenda item complete. The letters will be attached to the final EC Report.

15. Draft a document memorializing when and how RRCA Accounting Procedures have changed
    a. Erickson's work on this matter has yielded a draft document. The document was presented digitally with David Barfield presenting a walkthrough of the four main sections. The document will be broken out into Accounting Procedure Changes, Model Updates and Resolution Actions, and how the document is kept current.
    b. There was some discussion surrounding the 5-run update and how that would be discussed in the document. The overall approach presented by Kansas was acknowledged by the other states as a reasonable way to handle the assignment. A more complete version of the document will be disseminated to Nebraska and Colorado for possible discussion at the annual meeting.

16. Summary of Meeting Actions/Assignments
    a. Kansas (and Colorado) will review the Groundwater Recharge proposal submitted by Nebraska on July 7, 2016.
    b. Erickson will distribute (or make available) the draft version of the website for comments, and look into a password protection option.
    c. An updated version of the SWInput sheet and accounting program will be posted by Schreuder and each state will review for potential future action.
    d. Nebraska and Colorado will review the draft document memorializing RRCA changes (when made available by Kansas).
    e. Franco will review the RRCA Rules and Regulations to determine notice requirements for Engineering Committee workshops.
    f. Franco will have a draft EC report ready for review no sooner than the first week of August.
    g. Franco will send out an amended save the date for the annual meeting.

17. Future Meeting Schedule
    - No future Engineering Committee meetings scheduled.
18. Adjournment
    a. Adjourned at about approximately 2 pm MST.

ATTACHMENT 5- Part 1 of 2

Attachment C

RESOLUTION OF THE REPUBLICAN RIVER COMPACT ADMINISTRATION

REGARDING REQUIRED CHANGES TO THE RRCA ACCOUNTING PROCEDURES AND REPORTING REQUIREMENTS REGARDING NON-IRRIGATION SEASON CANAL DIVERSIONS FOR GROUNDWATER RECHARGE PURPOSES

Whereas, the States of Kansas, Nebraska, and Colorado entered into a Final Settlement Stipulation ("FSS"_) as of December 15, 2002, to resolve pending litigation in the United States Supreme Court regarding the Republican River Compact ("Compact") in the case of *Kansas v. Nebraska and Colorado*, no. 126 Original;

Whereas, the FSS was approved by the United States Supreme Court on May 19, 2003;

Whereas, by memorandum dated May 14, 2015 and provided at the quarterly RRCA Engineering Committee Meeting on that same date, the state of Nebraska introduced the reformed RRCA Accounting Procedures and Reporting Requirements regarding non-irrigation season canal recharge diversions and the estimated percent loss assigned to those diversions.

Whereas, the proposed changes to the RRCA Accounting Procedures and Reporting Requirements shall be enacted for the accounting years 2016 and forward.

NOW THEREFORE BE IT RESOLVED , the Republican River Compact Administration approves and adopts the proposal set forth in Nebraska's May 14, 2015 memorandum, a copy of which is attached hereto as Exhibit A and incorporated as if the same were set forth fully herein with the exception of the following:

> *Provision*: Non-irrigation season canal recharge diversions shall be limited to 10,000 acre-feet. If canal recharge diversions exceed 10,000 acre-feet, the method established for irrigation season canal diversions shall apply.

Approved by the Republican River compact Administration this 27th day of August, 2015.

_____ _____

Gordon W. Fassett, P.E. Date
Nebraska Member

_____ _____

David Barfield, P.E. Date
Kansas Member

_____ _____

Dick Wolfe, P.E. Date
Colorado Member

ATTACHMENT 5 -Part 2 of 2

Nebraska Department of Natural Resources

DNR MEMO

DATE: July 7, 2016

TO: Jennifer Schellpeper

FROM: Kari Burgert

SUBJECT: Proposed Changes to the RRCA Accounting Procedures Documentation Regarding Attachment 7 of the August 27, 2015, RRCA Accounting Procedures and Reporting Requirements Document

Executive Summary

The purpose of this Memorandum is to provide documentation of the August 2015 RRCA Accounting Procedures and Reporting Requirements edited to suggest changes to non-irrigation season accounting and Attachment 7 in the document.

Proposed changes to Attachment 7 include editing the spreadsheet to adjust for the Estimated Percent Loss for Column 10 of the original attachment to 92% for diversion which take place during the Non-Irrigation period (October-April).

The following sections provide justification for the proposed changes to the RRCA Accounting Procedures documentation. For the proposed changes, editing the table to adjust for the Percent Field and Canal Loss That Returns to the Stream will result in additions to the specific formulas for each sub-basin and the main stem.

Attachment A of this Memorandum provides an example from the year 2009 using the proposed changes to Attachment 7. Attachment B contains the edited Republican River Compact Administration Accounting Procedures and Reporting Requirements (August 2015) with proposed changes for editing Attachment 7 for Percent Field and Canal Loss that Returns to Stream for the Non-Irrigation Season. Attachment C contains a draft resolution regarding the herein proposed edits.

Edits to Attachment 7 Regarding Column 10, "Percent Field and Canal Loss That Returns to the Stream"

In a previous Memorandum entitled "Documentation of Procedures Producing Charts Depicting Net Evaporation, with Executive Summary of Comparisons between Irrigation and Non-Irrigation Seasons or Months for Reservoirs along the Republican River" and summarized in the Memorandum entitled "Changes to the RRCA Accounting Procedures Documentation Including those Ordered by the U.S. Supreme Court and those Regarding Attachment 7 of the August 12, 2010 RRCA Accounting Procedures and Reporting Requirements Document," it was determined that during the Irrigation Season (May-September), much greater amounts of water are annually lost to evaporative effects than during the Non-

Irrigation Season (October-April). On an annual basis, an average ratio of Irrigation Season Evaporation to Non-Irrigation Season Evaporation was determined to be 70/30 after analyzing data for the 10-year period from 2004-2013.

Given that the current evaporation rate of 18% (Percent Field and Canal Loss That Returns to the Stream = 82%) applied in Column 10 of Attachment 7 of the RRCA Accounting Procedures document is a seasonal value normally used for diversion during the Irrigation season and that the ratio of Irrigation Season to Non-Irrigation Season is equal to 70/30, the following derivation can be implied to determine an appropriate value for the evaporation rate (1-Percent Field and Canal Loss That Returns to the Stream) during the Non-Irrigation Seasons.

Derivation of Non-Irrigation Season Evaporation Rate:

X = Irrigation Season Evaporation Rate (18%)
Y = Non-Irrigation Season Evaporation Rate (___%)
70/30 = Ratio of Irrigation Season to Non-Irrigation Season Evaporation Rates

Where,
X/Y = 70/30
And
Y = X / (70/30)

Therefore,
Y = 0.18/(70/30)
And simplifying,
Y = 0.077

From this derivation, it can be implied then that if Column 10 of Attachment 7 = 82% (1-0.18) for the Irrigation Season, Column 10 of Attachment 7 would then equal 92% (1-0.077) for the Non-Irrigation Season.

Calculations for each canal must then be broken down according to Irrigation Season diversions and Non-Irrigation Season diversion. For Non-Irrigation Season calculations, Column 5 “Field Deliveries” will always be zero, since water is not diverted for field use. As shown in the following example in Attachment B for the year 2009, we will assume a Canal Diversion value of 100 Ac-ft. SWW of 0 Ac-ft., Field Deliveries of 0 Ac-ft., and an Average Field Loss factor of (30%).

Because Column 5 is equal to zero, Column 6 “Canal Loss” will be equal to the original diversion amount minus Column 3 “Spill to Waste-way (SWW)”, and Column 8 “Field Loss” will be zero. Therefore, Column 9 “Total Loss from District” will be equal to the original diversion amount minus Column 3 “SWW”.

Then, Column 11 “Total Return to Stream from Canal and Field Loss” is equal to Column 9 “Total Loss from District” multiplied by the value present in Column 10 (92%) plus Column 3 “SWW.”

Finally, it is then implied that Column 12 “Return as Percent of Canal Diversion” (%BRF) will be equal to the Column 11 value divided by the original diversion amount. %BRF, or Percent of Diversion from Bureau Canals that returns to the Stream (Column 12), is the only value from Attachment 7 which is represented in §IV.B of the RRCA Accounting Procedures document. Therefore, the changes to Attachment 7 must be reflected when calculating the specific formulas for each sub-basin and the main stem. Edits to the formulas must be made to implement this data into the accounting process.

The following example formula from §IV.B #8 of the RRCA Accounting Procedures document for Frenchman Creek in Nebraska depicts the necessary formula additions need to calculate CBCU Nebraska.

> CBCU Nebraska = Culbertson Canal Diversion (IRR Season) x (1-%BRF) + Culbertson Canal Diversions (Non-IRR Season) x (1-92%) + Culbertson Extension (IRR Season) x (1-%BRF) + Culbertson Extension (Non-IRR Season) x (1-92%) + 0.6 x Champion Canal Diversion + 0.6 x Riverside Canal Diversion + 0.6 x Dn + % x Pn + 0.5 x M&In + EvNFRn + Enders Reservoir Ev + GWn

This correction should be applied to all CBCU Nebraska calculations for Sub-Basins and Main-Stem in §IV.B of the RRCA Accounting Procedures document.

A copy of the RRCA Accounting Procedures and Reporting Requirements (August 2015) document containing the proposed changes for editing Attachment 7 for Percent Field and Canal Loss that Returns to Stream for the Non-Irrigation Season can be found in Attachment B.

Conclusions and Final Documentation

Attachment A of this Memorandum provides an example from the year 2009 using the proposed changes to Attachment 7. Attachment B contains the edited Republican River Compact Administration Accounting Procedures and Reporting Requirements (August 2015) with proposed changes for editing Attachment 7 for Percent Field and Canal Loss that Returns to Stream for the Non-Irrigation Season. Attachment C contains a draft resolution regarding the herein proposed edits.

Attachment A

Attachment 7: Calculations of Return Flows from Bureau of Reclamation Canals

Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9	Col 10	Col 11	Col 12
Canal	Canal Diversion	Spill to Waste-way	Net Diversion	Field Deliveries	Canal Loss	Average Field Loss Factor	Field Loss	Total Loss from District	Percent field and Canal Loss That Returns to the Stream	Total return to Stream from Canal and Field Loss	Return as Percent of Canal Diversion
Name Canal ∑ Irrigation Season ∑ Non-Irrigation Season	Headgate Diversion	Sum of measured spills to river	Col 2 - Col 3	Sum of deliveries to the field	Col 4 – Col 5	1 – Weighted Average Efficiency of Application System for the District*	Col 5 x Col 7	Col 6 + Col 8	Estimated Percent Loss*	Col 9 x Col 10 + Col 3	Col 11 / Col 2
Example	100	5	95	60	35	30%	18	53	82%	48	48%
	100	5	95	0	95	30%	0	95	92%	87.4	87%
Culbertson						30%			82%		
						30%			92%		
Culbertson Extension						30%			82%		
						30%			92%		
Meeker - Driftwood	23,274		23,274	5,603	17,671	30%	1,681	19,352	82%	15,869	68%
	3,491	0	3,491	0	3,491	30%	0	3,491	92%	3,212	92%
Red Willow						30%			82%		
						30%			92%		
Bartley						30%			82%		
						30%			92%		
Cambridge						30%			82%		
						30%			92%		
Naponee						35%			82%		
						35%			92%		
Franklin						35%			82%		
						35%			92%		
Franklin Pump						35%			82%		
						35%			92%		
Almena						30%			82%		
Superior						31%			82%		
						31%			92%		
Nebraska Courtland						23%			82%		
Courtland Canal Above Lovewell (KS)						23%			82%		
Courtland Canal Below Lovewell						23%			82%		

*The average field efficiencies for each district and percent loss that returns to the stream may be reviewed and, if necessary, changed by the RRCA to improve the accuracy of the estimates.

Attachment B

Republican River Compact Administration

ACCOUNTING PROCEDURES AND

REPORTING REQUIREMENTS

Revised August 27, 2015

Table of Contents

Introduction

This document describes the definitions, procedures, basic formulas, specific formulas, and data requirements and reporting formats to be used by the RRCA to compute the Virgin Water Supply, Computed Water Supply, Allocations, Imported Water Supply Credit and Computed Beneficial Consumptive Use. These computations shall be used to determine supply, allocations, use and compliance with the Compact according to the Stipulation. These definitions, procedures, basic and specific formulas, data requirements and attachments may be changed by consent of the RRCA consistent with Subsection I.F of the Stipulation. This document will be referred to as the RRCA Accounting Procedures. Attached to these RRCA Accounting Procedures as Figure 1 is the map attached to the Compact that shows the Basin, its streams and the Basin boundaries.

II. Definitions

The following words and phrases as used in these RRCA Accounting Procedures are defined as follows:

Additional Water Administration Year - a year when the projected or actual irrigation water supply is less than 130,000 Acre-feet of storage available for use from Harlan County Lake as determined by the Bureau of Reclamation using the methodology described in the Harlan County Lake Operation Consensus Plan attached as Appendix K to the Stipulation.

Allocation(s): the water supply allocated to each State from the Computed Water Supply;

Annual: yearly from January 1 through December 31;

Basin: the Republican River Basin as defined in Article II of the Compact;

Beneficial Consumptive Use: that use by which the Water Supply of the Basin is consumed through the activities of man, and shall include water consumed by evaporation from any reservoir, canal, ditch, or irrigated area;

Change in Federal Reservoir Storage: the difference between the amount of water in storage in the reservoir on December 31 of each year and the amount of water in storage on December 31 of the previous year. The current area capacity table supplied by the appropriate federal operating agency shall be used to determine the contents of the reservoir on each date;

Compact: the Republican River Compact, Act of February 22, 1943, 1943 Kan. Sess. Laws 612, codified at Kan. Stat. Ann. § 82a-518 (1997); Act of February 24, 1943, 1943 Neb. Laws 377, codified at 2A Neb. Rev. Stat. App. § 1-106 (1995), Act of March 15, 1943, 1943 Colo. Sess. Laws 362, codified at Colo. Rev. Stat. §§ 37-67-101 and 37-67-102 (2001); Republican River Compact, Act of May 26, 1943, ch. 104, 57 Stat. 86;

Computed Beneficial Consumptive Use: for purposes of Compact accounting, the stream flow depletion resulting from the following activities of man:

Irrigation of lands in excess of two acres;
Any non-irrigation diversion of more than 50 Acre-feet per year;
Multiple diversions of 50 Acre-feet or less that are connected or otherwise combined to serve a single project will be considered as a single diversion for accounting purposes if they total more than 50 Acre-feet;
Net evaporation from Federal Reservoirs;
Net evaporation from Non-federal Reservoirs within the surface boundaries of the Basin;
Any other activities that may be included by amendment of these formulas by the RRCA;

Computed Water Supply: the Virgin Water Supply less the Change in Federal Reservoir Storage in any Designated Drainage Basin, and less the Flood Flows;

Designated Drainage Basins: the drainage basins of the specific tributaries and the Main Stem of the Republican River as described in Article III of the Compact. Attached hereto as Figure 3 is a map of the Sub-basins and Main Stem;

Dewatering Well: a Well constructed solely for the purpose of lowering the groundwater elevation;

Federal Reservoirs:

Bonny Reservoir
Swanson Lake
Enders Reservoir
Hugh Butler Lake
Harry Strunk Lake
Keith Sebelius Lake
Harlan County Lake
Lovewell Reservoir

Flood Flows: the amount of water deducted from the Virgin Water Supply as part of the computation of the Computed Water Supply due to a flood event as determined by the methodology described in Subsection III.B.1.;

Gaged Flow: the measured flow at the designated stream gage;

Guide Rock: a point at the Superior-Courtland Diversion Dam on the Republican River near Guide Rock, Nebraska; the Superior-Courtland Diversion Dam gage plus any flows through the sluice gates of the dam, specifically excluding any diversions to the Superior and Courtland Canals, shall be the measure of flows at Guide Rock;

Historic Consumptive Use: that amount of water that has been consumed under appropriate and reasonably efficient practices to accomplish without waste the purposes for which the appropriation or other legally permitted use was lawfully made;

Imported Water Supply: the water supply imported by a State from outside the Basin resulting from the activities of man;

Imported Water Supply Credit: the accretions to stream flow due to water imports from outside of the Basin as computed by the RRCA Groundwater Model. The Imported Water Supply Credit of a State shall not be included in the Virgin Water Supply and shall be counted as a credit/offset against the Computed Beneficial Consumptive Use of water allocated to that State, except as provided in Subsection V.B.2. of the Stipulation and Subsections III.I. – J. of these RRCA Accounting Procedures;

Main Stem: the Designated Drainage Basin identified in Article III of the Compact as the North Fork of the Republican River in Nebraska and the main stem of the Republican River between the junction of the North Fork and the Arikaree River and the lowest crossing of the river at the Nebraska-Kansas state line and the small tributaries thereof, and also including the drainage basin Blackwood Creek;

Main Stem Allocation: the portion of the Computed Water Supply derived from the Main Stem and the Unallocated Supply derived from the Sub-basins as shared by Kansas and Nebraska;

Meeting(s): a meeting of the RRCA, including any regularly scheduled annual meeting or any special meeting;

Modeling Committee: the modeling committee established in Subsection IV.C. of the Stipulation;

Moratorium: the prohibition and limitations on construction of new Wells in the geographic area described in Section III. of the Stipulation;

Non-federal Reservoirs: reservoirs other than Federal Reservoirs that have a storage capacity of 15 Acre-feet or greater at the principal spillway elevation;

Northwest Kansas: those portions of the Sub-basins within Kansas;

Replacement Well: a Well that replaces an existing Well that a) will not be used after construction of the new Well and b) will be abandoned within one year after such construction or is used in a manner that is excepted from the Moratorium pursuant to Subsections III.B.1.c.-f. of the Stipulation;

RRCA: Republican River Compact Administration, the administrative body composed of the State officials identified in Article IX of the Compact;

RRCA Accounting Procedures: this document and all attachments hereto;

RRCA Groundwater Model: the groundwater model developed under the provisions of Subsection IV.C. of the Stipulation and as subsequently adopted and revised through action of the RRCA;

State: any of the States of Colorado, Kansas, and Nebraska;

States: the States of Colorado, Kansas and Nebraska;

Stipulation: the Final Settlement Stipulation to be filed in *Kansas v. Nebraska and Colorado*, No. 126, Original, including all Appendices attached thereto;

Sub-basin: the Designated Drainage Basins, except for the Main Stem, identified in Article III of the Compact. For purposes of Compact accounting the following Sub-basins will be defined as described below:

North Fork of the Republican River in Colorado drainage basin is that drainage area above USGS gaging station number 06823000, North Fork Republican River at the Colorado-Nebraska State Line,

Arikaree River drainage basin is that drainage area above USGS gaging station number 06821500, Arikaree River at Haigler, Nebraska,

Buffalo Creek drainage basin is that drainage area above USGS gaging station number 06823500, Buffalo Creek near Haigler, Nebraska,

Rock Creek drainage basin is that drainage area above USGS gaging station number 06824000, Rock Creek at Parks, Nebraska,

South Fork of the Republican River drainage basin is that drainage area above USGS gaging station number 06827500, South Fork Republican River near Benkelman, Nebraska,

Frenchman Creek (River) drainage basin in Nebraska is that drainage area above USGS gaging station number 06835500, Frenchman Creek in Culbertson, Nebraska,

Driftwood Creek drainage basin is that drainage area above USGS gaging station number 06836500, Driftwood Creek near McCook, Nebraska,

Red Willow Creek drainage basin is that drainage area above USGS gaging station number 06838000, Red Willow Creek near Red Willow, Nebraska,

Medicine Creek drainage basin is that drainage area above the Medicine Creek below Harry Strunk Lake, State of Nebraska gaging station number 06842500; and the drainage area between the gage and the confluence with the Main Stem,

Sappa Creek drainage basin is that drainage area above USGS gaging station number 06847500, Sappa Creek near Stamford, Nebraska and the drainage area between the gage and the confluence with the Main Stem; and excluding the Beaver Creek drainage basin area downstream from the State of Nebraska gaging station number 06847000 Beaver Creek near Beaver City, Nebraska to the confluence with Sappa Creek,

Beaver Creek drainage basin is that drainage area above State of Nebraska gaging station number 06847000, Beaver Creek near Beaver City, Nebraska, and the drainage area between the gage and the confluence with Sappa Creek,

Prairie Dog Creek drainage basin is that drainage area above USGS gaging station number 06848500, Prairie Dog Creek near Woodruff, Kansas, and the drainage area between the gage and the confluence with the Main Stem;

Attached hereto as Figure 2 is a line diagram depicting the streams, Federal Reservoirs and gaging stations;

Test hole: a hole designed solely for the purpose of obtaining information on hydrologic and/or geologic conditions;

Trenton Dam: a dam located at 40 degrees, 10 minutes, 10 seconds latitude and 101 degrees, 3 minutes, 35 seconds longitude, approximately two and one-half miles west of the town of Trenton, Nebraska;

Unallocated Supply: the "water supplies of upstream basins otherwise unallocated" as set forth in Article IV of the Compact;

Upstream of Guide Rock, Nebraska: those areas within the Basin lying west of a line proceeding north from the Nebraska-Kansas state line and following the western edge of Webster County, Township 1, Range 9, Sections 34, 27, 22, 15, 10 and 3 through Webster County, Township 2, Range 9, Sections 34, 27 and 22; then proceeding west along the southern edge of Webster County, Township 2, Range 9, Sections 16, 17 and 18; then proceeding north following the western edge of Webster County, Township 2, Range 9, Sections 18, 7 and 6, through Webster County, Township 3, Range 9, Sections 31, 30, 19, 18, 7 and 6 to its intersection with the northern boundary of Webster County. Upstream of Guide Rock, Nebraska shall not include that area in Kansas east of the 99° meridian and south of the Kansas-Nebraska state line;

Virgin Water Supply: the Water Supply within the Basin undepleted by the activities of man;

Water Short Year Administration: administration in a year when the projected or actual irrigation water supply is less than 119,000 acre feet of storage available for use from Harlan County Lake as determined by the Bureau of Reclamation using the methodology described in the Harlan County Lake Operation Consensus Plan attached as Appendix K to the Stipulation.

Water Supply of the Basin or **Water Supply within the Basin:** the stream flows within the Basin, excluding Imported Water Supply;

Well: any structure, device or excavation for the purpose or with the effect of obtaining groundwater for beneficial use from an aquifer, including wells, water wells, or groundwater wells as further defined and used in each State's laws, rules, and regulations.

III. Basic Formulas

The basic formulas for calculating Virgin Water Supply, Computed Water Supply, Imported Water Supply, Allocations and Computed Beneficial Consumptive Use are set forth below. The results of these calculations shall be shown in a table format as shown in Table 1.

Basic Formulas for Calculating Virgin Water Supply, Computed Water Supply, Allocations and Computed Beneficial Consumptive Use		
Sub-basin VWS	=	Gage + All CBCU +ΔS – IWS
Main Stem VWS	=	Hardy Gage – Σ Sub-basin gages + All CBCU in the Main Stem +ΔS – IWS
CWS	=	VWS - Δ S – FF
Allocation for each State in each Sub-basin And Main Stem	=	CWS x %
State's Allocation	=	Σ Allocations for Each State
State's CBCU	=	Σ State's CBCUs in each Sub-basin and Main Stem

Abbreviations:

CBCU = Computed Beneficial Consumptive Use
FF = Flood Flows
Gage = Gaged Flow
IWS = Imported Water Supply Credit
CWS = Computed Water Supply
VWS = Virgin Water Supply

% = the ratio used to allocate the Computed Water Supply between the States. This ratio is based on the allocations in the Compact
ΔS = Change in Federal Reservoir Storage

A. Calculation of Annual Virgin Water Supply

1. Sub-basin calculation:

The annual Virgin Water Supply for each Sub-basin will be calculated by adding: a) the annual stream flow in that Sub-basin at the Sub-basin stream gage designated in Section II., b) the annual Computed Beneficial Consumptive Use above that gaging station, and c) the Change in Federal Reservoir Storage in that Sub-basin; and from that total subtract any Imported Water Supply Credit. The Computed Beneficial Consumptive Use will be calculated as described in Subsection III. D. Adjustments for flows diverted around stream gages and for Computed Beneficial Consumptive Uses in the Sub-basin between the Sub-basin stream gage and the confluence of the Sub-basin tributary and the Main Stem shall be made as described in Subsections III. D. 1 and 2 and IV. B.

2. Main Stem Calculation:

The annual Virgin Water Supply for the Main Stem will be calculated by adding: a) the flow at the Hardy gage minus the flows from the Sub-basin gages listed in Section II, b) the annual Computed Beneficial Consumptive Use in the Main Stem, and c) the Change in Federal Reservoir Storage from Swanson Lake and Harlan County Lake; and from that total subtract any Imported Water Supply Credit for the Main Stem. Adjustments for flows diverted around Sub-basin stream gages and for Computed Beneficial Consumptive Uses in a Sub-basin between the Sub-basin stream gage and the confluence of the Sub-basin tributary and the Mains Stem shall be made as described in Subsections III. D. 1 and 2 and IV.B.,

3. Imported Water Supply Credit Calculation:

The amount of Imported Water Supply Credit shall be determined by the RRCA Groundwater Model. The Imported Water Supply Credit of a State shall not be included in the Virgin Water Supply and shall be counted as a credit/offset against the Computed Beneficial Consumptive Use of water allocated to that State. Currently, the Imported Water Supply Credits shall be determined using two runs of the RRCA Groundwater Model:

a. The “base” run shall be the run with all groundwater pumping, groundwater pumping recharge, and surface water recharge within the model study

boundary for the current accounting year turned "on."

b. The "no NE import" run shall be the run with the same model inputs as the base run with the exception that surface water recharge associated with Nebraska's Imported Water Supply shall be turned "off." This will be the same "no NE import" run used to determine groundwater Computed Beneficial Consumptive Uses.

The Imported Water Supply Credit shall be the difference in stream flows between these two model runs. Differences in stream flows shall be determined at the same locations as identified in Subsection III.D.1.for the "no pumping" runs.
Should another State import water into the Basin in the future, the RRCA will develop a similar procedure to determine Imported Water Supply Credits.

B. Calculation of Computed Water Supply

On any Designated Drainage Basin without a Federal Reservoir, the Computed Water Supply will be equal to the Virgin Water Supply of that Designated Drainage Basin minus Flood Flows.

On any Designated Drainage Basin with a Federal Reservoir, the Computed Water Supply will be equal to the Virgin Water Supply minus the Change in Federal Reservoir Storage in that Designated Drainage Basin and minus Flood Flows.

1. Flood Flows

If in any calendar year there are five consecutive months in which the total actual stream flow[1] at the Hardy gage is greater than 325,000 Acre-feet, or any two consecutive months in which the total actual stream flow is greater than 200,000 Acre-feet, the annual flow in excess of 400,000 Acre-feet at the Hardy gage will be considered to be Flood Flows that will be subtracted from the Virgin Water Supply to calculate the Computed Water Supply, and Allocations. The Flood Flow in excess of 400,000 Acre-feet at the Hardy gage will be subtracted from the Virgin Water Supply of the Main Stem to compute the Computed Water Supply unless the Annual Gaged Flows from a Sub-basin were in excess of the flows shown for that Sub-basin in Attachment 1. These excess Sub-basin flows shall be considered to be Sub-basin Flood Flows.

If there are Sub-basin Flood Flows, the total of all Sub-basin Flood Flows shall be compared to the amount of Flood Flows at the Hardy gage. If the sum of the Sub-basin Flood Flows are in excess of the Flood Flow at the Hardy gage, the flows to

[1] These actual stream flows reflect Gaged Flows after depletions by Beneficial Consumptive Use and change in reservoir storage above the gage.

be deducted from each Sub-basin shall be the product of the Flood Flows for each Sub-basin times the ratio of the Flood Flows at the Hardy gage divided by the sum of the Flood Flows of the Sub-basin gages. If the sum of the Sub-basin Flood Flows is less than the Flood Flow at the Hardy gage, the entire amount of each Sub-basin Flood Flow shall be deducted from the Virgin Water Supply to compute the Computed Water Supply of that Sub-basin for that year. The remainder of the Flood Flows will be subtracted from the flows of the Main Stem.

C. Calculation of Annual Allocations

Article IV of the Compact allocates 54,100 Acre-feet for Beneficial Consumptive Use in Colorado, 190,300 Acre-feet for Beneficial Consumptive Use in Kansas and 234,500 Acre-feet for Beneficial Consumptive Use in Nebraska. The Compact provides that the Compact totals are to be derived from the sources and in the amounts specified in Table 2.

The Allocations derived from each Sub-basin to each State shall be the Computed Water Supply multiplied by the percentages set forth in Table 2. In addition, Kansas shall receive 51.1% of the Main Stem Allocation and the Unallocated Supply and Nebraska shall receive 48.9% of the Main Stem Allocation and the Unallocated Supply.

D. Calculation of Annual Computed Beneficial Consumptive Use

1. Groundwater

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 streamflows using two runs of the model:

The "no NE import" run shall be the run with all groundwater pumping, groundwater pumping recharge, and surface water recharge within the model study boundary for the current accounting year "on", with the exception that surface water recharge associated with Nebraska's Imported Water Supply shall be turned "off."

The "no State pumping" run shall be the run with the same model inputs as the "no NE import" 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 "no NE import" run and the "no-State- pumping" model run is assumed to be the depletions to streamflows.

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.

2. Surface Water

The Computed Beneficial Consumptive Use of surface water for irrigation and non-irrigation uses shall be computed by taking the diversions from the river and subtracting the return flows to the river resulting from those diversions, as described in Subsections IV.A.2.a.-d. The Computed Beneficial Consumptive Use of surface water from Federal Reservoir and Non-Federal Reservoir evaporation shall be the net reservoir evaporation from the reservoirs, as described in Subsections IV.A.2.e.-f.

For Sub-basins where the gage designated in Section II. is near the confluence with the Main Stem, each State's Sub-basin Computed Beneficial Consumptive Use of surface water shall be the State's Computed Beneficial Consumptive Use of surface water above the Sub-basin gage. For Medicine Creek, Sappa Creek, Beaver Creek and Prairie Dog Creek, where the gage is not near the confluence with the Main Stem, each State's Computed Beneficial Consumptive Use of surface water shall be the sum of the State's Computed Beneficial Consumptive Use of surface water above the gage, and its Computed Beneficial Consumptive Use of surface water between the gage and the confluence with the Main Stem.

E. Calculation to Determine Compact Compliance Using Five-Year Running Averages

Each year, using the procedures described herein, the RRCA will calculate the Annual Allocations by Designated Drainage Basin and total for each State, the Computed Beneficial Consumptive Use by Designated Drainage Basin and total for each State and the Imported Water Supply Credit that a State may use for the preceding year. These results for the current Compact accounting year as well as the results of the previous four accounting years and the five-year average of these results will be displayed in the format shown in Table 3.

F. Calculations To Determine Colorado's and Kansas's Compliance with the Sub-basin Non-Impairment Requirement

The data needed to determine Colorado's and Kansas's compliance with the Sub-basin non-impairment requirement in Subsection IV.B.2. of the Stipulation are shown in Tables 4.A. and B.

G. Calculations To Determine Projected Water Supply

1. Procedures to Determine Water Short Years

The Bureau of Reclamation will provide each of the States with a monthly or, if requested by any one of the States, a more frequent update of the projected or actual irrigation supply from Harlan County Lake for that irrigation season using the methodology described in the Harlan County Lake Operation Consensus Plan, attached as Appendix K to the Stipulation. The steps for the calculation are as follows:

Step 1. At the beginning of the calculation month (1) the total projected inflow for the calculation month and each succeeding month through the end of May shall be added to the previous end of month Harlan County Lake content and (2) the total projected 1993 level evaporation loss for the calculation month and each succeeding month through the end of May shall then be subtracted. The total projected inflow shall be the 1993 level average monthly inflow or the running average monthly inflow for the previous five years, whichever is less.

Step 2. Determine the maximum irrigation water available by subtracting the sediment pool storage (currently 164,111 Acre-feet) and adding the summer sediment pool evaporation (20,000 Acre-feet) to the result from Step 1.

Step 3. For October through January calculations, take the result from Step 2 and using the Shared Shortage Adjustment Table in Attachment 2 hereto, determine the preliminary irrigation water available for release. The calculation using the end of December content (January calculation month) indicates the minimum amount of irrigation water available for release at the end of May. For February through June calculations, subtract the maximum irrigation water available for the January calculation month from the maximum irrigation water available for the calculation month. If the result is negative, the irrigation water available for release (January calculation month) stays the same. If the result is positive the preliminary irrigation

water available for release (January calculation month) is increased by the positive amount.

Step 4. Compare the result from Step 3 to 119,000 Acre-feet. If the result from Step 3 is less than 119,000 Acre-feet Water Short Year Administration is in effect.

Step 5. The final annual Water-Short Year Administration calculation determines the total estimated irrigation supply at the end of June (calculated in July). Use the result from Step 3 for the end of May irrigation release estimate, add the June computed inflow to Harlan County Lake and subtract the June computed gross evaporation loss from Harlan County Lake.

2. Procedures to Determine 130,000 Acre Feet Projected Water Supply

To determine the preliminary irrigation supply for the October through June calculation months, follow the procedure described in steps 1 through 4 of the "Procedures to determine Water Short Years" Subsection III. G. 1. The result from step 4 provides the forecasted water supply, which is compared to 130,000 Acre-feet. For the July through September calculation months, use the previous end of calculation month preliminary irrigation supply, add the previous month's Harlan County Lake computed inflow and subtract the previous month's computed gross evaporation loss from Harlan County Lake to determine the current preliminary irrigation supply. The result is compared to 130,000 Acre-feet.

H. Calculation of Computed Water Supply, Allocations and Computed Beneficial Consumptive Use Above and Below Guide Rock During Water-Short Administration Years.

For Water-Short-Administration Years, in addition to the normal calculations, the Computed Water Supply, Allocations, Computed Beneficial Consumptive Use and Imported Water Supply Credits shall also be calculated above Guide Rock as shown in Table 5C. These calculations shall be done in the same manner as in non-Water-Short Administration years except that water supplies originating below Guide Rock shall not be included in the calculations of water supplies originating above Guide Rock. The calculations of Computed Beneficial Consumptive Uses shall be also done in the same manner as in non-Water-Short Administration years except that Computed Beneficial Consumptive Uses from diversions below Guide Rock shall not be included. The depletions from the water diverted by the Superior and Courtland Canals at the Superior-Courtland Diversion Dam shall be included in the calculations of Computed Beneficial Consumptive Use above Guide Rock. Imported Water Supply Credits above Guide Rock, as described in Sub-section III.I., may be used as offsets against the Computed Beneficial Consumptive Use above Guide Rock by the State providing the Imported Water Supply Credits.

The Computed Water Supply of the Main Stem reach between Guide Rock and the Hardy gage shall be determined by taking the difference in stream flow at Hardy and Guide Rock, adding Computed Beneficial Consumptive Uses in the reach (this does not include the Computed Beneficial Consumptive Use from the Superior and Courtland Canal diversions), and subtracting return flows from the Superior and Courtland Canals in the reach. The Computed Water Supply above Guide Rock shall be determined by subtracting the Computed Water Supply of the Main Stem reach between Guide Rock and the Hardy gage from the total Computed Water Supply. Nebraska's Allocation above Guide Rock shall be determined by subtracting 48.9% of the Computed Water Supply of the Main Stem reach between Guide Rock and the Hardy gage from Nebraska's total Allocation. Nebraska's Computed Beneficial Consumptive Uses above Guide Rock shall be determined by subtracting Nebraska's Computed Beneficial Consumptive Uses below Guide Rock from Nebraska's total Computed Beneficial Consumptive Use.

I. Calculation of Imported Water Supply Credits During Water-Short Year Administration Years.

Imported Water Supply Credit during Water-Short Year Administration years shall be calculated consistent with Subsection V.B.2.b. of the Stipulation.

The following methodology shall be used to determine the extent to which Imported Water Supply Credit, as calculated by the RRCA Groundwater Model, can be credited to the State importing the water during Water-Short Year Administration years.

1. Monthly Imported Water Supply Credits

The RRCA Groundwater Model will be used to determine monthly Imported Water Supply Credits by State in each Sub-basin and for the Main Stem. 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 1) above Harlan County Dam, 2) between Harlan County Dam and Guide Rock, and 3) between Guide Rock and the Hardy gage. The Imported Water Supply Credit shall be the difference in stream flow for two runs of the model: a) the "base" run and b) the "no State import" run.

During Water-Short Year Administration years, Nebraska's credits in the Sub-basins shall be determined as described in Section III. A. 3.

2. Imported Water Supply Credits Above Harlan County Dam

Nebraska's Imported Water Supply Credits above Harlan County Dam shall be the sum of all the credits in the Sub-basins and the Main Stem above Harlan County Dam.

3. Imported Water Supply Credits Between Harlan County Dam and Guide Rock During the Irrigation Season

a. During Water-Short Year Administration years, monthly credits in the reach between Harlan County Dam and Guide Rock shall be determined as the differences in the stream flows between the two runs at Guide Rock.

b. The irrigation season shall be defined as starting on the first day of release of water from Harlan County Lake for irrigation use and ending on the last day of release of water from Harlan County Lake for irrigation use.

c. Credit as an offset for a State's Computed Beneficial Consumptive Use above Guide Rock will be given to all the Imported Water Supply accruing in the reach between Harlan County Dam and Guide Rock during the irrigation season. If the period of the irrigation season does not coincide with the period of modeled flows, the amount of the Imported Water Supply credited during the irrigation season for that month shall be the total monthly modeled Imported Water Supply Credit times the number of days in the month occurring during the irrigation season divided by the total number of days in the month.

4. Imported Water Supply Credits Between Harlan County Dam and Guide Rock During the Non-Irrigation Season

a. Imported Water Supply Credit shall be given between Harlan County Dam and Guide Rock during the period that flows are diverted to fill Lovewell Reservoir to the extent that imported water was needed to meet Lovewell Reservoir target elevations.

b. Fall and spring fill periods shall be established during which credit shall be given for the Imported Water Supply Credit accruing in the reach. The fall period shall extend from the end of the irrigation season to December 1. The spring period shall extend from March 1 to May 31. The Lovewell target elevations for these fill periods are the projected end of November reservoir level and the projected end of May reservoir level for most

probable inflow conditions as indicated in Table 4 in the current Annual Operating Plan prepared by the Bureau of Reclamation.

c. The amount of water needed to fill Lovewell Reservoir for each period shall be calculated as the storage content of the reservoir at its target elevation at the end of the fill period minus the reservoir content at the start of the fill period plus the amount of net evaporation during this period minus White Rock Creek inflows for the same period.

d. If the fill period as defined above does not coincide with the period of modeled flows, the amount of the Imported Water Supply Credit during the fill period for that month shall be the total monthly modeled Imported Water Supply Credit times the number of days in the month occurring during the fill season divided by the total number of days in the month.

e. The amount of non-imported water available to fill Lovewell Reservoir to the target elevation shall be the amount of water available at Guide Rock during the fill period minus the amount of the Imported Water Supply Credit accruing in the reach during the same period.

f. The amount of the Imported Water Supply Credit that shall be credited against a State's Consumptive Use shall be the amount of water imported by that State that is available in the reach during the fill period or the amount of water needed to reach Lovewell Reservoir target elevations minus the amount of non-imported water available during the fill period, whichever is less.

5. Other Credits

Kansas and Nebraska will explore crediting Imported Water Supply that is otherwise useable by Kansas.

J. Calculations of Compact Compliance in Water-Short Year Administration Years

During Water-Short Year Administration, using the procedures described in Subsections III.A-D, the RRCA will calculate the Annual Allocations for each State, the Computed Beneficial Consumptive Use by each State, and Imported Water Supply Credit that a State may use to offset Computed Beneficial Consumptive Use in that year. The resulting annual and average values will be calculated as displayed in Tables 5 A-C and E.

If Nebraska is implementing an Alternative Water-Short-Year Administration Plan, data to determine Compact compliance will be shown in Table 5D. Nebraska's compliance with the Compact will be determined in the same manner as Nebraska's Above Guide Rock

compliance except that compliance will be based on a three-year running average of the current year and previous two year calculations. In addition, Table 5 D. will display the sum of the previous two-year difference in Allocations above Guide Rock and Computed Beneficial Consumptive Uses above Guide Rock minus any Imported Water Credits and compare the result with the Alternative Water-Short-Year Administration Plan's expected decrease in Computed Beneficial Consumptive Use above Guide Rock. Nebraska will be within compliance with the Compact as long as the three-year running average difference in Column 8 is positive and the sum of the previous year and current year deficits above Guide Rock are not greater than the expected decrease in Computed Beneficial Consumptive Use under the plan.

IV. **Specific Formulas**

A. Computed Beneficial Consumptive Use

1. Computed Beneficial Consumptive Use of Groundwater:

The Computed Beneficial Consumptive Use caused by groundwater diversion shall be determined by the RRCA Groundwater Model as described in Subsection III.D.1.

2. Computed Beneficial Consumptive Use of Surface Water:

The Computed Beneficial Consumptive Use of surface water shall be calculated as follows:

a) Non-Federal Canals

Computed Beneficial Consumptive Use from diversions by non- federal canals shall be 60 percent of the diversion; the return flow shall be 40 percent of the diversion

b) Individual Surface Water Pumps

Computed Beneficial Consumptive Use from small individual surface water pumps shall be 75 percent of the diversion; return flows will be 25 percent of the diversion unless a state provides data on the amount of different system types in a Sub-basin, in which case the following percentages will be used for each system type:

Gravity Flow. 30%

Center Pivot	17%
LEPA	10%

c) Federal Canals

Computed Beneficial Consumptive Use of diversions by Federal canals will be calculated as shown in Attachment 7. For each Bureau of Reclamation Canal the field deliveries shall be subtracted from the diversion from the river to determine the canal losses. The field delivery shall be multiplied by one minus an average system efficiency for the district to determine the loss of water from the field. Eighty-two percent of the sum of the field loss plus the canal loss shall be considered to be the return flow from the canal diversion for diversions occurring during the irrigation season (May-September). For recharge diversions occurring during the non-irrigation season (October-April), 92 percent of the sum of the field loss plus the canal loss shall be considered to be the return flow from the canal diversion. The assumed field efficiencies and the amount of the field and canal loss that reaches the stream may be reviewed by the RRCA and adjusted as appropriate to insure their accuracy.

d) Non-irrigation Uses

Any non-irrigation uses diverting or pumping more than 50 acre-feet per year will be required to measure diversions. Non-irrigation uses diverting more than 50 Acre-feet per year will be assessed a Computed Beneficial Consumptive Use of 50% of what is pumped or diverted, unless the entity presents evidence to the RRCA demonstrating a different percentage should be used.

e) Evaporation from Federal Reservoirs

Net Evaporation from Federal Reservoirs will be calculated as follows:

(1) Harlan County Lake, Evaporation Calculation

April 1 through October 31:

Evaporation from Harlan County Lake is calculated by the Corps of Engineers on a daily basis from April 1 through October 31. Daily readings are taken from a Class A evaporation pan maintained near the project office. Any precipitation recorded at the project office is added to the pan reading to obtain the actual evaporation amount.

The pan value is multiplied by a pan coefficient that varies by month. These values are:

March	.56
April	.52
May	.53
June	.60
July	.68
August	.78
September	.91
October	1.01

The pan coefficients were determined by studies the Corps of Engineers conducted a number of years ago. The result is the evaporation in inches. It is divided by 12 and multiplied by the daily lake surface area in acres to obtain the evaporation in Acre-feet. The lake surface area is determined by the 8:00 a.m. elevation reading applied to the lake's area-capacity data. The area-capacity data is updated periodically through a sediment survey. The last survey was completed in December 2000.

November 1 through March 31

During the winter season, a monthly total evaporation in inches has been determined. The amount varies with the percent of ice cover. The values used are:

HARLAN COUNTY LAKE

Estimated Evaporation in Inches
Winter Season -- Monthly Total

PERCENTAGE OF ICE COVER

	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
JAN	0.88	0.87	0.85	0.84	0.83	0.82	0.81	0.80	0.78	0.77	0.76
FEB	0.90	0.88	0.87	0.86	0.85	0.84	0.83	0.82	0.81	0.80	0.79
MAR	1.29	1.28	1.27	1.26	1.25	1.24	1.23	1.22	1.21	1.20	1.19
OCT	4.87			NO ICE							
NOV	2.81			NO ICE							
DEC	1.31	1.29	1.27	1.25	1.24	1.22	1.20	1.18	1.17	1.16	1.14

The monthly total is divided by the number of days in the month

to obtain a daily evaporation value in inches. It is divided by 12 and multiplied by the daily lake surface area in acres to obtain the evaporation in Acre-feet. The lake surface area is determined by the 8:00 a.m. elevation reading applied to the lake's area-capacity data. The area-capacity data is updated periodically through a sediment survey. The last survey was completed in December 2000.

To obtain the net evaporation, the monthly precipitation on the lake is subtracted from the monthly gross evaporation. The monthly precipitation is calculated by multiplying the sum of the month's daily precipitation in inches by the average of the end of the month lake surface area for the previous month and the end of the month lake surface area for the current month in acres and dividing the result by 12 to obtain the precipitation for the month in acre feet.

The total annual net evaporation (Acre-feet) will be charged to Kansas and Nebraska in proportion to the annual diversions made by the Kansas Bostwick Irrigation District and the Nebraska Bostwick Irrigation District during the time period each year when irrigation releases are being made from Harlan County Lake. For any year in which no irrigation releases were made from Harlan County Lake, the annual net evaporation charged to Kansas and Nebraska will be based on the average of the above calculation for the most recent three years in which irrigation releases from Harlan County Lake were made. In the event Nebraska chooses to substitute supply for the Superior Canal from Nebraska's allocation below Guide Rock in Water-Short Year Administration years, the amount of the substitute supply will be included in the calculation of the split as if it had been diverted to the Superior Canal at Guide Rock.

(2) Evaporation Computations for Bureau of Reclamation Reservoirs

The Bureau of Reclamation computes the amount of evaporation loss on a monthly basis at Reclamation reservoirs. The following procedure is utilized in calculating the loss in Acre-feet.

An evaporation pan reading is taken each day at the dam site. This measurement is the amount of water lost from the pan over a 24-hour period in inches. The evaporation pan reading is adjusted for any precipitation recorded during the 24-hour period. Instructions for determining the daily pan evaporation are found in the "National Weather Service Observing Handbook No. 2 – Substation Observations." All dams located in the Kansas River Basin with the exception of Bonny Dam are National Weather Service Cooperative

Observers. The daily evaporation pan readings are totaled at the end of each month and converted to a "free water surface" (FWS) evaporation, also referred to as "lake" evaporation. The FWS evaporation is determined by multiplying the observed pan evaporation by a coefficient of .70 at each of the reservoirs. This coefficient can be affected by several factors including water and air temperatures. The National Oceanic and Atmospheric Administration (NOAA) has published technical reports describing the determination of pan coefficients. The coefficient used is taken from the "NOAA Technical Report NWS 33, Map of coefficients to convert class A pan evaporation to free water surface evaporation". This coefficient is used for the months of April through October when evaporation pan readings are recorded at the dams. The monthly FWS evaporation is then multiplied by the average surface area of the reservoir during the month in acres. Dividing this value by twelve will result in the amount of water lost to evaporation in Acre-feet during the month.

During the winter months when the evaporation pan readings are not taken, monthly evaporation tables based on the percent of ice cover are used. The tables used were developed by the Corps of Engineers and were based on historical average evaporation rates. A separate table was developed for each of the reservoirs. The monthly evaporation rates are multiplied by the .70 coefficient for pan to free water surface adjustment, divided by twelve to convert inches to feet and multiplied by the average reservoir surface area during the month in acres to obtain the total monthly evaporation loss in Acre-feet.

To obtain the net evaporation, the monthly precipitation on the lake is subtracted from the monthly gross evaporation. The monthly precipitation is calculated by multiplying the sum of the month's daily precipitation in inches by the average of the end of the month lake surface area for the previous month and the end of the month lake surface area for the current month in acres and dividing the result by 12 to obtain the precipitation for the month in acre feet.

f) Non-Federal Reservoir Evaporation:

For Non-Federal Reservoirs with a storage capacity less than 200 Acre-feet, the presumptive average annual surface area is 25% of the area at the principal spillway elevation. Net evaporation for each such Non-Federal Reservoir will be calculated by multiplying the presumptive average annual surface area by the net evaporation from the nearest climate and evaporation

station to the Non-Federal Reservoir. A State may provide actual data in lieu of the presumptive criteria.

Net evaporation from Non-Federal Reservoirs with 200 Acre-feet of storage or greater will be calculated by multiplying the average annual surface area (obtained from the area-capacity survey) and the net evaporation from the nearest evaporation and climate station to the reservoir. If the average annual surface area is not available, the Non-Federal Reservoirs with 200 Acre-feet of storage or greater will be presumed to be full at the principal spillway elevation.

B. Specific Formulas for Each Sub-basin and the Main Stem

All calculations shall be based on the calendar year and shall be rounded to the nearest 10 Acre-feet using the conventional rounding formula of rounding up for all numbers equal to five or higher and otherwise rounding down.

Abbreviations:
CBCU = Computed Beneficial Consumptive Use
CWS = Computed Water Supply
D = Non-Federal Canal Diversions for Irrigation
Ev = Evaporation from Federal Reservoirs
EvNFR = Evaporation from Non-Federal Reservoirs
FF = Flood Flow
GW = Groundwater Computed Beneficial Consumptive Use (includes irrigation and non-irrigation uses)
IWS = Imported Water Supply Credit from Nebraska
M&I = Non-Irrigation Surface Water Diversions (Municipal and Industrial)
P = Small Individual Surface Water Pump Diversions for Irrigation
RF = Return Flow
VWS = Virgin Water Supply
c = Colorado
k = Kansas
n = Nebraska
ΔS = Change in Federal Reservoir Storage
% = Average system efficiency for individual pumps in the Sub-basin
% BRF = Percent of Diversion from Bureau Canals that returns to the stream
= Value expected to be zero

3. North Fork of Republican River in Colorado [2]

CBCU Colorado = 0.6 x Haigler Canal Diversion Colorado + 0.6 x Dc + % x Pc + 0.5 x M&Ic + EvNFRc + GWc

CBCU Kansas = GWk

CBCU Nebraska = 0.6 x Haigler Canal Diversion Nebraska + GWn

Note: The diversion for Haigler Canal is split between Colorado and Nebraska based on the percentage of land irrigated in each state

VWS = North Fork of the Republican River at the State Line, Stn. No. 06823000 + CBCUc + CBCUk + CBCUn + Nebraska Haigler Canal RF– IWS

Note: The Nebraska Haigler Canal RF returns to the Main Stem

CWS = VWS - FF

Allocation Colorado = 0.224 x CWS

Allocation Nebraska = 0.246 x CWS

Unallocated = 0.53 x CWS

4. Arikaree River [2]

CBCU Colorado = 0.6 x Dc + % x Pc + 0.5 x M&Ic + EvNFRc + GWc

CBCU Kansas = 0.6 x Dk + % x Pk + 0.5 x M&Ik + EvNFRk + GWk

CBCU Nebraska = 0.6 x Dn + % x Pn + 0.5 x M&In + EvNFRn + GWn

VWS = Arikaree Gage at Haigler Stn. No. 06821500 + CBCUc + CBCUk + CBCUn – IWS

[2] The RRCA will investigate whether return flows from the Haigler Canal diversion in Colorado may return to the Arikaree River, not the North Fork of the Republican River, as indicated in the formulas. If there are return flows from the Haigler Canal to the Arikaree River, these formulas will be changed to recognize those returns.

CWS = VWS - FF

Allocation Colorado = 0.785 x CWS

Allocation Kansas = 0.051 x CWS

Allocation Nebraska = 0.168 x CWS

Unallocated =-0.004 x CWS

5. Buffalo Creek

CBCU Colorado = 0.6 x Dc + % x Pc + 0.5 x M&In + EvNFRc + GWc

CBCU Kansas = GWk

CBCU Nebraska = 0.6 x Dn + % x Pn + 0.5 x M&In + EvNFRn + GWn

VWS = Buffalo Creek near Haigler Gage Stn. No. 06823500 + CBCUc + CBCUk + CBCUn – IWS

CWS = VWS - FF

Allocation Nebraska = 0.330 x CWS

Unallocated = 0.670 x CWS

6. Rock Creek

CBCU Colorado = GWc

CBCU Kansas = GWk

CBCU Nebraska = 0.6 x Dn + % x Pn + 0.5 x M&In + EvNFRn + GWn

VWS = Rock Creek at Parks Gage Stn. No. 06824000 + CBCUc + CBCUk + CBCUn – IWS

CWS = VWS - FF

Allocation Nebraska = 0.400 x CWS

Unallocated = 0.600 x CWS

7. South Fork Republican River

CBCU Colorado = 0.6 x Hale Ditch Diversion + 0.6 x Dc + % x Pc + 0.5 x M&Ic + EvNFRc + Bonny Reservoir Ev + GWc

CBCU Kansas = 0.6 x Dk + % x Pk + 0.5 x M&Ik + EvNFRk + GWk

CBCU Nebraska = 0.6 x Dn + % x Pn + 0.5 x M&In + EvNFRn + GWn

VWS = South Fork Republican River near Benkelman Gage Stn. No. 06827500 + CBCUc + CBCUk + CBCUn + ΔS Bonny Reservoir – IWS

CWS = VWS - ΔS Bonny Reservoir - FF

Allocation Colorado = 0.444 x CWS

Allocation Kansas = 0.402 x CWS

Allocation Nebraska = 0.014 x CWS

Unallocated = 0.140 x CWS

8. Frenchman Creek in Nebraska

CBCU Colorado = GWc

CBCU Kansas = GWk

CBCU Nebraska = Culbertson Canal Diversions (IRR Season) x (1-%BRF) + Culbertson Canal Diversions (Non-IRR Season) x (1-92%) + Culbertson Extension (IRR Season) x (1-%BRF) + Culbertson Extension (Non-IRR Season) x (1-92%) + 0.6 x Champion Canal Diversion + 0.6 x Riverside Canal Diversion + 0.6 x Dn + % x Pn + 0.5 x M&In + EvNFRn + Enders Reservoir Ev + GWn

VWS = Frenchman Creek in Culbertson, Nebraska Gage Stn. No. 06835500 + CBCUc + CBCUk + CBCUn + 0.17 x

Culbertson Diversion RF + Culbertson Extension RF + 0.78 x Riverside Diversion RF + ΔS Enders Reservoir – IWS

Note: 17% of the Culbertson Diversion RF and 100% of the Culbertson Extension RF return to the Main Stem

CWS = VWS - ΔS Enders Reservoir – FF

Allocation Nebraska = 0.536 x CWS

Unallocated = 0.464 x CWS

9. Driftwood Creek

CBCU Colorado = GWc

CBCU Kansas = 0.6 x Dk + % x Pk + 0.5 x M&Ik + EvNFRk + GWk

CBCU Nebraska = 0.6 x Dn + % x Pn + 0.5 x M&In + EvNFRn + GWn

VWS = Driftwood Creek near McCook Gage Stn. No. 06836500 + CBCUc + CBCUk + CBCUn – 0.24 x Meeker Driftwood Canal RF - IWS

Note: 24 % of the Meeker Driftwood Canal RF returns to Driftwood Creek

CWS = VWS – FF

Allocation Kansas = 0.069 x CWS

Allocation Nebraska = 0.164 x CWS

Unallocated = 0.767 x CWS

10. Red Willow Creek in Nebraska

CBCU Colorado = GWc

CBCU Kansas = GWk

CBCU Nebraska = 0.1 x Red Willow Canal CBCU + 0.6 x Dn + % x Pn + 0.5 x M&In + EvNFRn + 0.1 x Hugh Butler Lake Ev + GWn

Note:
Red Willow Canal CBCU = Red Willow Canal Diversion (IRR Season) x (1- % BRF) + Red Willow Canal Diversion (Non-IRR Season) x (1-92%)

90% of the Red Willow Canal CBCU and 90% of Hugh Butler Lake Ev charged to Nebraska's CBCU in the Main Stem

VWS = Red Willow Creek near Red Willow Gage Stn. No. 06838000 + CBCUc + CBCUk + CBCUn + 0.9 x Red Willow Canal CBCU + 0.9 x Hugh Butler Lake Ev + 0.9 xRed Willow Canal RF + ΔS Hugh Butler Lake – IWS

Note: 90% of the Red Willow Canal RF returns to the Main Stem

CWS = VWS - ΔS Hugh Butler Lake - FF

Allocation Nebraska = 0.192 x CWS

Unallocated = 0.808 x CWS

11. Medicine Creek

CBCU Colorado = GWc

CBCU Kansas = GWk

CBCU Nebraska = 0.6 x Dn above and below gage + % x Pn above and below gage + 0.5 x M&In above and below gage + EvNFRn above and below gage + GWn

Note: Harry Strunk Lake Ev charged to Nebraska's CBCU in the Main Stem.

CU from Harry Strunk releases in the Cambridge Canal is charged to the Main stem (no adjustment to the VWS formula is needed as this water shows up in the Medicine Creek gage).

VWS = Medicine Creek below Harry Strunk Lake Gage Stn. No.

06842500 + CBCUc + CBCUk + CBCUn – 0.6 x Dn below gage - % x Pn below gage – 0.5 * M&In below gage - EvNFRn below gage + Harry Strunk Lake Ev + ΔS Harry Strunk Lake– IWS

Note: The CBCU surface water terms for Nebraska which occur below the gage are added in the VWS for the Main Stem

CWS = VWS - ΔS Harry Strunk Lake - FF

Allocation Nebraska = 0.091 x CWS

Unallocated = 0.909 x CWS

12. Beaver Creek

CBCU Colorado = 0.6 x Dc + % x Pc + 0.5 x M&Ic + EvNFRc + GWc

CBCU Kansas = 0.6 x Dk + % x Pk + 0.5 x M&Ik + EvNFRk + GWk

CBCU Nebraska = 0.6 x Dn above and below gage + % x Pn above and below gage + 0.5 x M&In above and below gage + EvNFRn above and below gage + GWn

VWS = Beaver Creek near Beaver City gage Stn. No. 06847000 + BCUc + CBCUk + CBCUn – 0.6 x Dn below gage - % x Pn below gage – 0.5 * M&In below gage - EvNFRn below gage – IWS

Note: The CBCU surface water terms for Nebraska which occur below the gage are added in the VWS for the Main Stem

CWS = VWS – FF

Allocation Colorado = 0.200 x CWS

Allocation Kansas = 0.388 x CWS

Allocation Nebraska = 0.406 x CWS

Unallocated = 0.006 x CWS

13. Sappa Creek

CBCU Colorado = GWc

CBCU Kansas = 0.6 x Dk + % x Pk + 0.5 x M&Ik + EvNFRk + GWk

CBCU Nebraska = 0.6 x Dn above and below gage + % x Pn above and below gage + 0.5 x M&In above and below gage + EvNFRn above and below gage + GWn

VWS = Sappa Creek near Stamford gage Stn. No. 06847500 – Beaver Creek near Beaver City gage Stn. No. 06847000 + CBCUc + CBCUk + CBCUn – 0.6 x Dn below gage - % x Pn below gage – 0.5 * M&In below gage - EvNFRn below gage – IWS

Note: The CBCU surface water terms for Nebraska which occur below the gage are added in the VWS for the Main Stem

CWS = VWS - FF

Allocation Kansas = 0.411 x CWS

Allocation Nebraska = 0.411 x CWS

Unallocated = 0.178 x CWS

14. Prairie Dog Creek

CBCU Colorado = GWc

CBCU Kansas = Almena Canal Diversion x (1-%BRF) + 0.6 x Dk + % x Pk + 0.5 x M&Ik + EvNFRk + Keith Sebelius Lake Ev + GWk

CBCU Nebraska = 0.6 x Dn below gage + % x Pn below gage + 0.5 x M&In below gage + EvNFRn + GWn below gage

VWS = Prairie Dog Creek near Woodruff, Kansas USGS Stn. No.

06848500 + CBCUc + CBCUk + CBCUn - 0.6 x Dn below gage - % x Pn below gage - 0.5 x M&In below gage - EvNFRn below gage + ΔS Keith Sebelius Lake – IWS

Note: The CBCU surface water terms for Nebraska which occur below the gage are added in the VWS for the Main Stem

CWS = VWS- ΔS Keith Sebelius Lake - FF

Allocation Kansas = 0.457 x CSW

Allocation Nebraska = 0.076 x CWS

Unallocated = 0.467 x CWS

15. The North Fork of the Republican River in Nebraska and the Main Stem of the Republican River between the junction of the North Fork and the Arikaree River and the Republican River near Hardy

CBCU Colorado = GWc

CBCU Kansas =
(Deliveries from the Courtland Canal to Kansas above Lovewell) x (1-%BRF)
+ Amount of transportation loss of Courtland Canal deliveries to Lovewell that does not return to the river, charged to Kansas
+ (Diversions of Republican River water from Lovewell Reservoir by the Courtland Canal below Lovewell) x (1-%BRF)
+ 0.6 x Dk
+ % x Pk
+ 0.5 x M&Ik
+ EvNFRk
+ Harlan County Lake Ev charged to Kansas
+ Lovewell Reservoir Ev charged to the Republican River
+ GWk

CBCU Nebraska =
Deliveries from Courtland Canal to Nebraska lands x (1-%BRF)
+ Superior Canal (IRR Season) x (1- %BRF) + Superior Canal

(Non-IRR Season) x (1 - 92%)
+ Franklin Pump Canal (IRR Season) x (1- %BRF) + Franklin Pump Canal (Non-IRR Season) x (1 - 92 %)
+ Franklin Canal (IRR Season) x (1- %BRF) + Franklin Canal (Non-IRR Season) x (1 - 92%)
+ Naponee Canal (IRR Season) x (1- %BRF) + Naponee Canal (Non-IRR Season) x (1 - 92%)
+ Cambridge Canal (IRR Season) x (1- %BRF) + Cambridge Canal (Non-IRR Season) x (1 - 92%)
+ Bartley Canal (IRR Season) x (1- %BRF) + Bartley Canal (Non-IRR Season) x (1 - 92%)
+ Meeker-Driftwood Canal (IRR Season) x (1- %BRF) + Meeker-Driftwood Canal (Non-IRR Season) x (1- 92%)
+ 0.9 x Red Willow Canal CBCU
+ 0.6 x Dn
+ % x Pn
+ 0.5 x M&In
+ EvNFRn
+ 0.9 x Hugh Butler Lake Ev
+ Harry Strunk Lake Ev
+ Swanson Lake Ev
+ Harlan County Lake Ev charged to Nebraska
+ GWn

Notes:
The allocation of transportation losses in the Courtland Canal above Lovewell between Kansas and Nebraska shall be done by the Bureau of Reclamation and reported in their "Courtland Canal Above Lovewell" spreadsheet. Deliveries and losses associated with deliveries to both Nebraska and Kansas above Lovewell shall be reflected in the Bureau's Monthly Water District reports. Losses associated with delivering water to Lovewell shall be separately computed.

Amount of transportation loss of the Courtland Canal deliveries to Lovewell that does not return to the river, charged to Kansas shall be 18% of the Bureau's estimate of losses associated with these deliveries.

Red Willow Canal CBCU = Red Willow Canal Diversion x (IRR Season) x (1- % BRF) + Red Willow Canal Diversion (Non-IRR Season) x (1 - 92%)

10% of the Red Willow Canal CBCU is charged to Nebraska's CBCU in Red Willow Creek sub-basin

10% of Hugh Butler Lake Ev is charged to Nebraska's CBCU in the Red Willow Creek sub-basin

None of the Harry Strunk Lake EV is charged to Nebraska's CBCU in the Medicine Creek sub-basin

VWS =

Republican River near Hardy Gage Stn. No. 06853500
- North Fork of the Republican River at the State Line, Stn. No. 06823000
- Arikaree Gage at Haigler Stn. No. 06821500
- Buffalo Creek near Haigler Gage Stn. No. 06823500
- Rock Creek at Parks Gage Stn. No. 06824000
-South Fork Republican River near Benkelman Gage Stn. No. 06827500
- Frenchman Creek in Culbertson Stn. No. 06835500
- Driftwood Creek near McCook Gage Stn. No. 06836500
- Red Willow Creek near Red Willow Gage Stn. No. 06838000
- Medicine Creek below Harry Strunk Lake Gage Stn. No. 06842500
- Sappa Creek near Stamford Gage Stn. No. 06847500
- Prairie Dog Creek near Woodruff, Kansas Stn. No. 68-485000
+ CBCUc
+ CBCUn
+ 0.6 x Dk
+ % x Pk
+ 0.5 x M&Ik
+ EvNFRk
+ Harlan County Lake Ev charged to Kansas
+Amount of transportation loss of the Courtland Canal above the Stateline that does not return to the river, charged to Kansas
+GWk

- 0.9 x Red Willow Canal CBCU
- 0.9 x Hugh Butler Ev
- Harry Strunk Ev

+ 0.6 x Dn below Medicine Creek gage

+ % x Pn below Medicine Creek gage
+ 0.5 * M&In below Medicine Creek gage
+ EvNFRn below Medicine Creek gage

+ 0.6 x Dn below Beaver Creek gage
+ % x Pn below Beaver Creek gage
+ 0.5 * M&In below Beaver Creek gage
+ EvNFRn below Beaver Creek gage

+ 0.6 x Dn below Sappa Creek gage
+ % x Pn below Sappa Creek gage
+ 0.5 * M&In below Sappa Creek gage
+ EvNFRn below Sappa Creek gage

+ 0.6 x Dn below Prairie Dog Creek gage
+ % x Pn below Prairie Dog Creek gage
+ 0.5 * M&In below Prairie Dog Creek gage
+ EvNFRn below Prairie Dog Creek gage

+ Change in Storage Harlan County Lake
+ Change in Storage Swanson Lake

- Nebraska Haigler Canal RF
- 0.78 x Riverside Canal RF
- 0.17 x Culbertson Canal RF
- Culbertson Canal Extension RF to Main Stem
+ 0.24 x Meeker Driftwood Canal RF which returns to Driftwood Creek
- 0.9 x Red Willow Canal RF

+ Courtland Canal at Kansas-Nebraska State Line Gage Stn No. 06852500
- Courtland Canal RF in Kansas above Lovewell Reservoir

-IWS

Notes:
None of the Nebraska Haigler Canal RF returns to the North Fork of the Republican River

83% of the Culbertson Diversion RF and none of the Culbertson Extension RF return to Frenchman Creek

24 % of the Meeker Driftwood Canal RF returns to Driftwood Creek.

10% of the Red Willow Canal RF returns to Red Willow Creek

Courtland Canal RF in Kansas above Lovewell Reservoir = 0.015 x (Courtland Canal at Kansas-Nebraska State Line Gage Stn No. 06852500)

CWS = VWS - Change in Storage Harlan County Lake - Change in Storage Swanson Lake - FF

Allocation Kansas = 0.511 x CWS

Allocation Nebraska = 0.489 x CWS

V. **Annual Data/ Information Requirements, Reporting, and Verification**

The following information for the previous calendar year shall be provided to the members of the RRCA Engineering Committee by April 15th of each year, unless otherwise specified.

All information shall be provided in electronic format, if available.

Each State agrees to provide all information from their respective State that is needed for the RRCA Groundwater Model and RRCA Accounting Procedures and Reporting Requirements, including but not limited to the following:

A. Annual Reporting

1. Surface water diversions and irrigated acreage:

Each State will tabulate the canal, ditch, and other surface water diversions that are required by RRCA annual compact accounting and the RRCA Groundwater Model on a monthly format (or a procedure to distribute annual data to a monthly basis) and will forward the surface water diversions to the other States. This will include available diversion, wasteway, and farm delivery data for canals diverting from the Platte River that contribute to Imported Water Supply into the Basin. Each State will provide the water right number, type of use, system type, location, diversion amount, and acres irrigated.

2. Groundwater pumping and irrigated acreage:

Each State will tabulate and provide all groundwater well pumping estimates that are required for the RRCA Groundwater Model to the other States.

Colorado – will provide an estimate of pumping based on a county format that is based upon system type, Crop Irrigation Requirement (CIR), irrigated acreage, crop distribution, and irrigation efficiencies. Colorado will require installation of a totalizing flow meter, installation of an hours meter with a measurement of the pumping rate, or determination of a power conversion coefficient for 10% of the active wells in the Basin by December 31, 2005. Colorado will also provide an annual tabulation for each groundwater well that measures groundwater pumping by a totalizing flow meter, hours meter or power conversion coefficient that includes: the groundwater well permit number, location, reported hours, use, and irrigated acreage.

Kansas - will provide an annual tabulation by each groundwater well that includes: water right number, groundwater pumping determined by a meter on each well (or group of wells in a manifold system) or by reported hours of use and rate; location; system type (gravity, sprinkler, LEPA, drip, etc.); and irrigated acreage. Crop distribution will be provided on a county basis.

Nebraska – will provide an annual tabulation through the representative Natural Resource District (NRD) in Nebraska that includes: the well registration number or other ID number; groundwater pumping determined by a meter on each well (or group of wells in a manifold system) or by reported hours of use and rate; wells will be identified by; location; system type (gravity, sprinkler, LEPA, drip, etc.); and irrigated acreage. Crop distribution will be provided on a county basis.

3. Climate information:

Each State will tabulate and provide precipitation, temperature, relative humidity or dew point, and solar radiation for the following climate stations:

State	Identification	Name
Colorado		
Colorado	C050109	Akron 4 E
Colorado	C051121	Burlington
Colorado	C054413	Julesburg
Colorado	C059243	Wray
Kansas	C140439	Atwood 2 SW
Kansas	C141699	Colby 1SW
Kansas	C143153	Goodland
Kansas	C143837	Hoxie

Kansas	C145856	Norton 9 SSE
Kansas	C145906	Oberlin1 E
Kansas	C147093	Saint Francis
Kansas	C148495	Wakeeny
Nebraska	C250640	Beaver City
Nebraska	C250810	Bertrand
Nebraska	C252065	Culbertson
Nebraska	C252690	Elwood 8 S
Nebraska	C253365	Gothenburg
Nebraska	C253735	Hebron
Nebraska	C253910	Holdredge
Nebraska	C254110	Imperial
Nebraska	C255090	Madrid
Nebraska	C255310	McCook
Nebraska	C255565	Minden
Nebraska	C256480	Palisade
Nebraska	C256585	Paxton
Nebraska	C257070	Red Cloud
Nebraska	C258255	Stratton
Nebraska	C258320	Superior
Nebraska	C258735	Upland
Nebraska	C259020	Wauneta 3 NW

4. Crop Irrigation Requirements:

Each State will tabulate and provide estimates of crop irrigation requirement information on a county format. Each State will provide the percentage of the crop irrigation requirement met by pumping; the percentage of groundwater irrigated lands served by sprinkler or flood irrigation systems, the crop irrigation requirement; crop distribution; crop coefficients; gain in soil moisture from winter and spring precipitation, net crop irrigation requirement; and/or other information necessary to compute a soil/water balance.

5. Streamflow Records from State-Maintained Gaging Records:

Streamflow gaging records from the following State maintained gages will be provided:

Station No.	Name
00126700	Republican River near Trenton
06831500	Frenchman Creek near Imperial
06832500	Frenchman Creek near Enders

06835000	Stinking Water Creek near Palisade
06837300	Red Willow Creek above Hugh Butler Lake
06837500	Red Willow Creek near McCook
06841000	Medicine Creek above Harry Strunk Lake
06842500	Medicine Creek below Harry Strunk Lake
06844000	Muddy Creek at Arapahoe
06844210	Turkey Creek at Edison
06847000	Beaver Creek near Beaver City
	Republican River at Riverton
06851500	Thompson Creek at Riverton
06852000	Elm Creek at Amboy
	Republican River at the Superior-Courtland Diversion Dam

6. Platte River Reservoirs:

The State of Nebraska will provide the end-of-month contents, inflow data, outflow data, area-capacity data, and monthly net evaporation, if available, from Johnson Lake; Elwood Reservoir; Sutherland Reservoir; Maloney Reservoir; and Jeffrey Lake.

7. Water Administration Notification:

The State of Nebraska will provide the following information that describes the protection of reservoir releases from Harlan County Lake and for the administration of water rights junior in priority to February 26, 1948:

Date of notification to Nebraska water right owners to curtail their diversions, the amount of curtailment, and length of time for curtailment.
The number of notices sent.
The number of diversions curtailed and amount of curtailment in the Harlan County Lake to Guide Rock reach of the Republican River.

8. Moratorium:

Each State will provide a description of all new Wells constructed in the Basin Upstream of Guide Rock including the owner, location (legal description), depth and diameter or dimension of the constructed water well, casing and screen information, static water level, yield of the water well in gallons per minute or gallons per hour, and intended use of the water well.

Designation whether the Well is a:

a. Test hole;

b. Dewatering Well with an intended use of one year or less;

c. Well designed and constructed to pump fifty gallons per minute or less;

d. Replacement Water Well, including a description of the Well that is replaced providing the information described above for new Wells and a description of the historic use of the Well that is replaced;

e. Well necessary to alleviate an emergency situation involving provision of water for human consumption, including a brief description of the nature of the emergency situation and the amount of water intended to be pumped by and the length of time of operation of the new Well;

f. Transfer Well, including a description of the Well that is transferred providing the information described above for new Wells and a description of the Historic Consumptive Use of the Well that is transferred;

g. Well for municipal and/or industrial expansion of use;

Wells in the Basin in Northwest Kansas or Colorado. Kansas and Colorado will provide the information described above for new Wells along with copies of any other information that is required to be filed with either State of local agencies under the laws, statutes, rules and regulations in existence as of April 30, 2002, and;

Any changes in State law in the previous year relating to existing Moratorium.

9. Non-Federal Reservoirs:

Each State will conduct an inventory of Non Federal Reservoirs by December 31, 2004, for inclusion in the annual Compact Accounting. The inventory shall include the following information: the location, capacity (in Acre-feet) and area (in acres) at the principal spillway elevation of each Non-Federal Reservoir. The States will annually provide any updates to the initial inventory of Non-Federal Reservoirs, including enlargements that are constructed in the previous year.

Owners/operators of Non-Federal Reservoirs with 200 Acre-feet of storage capacity or greater at the principal spillway elevation will be required to provide an area-capacity survey from State-approved plans or prepared by a licensed professional engineer or land surveyor.

B. RRCA Groundwater Model Data Input Files

1. Monthly groundwater pumping, surface water recharge, groundwater recharge, and precipitation recharge provided by county and indexed to the one square mile cell size.

2. Potential Evapotranspiration rate is set as a uniform rate for all phreatophyte vegetative classes – the amount is X at Y climate stations and is interpolated spatially using kriging.

C. Inputs to RRCA Accounting

1. Surface Water Information

a. Streamflow gaging station records: obtained as preliminary USGS or Nebraska streamflow records, with adjustments to reflect a calendar year, at the following locations:

Arikaree River at Haigler, Nebraska
North Fork Republican River at Colorado-Nebraska state line
Buffalo Creek near Haigler, Nebraska
Rock Creek at Parks, Nebraska
South Fork Republican River near Benkelman, Nebraska
Frenchman Creek at Culbertson, Nebraska
Red Willow Creek near Red Willow, Nebraska
Medicine Creek below Harry Strunk Lake, Nebraska*
Beaver Creek near Beaver City, Nebraska*
Sappa Creek near Stamford, Nebraska
Prairie Dog Creek near Woodruff, Kansas
Courtland Canal at Nebraska-Kansas state line
Republican River near Hardy, Nebraska
Republican River at Superior-Courtland Diversion Dam near Guide Rock,
Nebraska (new)*

b. Federal reservoir information: obtained from the United States Bureau of Reclamation:

Daily free water surface evaporation, storage, precipitation, reservoir release information, and updated area-capacity tables.
Federal Reservoirs:
Bonny Reservoir

Swanson Lake
Harry Strunk Lake
Hugh Butler Lake
Enders Reservoir
Keith Sebelius Lake
Harlan County Lake
Lovewell Reservoir

c. Non-federal reservoirs obtained by each state: an updated inventory of reservoirs that includes the location, surface area (acres), and capacity (in Acre-feet), of each non-federal reservoir with storage capacity of fifteen (15) Acre-feet or greater at the principal spillway elevation. Supporting data to substantiate the average surface water areas that are different than the presumptive average annual surface area may be tendered by the offering State.

d. Diversions and related data from USBR

Irrigation diversions by canal, ditch, and pumping station that irrigate more than two (2) acres
Diversions for non-irrigation uses greater than 50 Acre-feet
Farm Deliveries
Wasteway measurements
Irrigated acres

e. Diversions and related data – from each respective State

Irrigation diversions by canal, ditch, and pumping station that irrigate more than two (2) acres
Diversions for non-irrigation uses greater than 50 Acre-feet
Wasteway measurements, if available

2. Groundwater Information

(From the RRCA Groundwater model as output files as needed for the accounting procedures)

a. Imported water - mound credits in amount and time that occur in defined streamflow points/reaches of measurement or compliance – ex: gaging stations near confluence or state lines

b. Groundwater depletions to streamflow (above points of measurement or compliance – ex: gaging stations near confluence or state lines)

3. Summary

The aforementioned data will be aggregated by Sub-basin as needed for RRCA accounting.

D. Verification

1. Documentation to be Available for Inspection Upon Request

a. Well permits/ registrations database
b. Copies of well permits/ registrations issued in calendar year
c. Copies of surface water right permits or decrees
d. Change in water right/ transfer historic use analyses
e. Canal, ditch, or other surface water diversion records
f. Canal, ditch, or other surface water measurements
g. Reservoir storage and release records
h. Irrigated acreage

2. Site Inspection

a. Accompanied – reasonable and mutually acceptable schedule among representative state and/or federal officials.

b. Unaccompanied – inspection parties shall comply with all laws and regulations of the State in which the site inspection occurs.

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

Designated Drainage Basin	Col. 1: Virgin Water Supply	Col. 2: Computed Water Supply	Col. 3: Allocations				Col. 4: Computed Beneficial Consumptive Use		
			Colorado	Nebraska	Kansas	Unallocated	Colorado	Nebraska	Kansas
North Fork in Colorado									
Arikaree									
Buffalo									
Rock									
South Fork of Republican River									
Frenchman									
Driftwood									
Red Willow									
Medicine									
Beaver									
Sappa									
Prairie Dog									
North Fork of Republican River in Nebraska and Main Stem									
Total All Basins									
North Fork Of Republican River in Nebraska and Mainstem Including Unallocated Water									
Total									

Table 2: Original Compact Virgin Water Supply and Allocations

Designated Drainage Basin	Virgin Water Supply	Colorado Allocation	% of Total Drainage Basin Supply	Kansas Allocation	% of Total Drainage Basin Supply	Nebraska Allocation	% of Total Drainage Basin Supply	Unallo-cated	% of Total Drainage Basin Supply
North Fork - CO	44,700	10,000	22.4			11,000	24.6	23,700	53.0
Arikaree River	19,610	15,400	78.5	1,000	5.1	3,300	16.8	-90	-0.4
Buffalo Creek	7,890					2,600	33.0	5,290	67.0
Rock Creek	11,000					4,400	40.0	6,600	60.0
South Fork	57,200	25,400	44.4	23,000	40.2	800	1.4	8,000	14.0
Frenchman Creek	98,500					52,800	53.6	45,700	46.4
Driftwood Creek	7,300			500	6.9	1,200	16.4	5,600	76.7
Red Willow Creek	21,900					4,200	19.2	17,700	80.8
Medicine Creek	50,800					4,600	9.1	46,200	90.9
Beaver Creek	16,500	3,300	20.0	6,400	38.8	6,700	40.6	100	0.6
Sappa Creek	21,400			8,800	41.1	8,800	41.1	3,800	17.8
Prairie Dog Creek	27,600			12,600	45.7	2,100	7.6	12,900	46.7
Sub-total Tributaries	384,400							175,500	
Main Stem + Blackwood Creek	94,500								
Main Stem + Unallocated	270,000			138,000	51.1	132,000	48.9		
Total	478,900	54,100		190,300		234,500			

Table 3A: Table to Be Used to Calculate Colorado's Five-Year Running Average Allocation and Computed Beneficial Consumptive Use for Determining Compact Compliance

Colorado				
	Col. 1	Col. 2	Col. 3	Col. 4
Year	Allocation	Computed Beneficial Consumptive	Imported Water Supply Credit	Difference between Allocation and the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit Col 1 – (Col 2- Col 3)
Year t= -4				
Year t= -3				
Year t= -2				
Year t= -1				
Current Year t= 0				
Average				

Table 3B. Table to Be Used to Calculate Kansas's Five-Year Running Average Allocation and Computed Beneficial Consumptive Use for Determining Compact Compliance

Kansas				
	Col. 1	Col. 2	Col. 3	Col. 4
Year	Allocation	Computed Beneficial Consumptive	Imported Water Supply Credit	Difference between Allocation and the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit Col 1 – (Col 2- Col 3)
Year t= -4				
Year t= -3				
Year t= -2				
Year t= -1				
Current Year t= 0				
Average				

Table 3C. Table to Be Used to Calculate Nebraska's Five-Year Running Average Allocation and Computed Beneficial Consumptive Use for Determining Compact Compliance

Nebraska				
	Col. 1	Col. 2	Col. 3	Col. 4
Year	Allocation	Computed Beneficial Consumptive	Imported Water Supply Credit	Difference between Allocation and the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit Col 1 – (Col 2- Col 3)
Year T= -4				
Year T= -3				
Year T= -2				
Year T= -1				
Current Year T= 0				
Average				

Table 4A: Colorado Compliance with the Sub-basin Non-impairment Requirement

	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6
Sub-basin	Colorado Sub-basin Allocation (5-year running average)	Unallocated Supply (5-year running average)	Credits from Imported Water Supply (5-year running average)	Total Supply Available = Col 1+ Col 2 + Col 3 (5-year running average)	Colorado Computed Beneficial Consumptive Use (5-year running average)	Difference Between Available Supply and Computed Beneficial Consumptive Use = Col 4 – Col 5 (5-year running average)
North Fork Republican River Colorado						
Arikaree River						
South Fork Republican River						
Beaver Creek						

Table 4B: Kansas Compliance with the Sub-basin Non-impairment Requirement

	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7
Sub-basin	Kansas Sub-basin Allocation (5-year running average)	Unallocated Supply (5-year running average)	Unused Allocation from Colorado (5-year running average)	Credits from Imported Water Supply (5-year running average)	Total Supply Available = Col 1+ Col 2+ Col 3 + Col 4 (5-year running average)	Kansas Computed Beneficial Consumptive Use (5-year running average)	Difference Between Available Supply and Computed Beneficial Consumptive Use = Col 5 – Col 6 (5-year running average)
Arikaree River							
South Fork Republican River							
Driftwood Creek							
Beaver Creek							
Sappa Creek							
Prairie Dog Creek							

Table 5A: Colorado Compliance During Water-Short Year Administration

Colorado				
	Col. 1	Col. 2	Col. 3	Col 4
Year	Allocation minus Allocation for Beaver Creek	Computed Beneficial Consumptive minus Computed Beneficial Consumptive Use for Beaver Creek	Imported Water Supply Credit excluding Beaver Creek	Difference between Allocation and the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit for All Basins Except Beaver Creek Col 1 – (Col 2 – Col 3)
Year T= -4				
Year T= -3				
Year T= -2				
Year T= -1				
Current Year T= 0				
Average				

Table 5B: Kansas Compliance During Water-Short Year Administration

Kansas						
Year	Allocation			Computed Beneficial Consumptive Use`	Imported Water Supply Credit	Difference Between Allocation and the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit
Column	1	2	3	4	5	6
	Sum Sub-basins	Kansas's Share of the Unallocated Supply	Total Col 1 + Col 2			Col 3 – (Col 4 – Col 5)
Previous Year						
Current Year						
Average						

Table 5C: Nebraska Compliance During Water-Short Year Administration

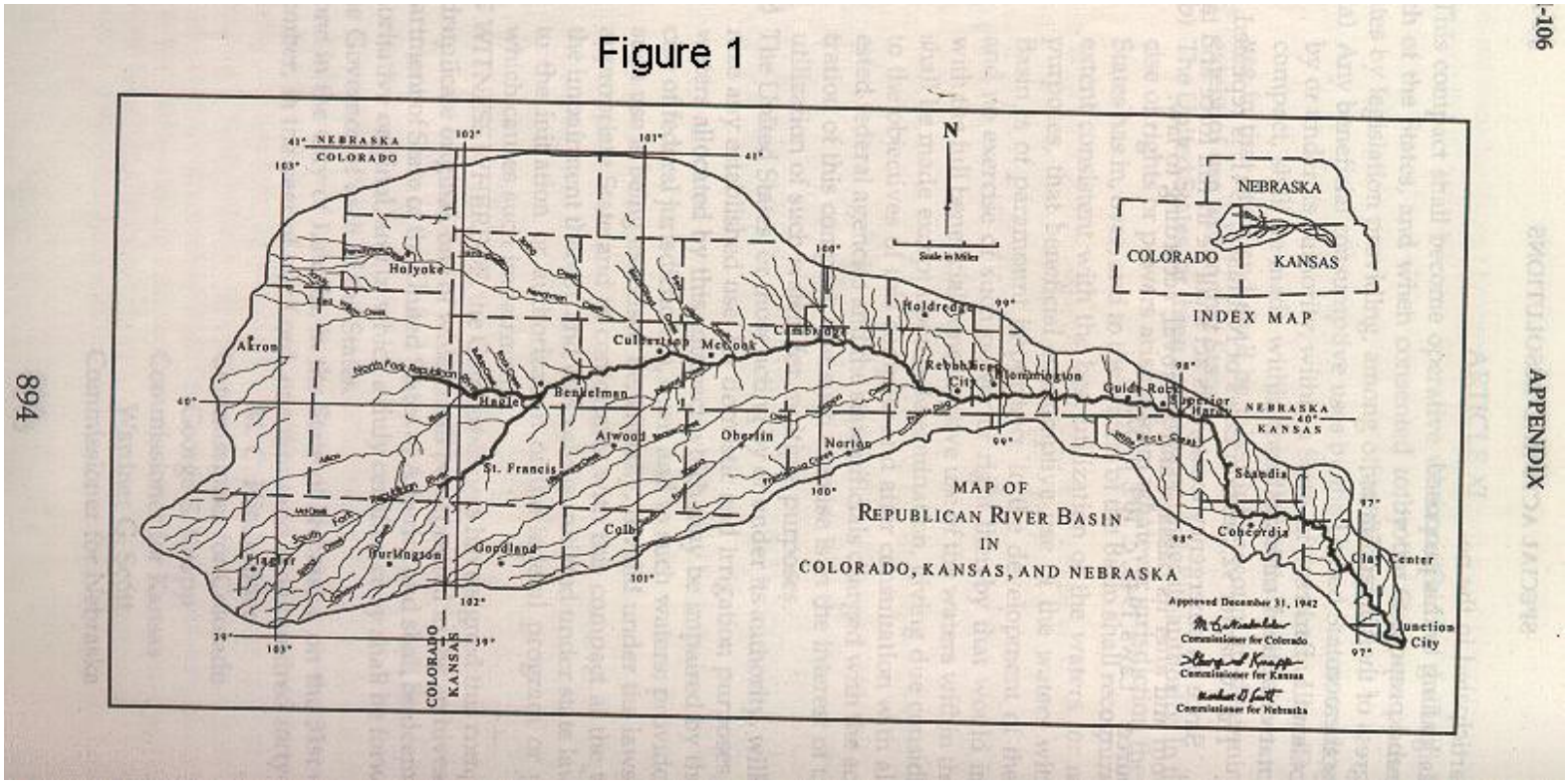
Nebraska								
Year	Allocation			Computed Beneficial Consumptive Use			Imported Water Supply Credit	Difference Between Allocation and the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit Above Guide Rock
Column	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8
	State Wide Allocation	Allocation below Guide Rock	State Wide Allocation above Guide Rock	State Wide CBCU	CBCU below Guide Rock	State Wide CBCU above Guide Rock	Credits above Guide Rock	Col 3 – (Col 6 – Col 7)
Previous Year								
Current Year								
Average								

Table 5D: Nebraska Compliance Under a Alternative Water-Short Year Administration Plan

Year	Allocation			Computed Beneficial Consumptive Use			Imported Water Supply Credit	Difference Between Allocation and the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit Above Guide Rock
Column	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8
	State Wide Allocation	Allocation below Guide Rock	State Wide Allocation above Guide Rock	State Wide CBCU	CBCU below Guide Rock	State Wide CBCU above Guide Rock	Credits above Guide Rock	Col 3 – (Col 6- Col 7)
Year = -2								
Year = -1								
Current Year								
Three-Year Average								
Sum of Previous Two-year Difference								
Expected Decrease in CBCU Under Plan								

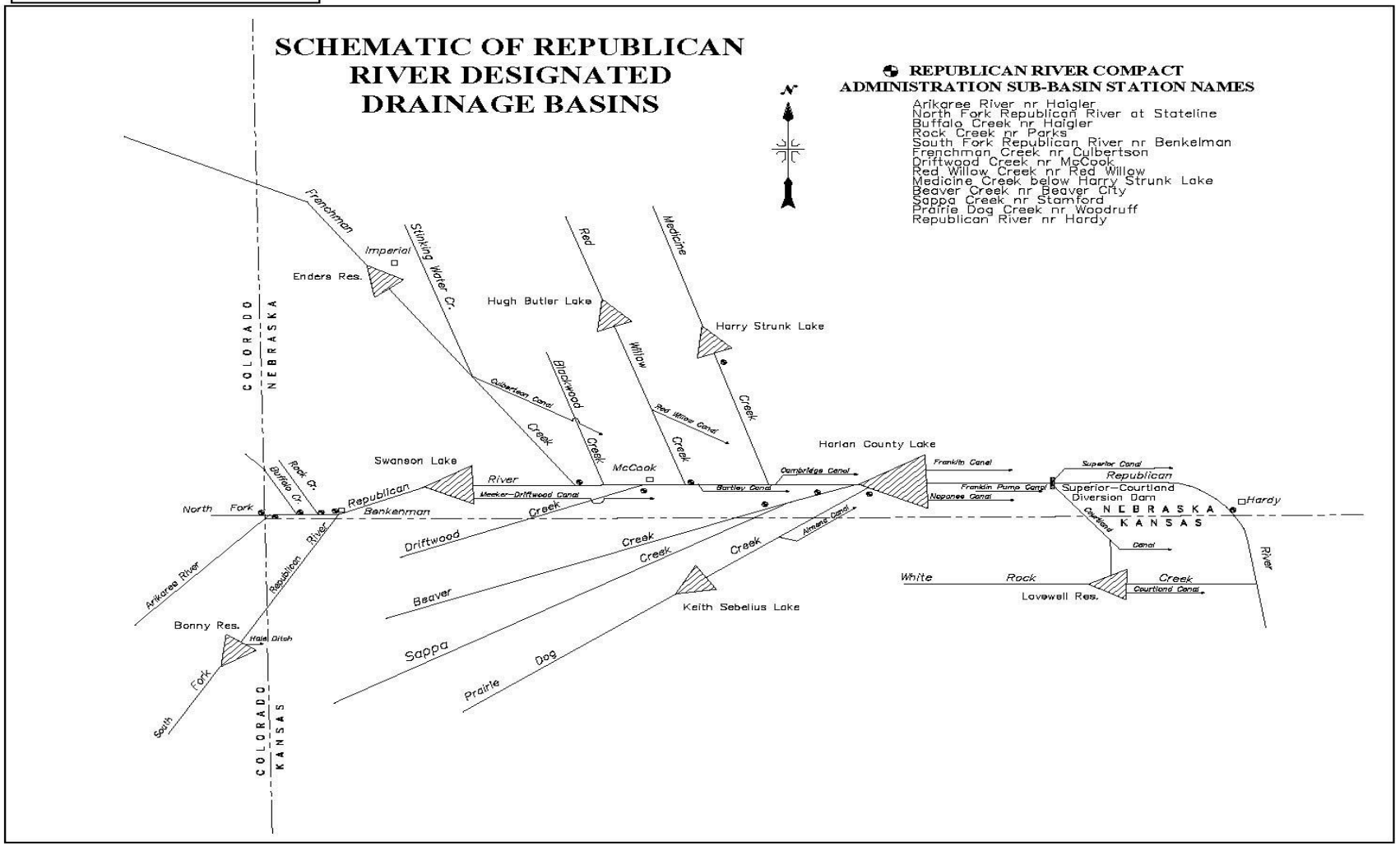
Table 5E: Nebraska Tributary Compliance During Water-Short Year Administration

Year	Sum of Nebraska Sub-basin Allocations	Sum of Nebraska's Share of Sub-basin Unallocated Supplies	Total Available Water Supply for Nebraska	Computed Beneficial Consumptive Use	Imported Water Supply Credit	Difference between Allocation And the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit
	Col 1	Col 2	`Col 3	Col 4	Col 5	Col 6
Previous Year						Col 3 -(Col 4-Col 5)
Current Year						
Average						

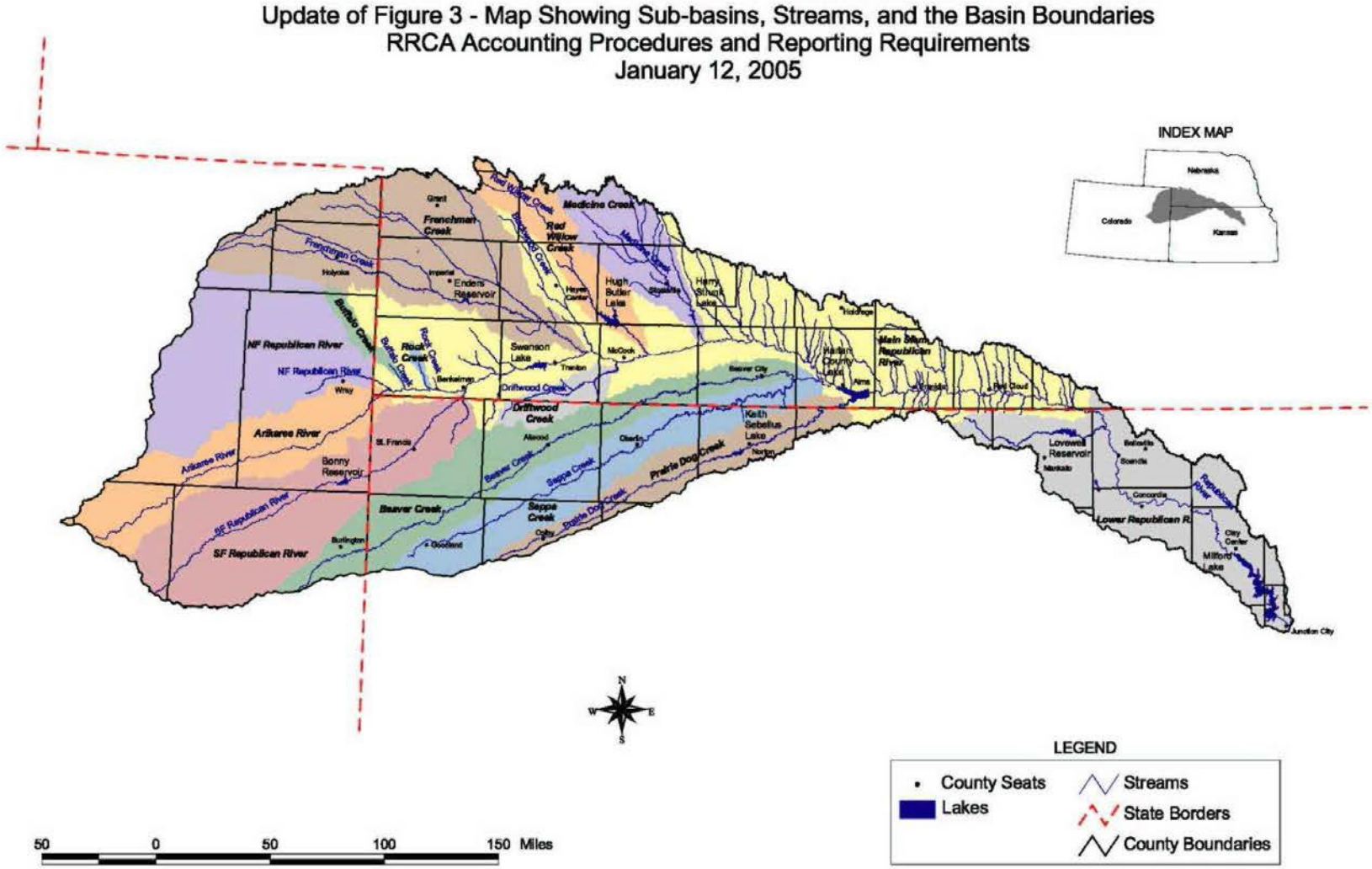


Basin Map Attached to Compact that Shows the Streams and the Basin Boundaries

Figure 2



Line Diagram of Designated Drainage Basins Showing Federal Reservoirs and Sub-basin Gaging Stations



Map Showing Sub-basins, Streams, and the Basin Boundaries

Attachment 1: Sub-basin Flood Flow Thresholds

Sub-basin	Sub-basin Flood Flow Threshold Acre-feet per Year[3]
Arikaree River	16,400
North Fork of Republican River	33,900
Buffalo Creek	4,800
Rock Creek	9,800
South Fork of Republican River	30,400
Frenchman Creek	51,900
Driftwood Creek	9,400
Red Willow Creek	15,100
Medicine Creek	55,100
Beaver Creek	13,900
Sappa Creek	26,900
Prairie Dog	15,700

[3] Flows considered to be Flood Flows are flows in excess of the 94% flow based on a flood frequency analysis for the years 1971-2000. The Gaged Flows are measured after depletions by Beneficial Consumptive Use and change in reservoir storage.

Attachment 2: Description of the Consensus Plan for Harlan County Lake

The Consensus Plan for operating Harlan County Lake was conceived after extended discussions and negotiations between Reclamation and the Corps. The agreement shaped at these meetings provides for sharing the decreasing water supply into Harlan County Lake. The agreement provides a consistent procedure for: updating the reservoir elevation/storage relationship, sharing the reduced inflow and summer evaporation, and providing a January forecast of irrigation water available for the following summer.

During the interagency discussions the two agencies found agreement in the following areas:

- The operating plan would be based on current sediment accumulation in the irrigation pool and other zones of the project.
- Evaporation from the lake affects all the various lake uses in proportion to the amount of water in storage for each use.
- During drought conditions, some water for irrigation could be withdrawn from the sediment pool.
- Water shortage would be shared between the different beneficial uses of the project, including fish, wildlife, recreation and irrigation.

To incorporate these areas of agreement into an operation plan for Harlan County Lake, a mutually acceptable procedure addressing each of these items was negotiated and accepted by both agencies.

1. Sediment Accumulation.

The most recent sedimentation survey for Harlan County project was conducted in 1988, 37 years after lake began operation. Surveys were also performed in 1962 and 1972; however, conclusions reached after the 1988 survey indicate that the previous calculations are unreliable. The 1988 survey indicates that, since closure of the dam in 1951, the accumulated sediment is distributed in each of the designated pools as follows:

Flood Pool	2,387 Acre-feet
Irrigation Pool	4,853 Acre-feet
Sedimentation Pool	33,527 Acre-feet

To insure that the irrigation pool retained 150,000 Acre-feet of storage, the bottom of the irrigation pool was lowered to 1,932.4 feet, msl, after the 1988 survey.

To estimate sediment accumulation in the lake since 1988, we assumed similar conditions have occurred at the project during the past 11 years. Assuming a consistent rate of deposition since 1988, the irrigation pool has trapped an additional 1,430 Acre-feet.

A similar calculation of the flood control pool indicates that the flood control pool has captured an additional 704 Acre-feet for a total of 3,090 Acre-feet since construction.

The lake elevations separating the different pools must be adjusted to maintain a 150,000-acre-foot irrigation pool and a 500,000-acre-foot flood control pool. Adjusting these elevations results in the following new elevations for the respective pools (using the 1988 capacity tables).

Top of Irrigation Pool	1,945.70 feet, msl
Top of Sediment Pool	1,931.75 feet, msl

Due to the variability of sediment deposition, we have determined that the elevation capacity relationship should be updated to reflect current conditions. We will complete a new sedimentation survey of Harlan County Lake this summer, and new area capacity tables should be available by early next year. The new tables may alter the pool elevations achieved in the Consensus Plan for Harlan County Lake.

2. Summer Evaporation.

Evaporation from a lake is affected by many factors including vapor pressure, wind, solar radiation, and salinity of the water. Total water loss from the lake through evaporation is also affected by the size of the lake. When the lake is lower, the surface area is smaller and less water loss occurs. Evaporation at Harlan County Lake has been estimated since the lake's construction using a Weather Service Class A pan which is 4 feet in diameter and 10 inches deep. We and Reclamation have jointly reviewed this information and assumed future conditions to determine an equitable method of distributing the evaporation loss from the project between irrigation and the other purposes.

During those years when the irrigation purpose expected a summer water yield of 119,000 Acre-feet or more, it was determined that an adequate water supply existed and no sharing of evaporation was necessary. Therefore, evaporation evaluation focused on the lower pool elevations when water was scarce. Times of water shortage would also generally be times of higher evaporation rates from the lake.

Reclamation and we agreed that evaporation from the lake during the summer (June through September) would be distributed between the irrigation and sediment pools based on their relative percentage of the total storage at the time of evaporation. If the sediment pool held 75 percent of the total storage, it would be charged 75 percent of the evaporation. If the sediment pool held 50 percent of the total storage, it would be charged 50 percent of the evaporation. At the bottom of the irrigation pool (1,931.75 feet, msl) all of the evaporation would be charged to the sediment pool.

Due to downstream water rights for summer inflow, neither the irrigation nor the sediment pool is credited with summer inflow to the lake. The summer inflows would be

assumed passed through the lake to satisfy the water right holders. Therefore, Reclamation and we did not distribute the summer inflow between the project purposes.

As a result of numerous lake operation model computer runs by Reclamation, it became apparent that total evaporation from the project during the summer averaged about 25,000 Acre-feet during times of lower lake elevations. These same models showed that about 20 percent of the evaporation should be charged to the irrigation pool, based on percentage in storage during the summer months. About 20 percent of the total lake storage is in the irrigation pool when the lake is at elevation 1,935.0 feet, msl. As a result of the joint study, Reclamation and we agreed that the irrigation pool would be credited with 20,000 Acre-feet of water during times of drought to share the summer evaporation loss.

Reclamation and we further agreed that the sediment pool would be assumed full each year. In essence, if the actual pool elevation were below 1,931.75 feet, msl, in January, the irrigation pool would contain a negative storage for the purpose of calculating available water for irrigation, regardless of the prior year's summer evaporation from sediment storage.

3. Irrigation withdrawal from sediment storage.

During drought conditions, occasional withdrawal of water from the sediment pool for irrigation is necessary. Such action is contemplated in the Field Working Agreement and the Harlan County Lake Regulation Manual: "Until such time as sediment fully occupies the allocated reserve capacity, it will be used for irrigation and various conservation purposes, including public health, recreation, and fish and wildlife preservation."

To implement this concept into an operation plan for Harlan County Lake, Reclamation and we agreed to estimate the net spring inflow to Harlan County Lake. The estimated inflow would be used by the Reclamation to provide a firm projection of water available for irrigation during the next season.

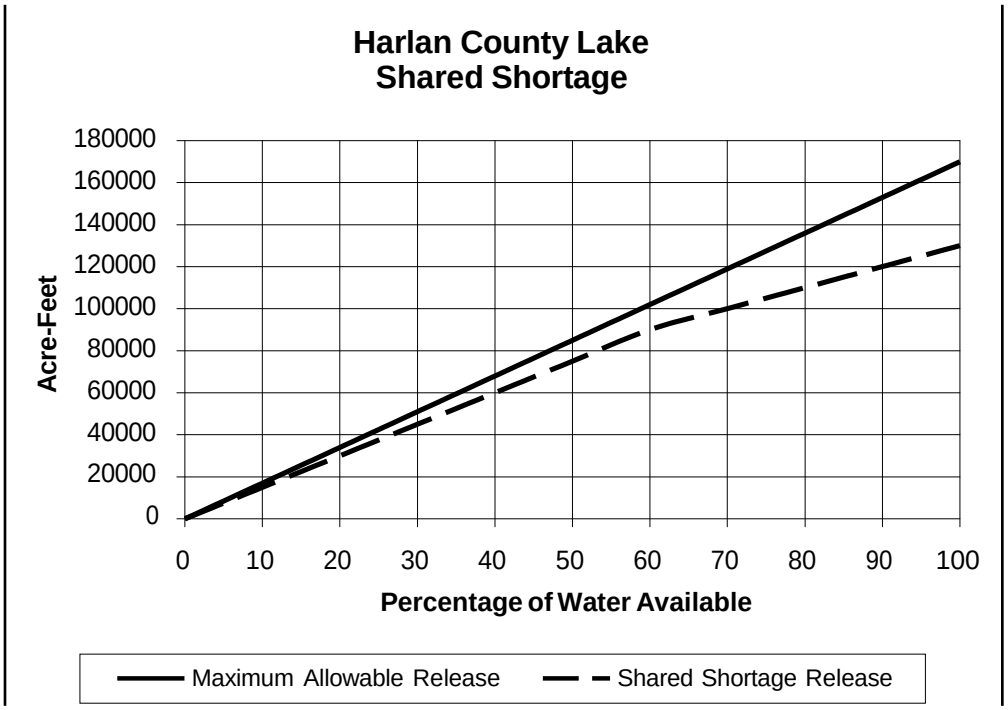
Since the construction of Harlan County Lake, inflows to the lake have been depleted by upstream irrigation wells and farming practices. Reclamation has recently completed an in-depth study of these depleted flows as a part of their contract renewal process. The study concluded that if the current conditions had existed in the basin since 1931, the average spring inflow to the project would have been 57,600 Acre-feet of water. The study further concluded that the evaporation would have been 8,800 Acre-feet of water during the same period. Reclamation and we agreed to use these values to calculate the net inflow to the project under the current conditions.

In addition, both agencies also recognized that the inflow to the project could continue to decrease with further upstream well development and water conservation farming. Due to these concerns, Reclamation and we determined that the previous 5-year inflow values would be averaged each year and compared to 57,600 Acre-feet. The inflow estimate for Harlan County Lake would be the smaller of these two values.

The estimated inflow amount would be used in January of each year to forecast the amount of water stored in the lake at the beginning of the irrigation season. Based on this forecast, the irrigation districts would be provided a firm estimate of the amount of water available for the next season. The actual storage in the lake on May 31 would be reviewed each year. When the actual water in storage is less than the January forecast, Reclamation may draw water from sediment storage to make up the difference.

4. Water Shortage Sharing.

A final component of the agreement involves a procedure for sharing the water available during times of shortage. Under the shared shortage procedure, the irrigation purpose of the project would remove less water then otherwise allowed and alleviate some of the adverse effects to the other purposes. The procedure would also extend the water supply during times of drought by "banking" some water for the next irrigation season. The following graph illustrates the shared shortage releases.



5. Calculation of Irrigation Water Available

Each January, the Reclamation would provide the Bostwick irrigation districts a firm estimate of the quantity of water available for the following season. The firm estimate of water available for irrigation would be calculated by using the following equation and shared shortage adjustment:

Storage + Summer Sediment Pool Evaporation + Inflow – Spring Evaporation=Maximum Irrigation Water Available

The variables in the equation are defined as:

- Maximum Irrigation Water Available. Maximum irrigation supply from Harlan County Lake for that irrigation season.
- Storage. Actual storage in the irrigation pool at the end of December. The sediment pool is assumed full. If the pool elevation is below the top of the sediment pool, a negative irrigation storage value would be used.
- Inflow. The inflow would be the smaller of the past 5-year average inflow to the project from January through May, or 57,600 Acre-feet.
- Spring Evaporation. Evaporation from the project would be 8,800 Acre-feet which is the average January through May evaporation.
- Summer Sediment Pool Evaporation. Summer evaporation from the sediment pool during June through September would be 20,000 Acre-feet. This is an estimate based on lower pool elevations, which characterize the times when it would be critical to the computations.

6. Shared Shortage Adjustment

To ensure that an equitable distribution of the available water occurs during short-term drought conditions, and provide for a "banking" procedure to increase the water stored for subsequent years, a shared shortage plan would be implemented. The maximum water available for irrigation according to the above equation would be reduced according to the following table. Linear interpolation of values will occur between table values.

Shared Shortage Adjustment Table

Irrigation Water Available (Acre-feet)	Irrigation Water Released (Acre-feet)
0	0
17,000	15,000
34,000	30,000
51,000	45,000
68,000	60,000
85,000	75,000
102,000	90,000
119,000	100,000
136,000	110,000
153,000	120,000
170,000	130,000

7. Annual Shutoff Elevation for Harlan County Lake

The annual shutoff elevation for Harlan County Lake would be estimated each January and finally established each June.

The annual shutoff elevation for irrigation releases will be estimated by Reclamation each January in the following manner:

1. Estimate the May 31 Irrigation Water Storage (IWS) (Maximum 150,000 Acre-feet) by taking the December 31 irrigation pool storage plus the January-May inflow estimate (57,600 Acre-feet or the average inflow for the last 5-year period, whichever is less) minus the January-May evaporation estimate (8,800 Acre-feet).
2. Calculate the estimated Irrigation Water Available, including all summer evaporation, by adding the Estimated Irrigation Water Storage (from item 1) to the estimated sediment pool summer evaporation (20,000 AF).
3. Use the above Shared Shortage Adjustment Table to determine the acceptable Irrigation Water Release from the Irrigation Water Available.
4. Subtract the Irrigation Water Release (from item 3) from the Estimated IWS (from item 1). The elevation of the lake corresponding to the resulting irrigation storage is the Estimated Shutoff Elevation. The shutoff elevation will not be below the bottom of the irrigation pool if over 119,000 AF of water is supplied to the districts, nor below 1,927.0 feet, msl. If the shutoff elevation is below the irrigation pool, the maximum irrigation release is 119,000 AF.

The annual shutoff elevation for irrigation releases would be finalized each June in accordance with the following procedure:

1. Compare the estimated May 31 IWS with the actual May 31 IWS.
2. If the actual end of May IWS is less than the estimated May IWS, lower the shutoff elevation to account for the reduced storage.
3. If the actual end of May IWS is equal to or greater than the estimated end of May IWS, the estimated shutoff elevation is the annual shutoff elevation.
4. The shutoff elevation will never be below elevation1,927.0 feet, msl, and will not be below the bottom of the irrigation pool if more than 119,000 Acre-feet of water is supplied to the districts.

Attachment 3: Inflows to Harlan County Lake 1993 Level of Development

BASELINE RUN - 1993 LEVEL INFLOW TO HARLAN COUNTY RESERVOIR

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1931	10.2	10.8	13.4	5.0	18.8	15.8	4.3	1.8	1.8	0.0	0.1	0.1	82.1
1932	6.8	16.6	18.5	4.6	3.8	47.6	3.8	2.8	4.8	0.0	0.0	0.4	109.7
1933	0.4	0.0	3.9	30.2	31.0	5.4	1.8	0.0	10.4	0.0	2.6	5.5	91.2
1934	2.1	0.0	3.2	1.8	0.7	7.3	0.8	0.0	1.3	0.0	2.2	0.0	19.4
1935	0.3	0.1	0.7	4.2	0.8	389.3	6.1	19.1	26.1	2.4	5.2	0.9	455.2
1936	0.3	0.0	11.9	0.0	35.9	4.7	0.4	0.0	1.8	0.0	1.6	3.8	60.4
1937	4.8	12.9	6.0	2.5	0.0	12.6	6.3	6.9	2.4	0.0	0.0	12.4	66.8
1938	9.9	7.8	8.7	10.4	18.7	8.6	7.3	7.8	4.9	0.2	0.0	4.7	89.0
1939	2.7	7.5	9.6	12.2	6.6	13.3	5.0	4.1	0.0	0.0	0.0	0.0	61.0
1940	0.0	0.0	12.2	5.2	4.6	23.7	2.8	3.2	0.0	3.6	0.0	1.4	56.7
1941	0.0	10.6	10.6	7.7	17.2	67.1	28.9	19.7	14.9	8.3	6.7	7.1	198.8
1942	3.3	10.6	0.5	34.1	30.8	83.9	11.7	10.9	36.5	3.1	8.7	0.3	234.4
1943	1.2	11.2	14.6	31.4	4.7	28.3	4.8	0.3	0.9	0.0	0.0	11.8	109.2
1944	0.1	4.3	9.0	43.1	31.9	63.9	26.6	15.4	0.5	0.3	3.0	4.5	202.6
1945	4.3	7.8	5.7	9.5	4.1	53.5	5.0	0.9	1.5	5.0	6.0	6.3	109.6
1946	5.9	11.2	9.3	4.9	7.0	3.1	1.6	11.4	28.1	129.9	25.0	12.1	249.5
1947	1.1	3.2	10.4	8.2	11.9	195.4	22.3	5.9	2.9	0.2	0.3	0.3	262.1
1948	6.2	9.8	24.1	5.4	0.2	39.8	13.5	6.8	4.2	0.0	0.1	0.1	110.2
1949	2.0	1.5	25.2	16.3	49.0	57.4	9.2	5.5	2.1	3.0	2.8	0.3	174.3
1950	0.3	5.7	10.8	10.9	28.9	10.1	12.7	9.3	7.8	7.2	3.8	3.1	110.6
1951	3.8	3.4	7.1	5.3	42.0	39.9	42.1	10.1	36.0	15.5	14.8	8.9	228.9
1952	16.4	21.4	26.3	23.8	34.6	4.0	9.3	3.1	1.5	11.7	4.3	0.1	156.5
1953	1.8	4.6	5.3	3.3	15.1	9.5	1.8	0.2	0.0	0.0	2.8	0.1	44.5
1954	1.0	6.8	1.9	3.2	7.1	2.4	0.0	1.2	0.0	0.0	0.0	0.0	23.6
1955	0.0	4.0	6.3	4.8	2.9	6.4	2.7	0.0	1.4	0.0	0.0	0.0	28.5
1956	1.6	3.4	2.9	2.4	1.3	1.5	0.0	0.6	0.0	0.0	0.0	0.0	13.7
1957	0.0	4.1	6.2	12.8	3.5	62.4	21.3	1.2	2.0	3.4	4.5	4.7	126.1
1958	0.8	3.0	14.2	14.0	18.7	1.3	3.4	2.2	0.0	0.4	0.0	0.6	58.6
1959	1.9	15.4	16.4	8.5	13.6	4.2	1.4	1.2	0.0	4.3	1.0	4.5	72.4
1960	1.4	12.3	71.4	23.9	21.7	53.7	14.1	3.2	0.0	0.0	0.2	2.8	204.7
1961	2.3	6.4	7.7	7.4	26.5	24.0	7.2	4.9	0.0	2.3	4.8	1.7	95.2

Attachment 3: Inflows to Harlan County Lake 1993 Level of Development

BASELINE RUN - 1993 LEVEL INFLOW TO HARLAN COUNTY RESERVOIR

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1962	4.5	9.1	16.2	9.9	14.4	42.6	41.6	21.1	2.3	8.7	8.3	5.7	184.4
1963	3.4	18.2	18.2	15.0	12.7	14.7	3.4	6.1	8.7	0.8	5.3	1.8	108.3
1964	5.4	7.6	8.3	8.4	9.9	11.9	7.2	6.5	2.4	1.9	1.4	2.3	73.2
1965	6.0	8.1	11.1	12.8	32.8	40.0	22.9	6.5	37.2	53.7	19.5	11.0	261.6
1966	8.9	21.4	15.7	11.4	12.0	34.7	12.4	2.5	3.5	5.4	6.8	5.7	140.4
1967	7.2	11.5	11.5	12.9	9.1	75.3	43.7	15.3	4.4	7.3	6.9	5.4	210.5
1968	3.9	10.2	8.5	11.6	10.8	12.5	3.1	2.7	1.6	2.0	4.3	3.4	74.6
1969	4.2	10.8	24.5	15.1	18.9	17.5	17.0	12.6	16.6	9.2	11.8	9.9	168.1
1970	3.5	8.7	8.5	10.5	11.1	7.7	4.6	3.2	0.5	3.3	4.7	4.5	70.8
1971	4.1	10.3	12.4	12.8	18.3	7.2	8.4	6.2	1.9	4.2	7.3	7.1	100.2
1972	5.5	8.1	9.2	8.3	14.8	8.5	6.5	4.4	0.1	2.9	7.6	4.1	80.0
1973	11.4	14.2	19.0	16.2	17.4	20.9	9.1	1.9	8.4	19.6	11.9	13.2	163.2
1974	13.2	13.4	12.0	14.3	15.4	17.2	5.5	0.0	0.0	0.0	4.9	5.5	101.4
1975	7.2	8.2	13.6	14.8	12.0	48.1	11.6	7.4	0.1	3.0	6.2	7.3	139.5
1976	7.0	10.2	10.1	16.0	12.1	3.5	2.2	1.8	0.9	1.0	3.2	3.1	71.1
1977	4.4	9.6	12.9	21.2	31.5	12.1	5.9	1.9	10.6	4.1	5.5	5.3	125.0
1978	5.0	6.5	20.6	12.9	11.8	3.8	0.0	1.0	0.0	0.0	0.3	1.6	63.5
1979	1.3	7.6	21.5	18.8	15.9	5.4	10.4	10.6	1.6	0.9	3.6	6.2	103.8
1980	5.7	9.3	11.6	15.2	10.4	2.1	2.5	0.0	0.0	0.0	2.5	2.2	61.5
1981	5.5	6.0	11.6	14.9	22.5	6.4	11.5	16.3	4.3	2.5	6.7	6.2	114.4
1982	5.3	12.5	17.9	14.3	26.8	27.1	8.9	2.7	0.0	6.5	6.3	15.5	143.8
1983	6.5	9.7	27.2	16.4	41.4	74.2	10.7	7.6	3.8	3.1	6.7	5.2	212.5
1984	6.8	14.6	17.2	32.9	40.6	15.5	8.1	4.5	0.0	5.5	4.8	6.2	156.7
1985	6.9	14.1	13.6	11.9	27.4	9.9	10.0	2.0	6.0	8.5	5.6	5.8	121.7
1986	9.1	9.4	12.2	11.7	34.3	13.0	13.5	4.6	3.3	5.9	5.4	7.1	129.5
1987	5.9	9.2	19.7	24.1	24.3	11.7	19.0	5.7	2.3	2.7	8.2	7.0	139.8
1988	6.2	13.7	11.6	15.2	15.2	7.0	17.9	10.4	0.6	2.0	5.9	5.4	111.1
1989	5.4	5.9	10.5	9.1	11.4	11.8	14.0	6.2	0.2	3.1	3.1	3.5	84.2
1990	6.6	7.7	13.2	9.7	15.5	1.4	4.3	10.7	0.6	3.2	2.0	2.7	77.6
1991	2.4	8.0	9.0	10.6	15.2	3.9	1.9	0.5	0.0	0.0	2.7	4.8	59.0
1992	8.0	8.8	12.7	8.5	4.5	6.1	6.5	9.4	2.4	6.9	6.7	5.2	85.7
1993	5.2	14.4	71.6	22.7	21.0	17.0	68.0	37.5	23.3	16.8	30.1	17.7	345.3
Avg	4.5	8.8	14.1	13.0	17.2	30.6	11.0	6.2	5.4	6.3	5.0	4.7	126.8

Attachment 4: Evaporation Loss Harlan County Lake 1993 Level of Development

BASELINE - 1993 LEVEL FLOWS - HARLAN COUNTY EVAPORATION

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1931	0.7	0.9	1.6	2.9	4.2	7.4	6.9	5.2	2.7	2.1	1.2	0.4	36.2
1932	0.6	0.8	1.5	2.7	4.1	5.0	6.8	5.0	2.7	2.1	1.2	0.4	32.9
1933	0.6	0.8	1.4	2.5	3.8	7.8	6.1	4.2	2.7	2.1	1.2	0.4	33.6
1934	0.6	0.8	1.4	2.4	4.5	6.5	8.0	6.2	2.7	2.0	1.2	0.4	36.7
1935	0.6	0.8	1.3	2.3	2.2	3.6	9.7	6.2	3.1	2.5	1.4	0.5	34.2
1936	0.7	0.9	1.6	2.9	5.5	6.8	8.7	6.5	2.7	2.1	1.2	0.4	40.0
1937	0.6	0.8	1.4	2.5	3.6	4.0	6.2	6.5	2.7	2.1	1.2	0.4	32.0
1938	0.6	0.9	1.5	2.7	3.4	4.9	6.5	5.7	2.7	2.1	1.2	0.4	32.6
1939	0.6	0.8	1.4	2.6	4.3	4.9	6.8	4.6	2.7	2.1	1.2	0.4	32.4
1940	0.6	0.8	1.4	2.4	3.5	5.0	6.5	4.6	2.7	2.1	1.2	0.4	31.2
1941	0.6	0.8	1.4	2.5	3.9	4.2	6.7	5.3	2.8	2.1	1.3	0.5	32.1
1942	0.6	0.9	1.5	2.8	4.0	5.2	8.3	5.1	3.2	2.5	1.5	0.5	36.1
1943	0.7	1.0	1.8	3.2	4.3	5.7	7.9	6.3	2.7	2.1	1.2	0.4	37.3
1944	0.6	0.8	1.4	2.7	4.2	5.3	7.0	5.8	3.5	2.6	1.5	0.5	35.9
1945	0.7	1.0	1.8	3.1	3.8	3.0	6.7	5.7	2.9	2.2	1.3	0.5	32.7
1946	0.6	0.9	1.6	2.8	3.5	5.1	5.6	4.4	2.9	2.7	1.8	0.6	32.5
1947	1.0	1.5	2.9	3.2	3.4	-1.2	5.8	5.3	3.7	1.7	0.5	0.1	27.9
1948	0.8	0.7	1.5	3.6	3.1	2.4	4.2	4.7	3.0	2.7	0.8	0.3	27.8
1949	0.1	0.9	0.7	1.8	1.1	0.7	6.5	4.1	3.1	1.7	1.5	0.4	22.6
1950	0.7	0.1	0.8	2.8	2.0	5.6	0.8	2.8	4.5	2.3	1.6	0.6	24.6
1951	0.5	0.2	2.1	0.7	-0.1	1.9	3.5	4.1	0.4	3.1	2.2	0.9	19.5
1952	1.1	1.2	1.9	2.5	5.2	6.2	1.5	3.4	3.6	2.9	1.1	-0.1	30.5
1953	0.5	1.0	1.5	2.9	4.7	4.5	4.6	6.6	5.3	3.3	0.1	0.0	35.0
1954	0.7	0.6	2.2	3.6	0.3	4.9	6.7	1.6	3.6	1.6	1.5	0.6	27.9
1955	0.5	1.0	2.1	4.6	3.4	-0.5	7.3	6.9	2.7	2.6	1.4	0.4	32.4
1956	0.6	1.1	1.9	2.8	3.9	4.5	5.0	3.7	4.7	3.7	1.3	0.5	33.7
1957	0.7	1.0	1.3	0.5	-0.6	-1.1	6.1	3.7	2.3	1.7	1.2	0.4	17.2
1958	0.7	0.1	1.0	0.6	2.3	4.4	1.0	1.9	3.3	3.3	1.0	0.6	20.2
1959	0.4	1.0	1.1	2.1	1.0	3.5	5.0	4.8	2.3	0.7	1.5	0.6	24.0
1960	0.1	0.7	2.0	2.7	0.9	0.1	4.9	3.6	3.9	2.0	1.3	0.4	22.6
1961	0.9	1.0	1.4	2.7	-1.1	0.6	5.1	2.9	1.2	2.4	0.7	0.1	17.9

Attachment 4: Evaporation Loss Harlan County Lake 1993 Level of Development

BASELINE - 1993 LEVEL FLOWS - HARLAN COUNTY EVAPORATION

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1962	0.6	0.6	0.9	3.7	3.4	1.5	0.3	1.6	2.0	2.0	1.7	0.3	18.6
1963	0.7	1.4	1.3	4.5	4.6	6.3	6.1	3.1	-0.8	2.7	1.5	0.4	31.8
1964	0.8	0.8	1.7	3.2	5.6	1.2	6.9	3.0	3.0	3.3	1.2	0.6	31.3
1965	0.4	0.7	1.2	2.8	1.5	-0.5	2.0	2.8	-3.9	1.7	2.1	0.4	11.2
1966	0.9	0.8	2.9	2.7	7.5	2.8	5.8	3.7	2.7	2.8	1.5	0.4	34.5
1967	0.7	1.2	2.5	3.0	2.0	-2.9	1.6	4.5	3.5	2.0	1.6	0.4	20.1
1968	0.9	1.2	2.8	2.6	3.2	4.9	4.7	1.8	2.3	0.7	1.2	0.2	26.5
1969	0.4	0.6	2.4	3.3	0.1	3.8	-0.7	2.9	2.2	-1.0	1.5	0.4	15.9
1970	0.7	1.4	2.3	2.8	4.7	4.4	6.5	5.9	0.9	1.0	1.5	0.7	32.8
1971	0.7	0.2	2.0	2.9	0.7	5.1	3.4	4.5	1.4	1.5	0.2	0.5	23.1
1972	0.8	1.3	2.0	1.7	1.1	0.0	3.3	1.8	2.1	1.7	-0.4	0.1	15.5
1973	0.5	1.1	-0.7	2.5	3.4	6.7	-1.7	4.2	-3.0	0.2	0.2	0.2	13.6
1974	0.7	1.5	2.6	1.5	3.7	2.5	9.1	2.6	3.4	1.4	1.1	0.3	30.4
1975	0.7	0.7	2.0	2.1	0.8	1.1	4.3	2.7	3.0	3.4	0.7	0.6	22.1
1976	0.8	1.2	1.7	0.7	1.5	5.0	5.9	5.7	-0.2	1.4	1.4	0.7	25.8
1977	0.7	1.3	0.2	1.1	0.0	4.6	4.0	0.6	2.0	1.6	1.0	0.4	17.5
1978	0.5	0.7	1.2	3.4	3.9	6.2	7.1	4.5	4.5	3.0	1.1	0.5	36.6
1979	0.5	0.6	1.1	3.9	4.4	4.6	3.5	5.1	4.1	2.8	1.4	0.7	32.7
1980	0.5	0.6	1.2	3.4	3.7	4.7	6.8	6.0	3.9	2.7	1.3	0.6	35.4
1981	0.5	0.6	1.2	3.8	3.2	4.8	4.2	3.7	2.9	1.7	1.3	0.7	28.6
1982	0.5	0.7	1.2	3.9	3.8	3.9	5.1	3.8	2.9	2.2	1.4	0.8	30.2
1983	0.5	0.7	1.4	2.9	4.2	5.3	8.6	7.2	4.6	1.8	1.5	0.6	39.3
1984	0.6	0.8	1.4	2.9	4.2	5.8	7.2	5.7	4.7	1.4	1.4	0.7	36.8
1985	0.5	0.7	1.3	2.3	4.0	4.5	5.6	3.5	3.8	1.5	1.5	0.7	29.9
1986	0.6	0.7	1.3	2.8	4.4	5.8	6.7	4.0	2.7	1.3	1.4	0.7	32.4
1987	0.5	0.8	1.3	3.1	4.2	6.2	6.9	3.5	3.1	2.2	1.4	0.7	33.9
1988	0.5	0.7	1.3	3.5	4.9	6.6	4.6	4.8	3.5	2.2	1.4	0.7	34.7
1989	0.5	0.7	1.2	4.2	4.5	4.4	4.8	3.6	3.0	2.5	1.4	0.7	31.5
1990	0.5	0.7	1.2	3.0	3.5	5.6	6.4	4.0	5.0	3.4	1.4	0.6	35.3
1991	0.5	0.7	1.2	2.8	3.3	5.5	6.0	5.0	5.1	3.2	1.3	0.6	35.2
1992	0.6	0.7	1.2	1.8	3.2	2.2	4.1	3.5	4.2	2.9	1.9	1.0	27.3
1993	0.6	0.5	1.0	2.2	3.1	4.6	4.2	4.9	4.5	4.4	3.1	1.2	34.3
Avg	0.6	0.8	1.5	2.7	3.2	3.9	5.3	4.3	2.8	2.2	1.3	0.5	29.1

Attachment 5: Projected Water Supply Spread Sheet Calculations

Trigger Calculations Based on Harlan County Lake Irrigation Supply	Units-1000 Acre-feet	Irrigation Trigger	119.0	Assume that during irrigation release season HCL Inflow = Evaporation Loss
		Total Irrigation Supply	130.0	
		Bottom Irrigation	164.1	
		Evaporation Adjust	20.0	

	Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Total**
1993 Level AVE inflow	6.3	5	4.7	4.5	8.8	14.1	13.0	17.2	30.6	11.0	6.2	5.4	126.8
1993 Level AVE evap	2.2	1.3	0.5	0.6	0.8	1.5	2.7	3.2	3.9	5.3	4.3	2.8	29.1
(1931-93)													
Avg. Inflow Last 5 Years	10.8	13.0	12.3	12.9	16.6	22.4	19.4	18.1	14.8	16.5	11.0	4.7	172.6

Year 2001-2002 Oct - Jun Trigger and Irrigation Supply Calculation									
Calculation Month	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**
Previous EOM Content	236.5	235.9	238.6	242.9	248.1	255.1	263.8	269.6	276.2
Inflow to May 31	73.6	67.3	62.3	57.6	53.1	44.3	30.2	17.2	0.0
Last 5 Yrs Avg Inflow to May 31	125.6	114.8	101.7	89.5	76.6	59.9	37.5	18.1	0.0
Evap to May 31	12.8	10.6	9.3	8.8	8.2	7.4	5.9	3.2	0.0
Est. Cont May 31	297.3	292.6	291.6	291.7	293.0	292.0	288.1	283.6	276.2
Est. Elevation May 31	1944.44	1944.08	1944.00	1944.01	1944.11	1944.03	1943.72	1943.37	1942.77
Max. Irrigation Available	153.2	148.5	147.5	147.6	148.9	147.9	144.0	139.5	132.1
Irrigation Release Est.	120.1	117.4	116.8	116.8	118.1	117.1	116.8	116.8	116.8
Trigger - Yes/No	NO	YES	YES	YES	YES	YES	YES	YES	YES
130 kAF Irrigation Supply - Yes/No	NO	NO	NO	NO	NO	NO	NO	NO	NO

Attachment 5: Projected Water Supply Spread Sheet Calculations

Year 2002 **Jul - Sep** **Final Trigger and** **Total Irrigation Supply** **Calculation**				
Calculation Month		**Jul**	**Aug**	**Sep**
Previous EOM Irrigation Release Est.		116.8	116.0	109.7
Previous Month Inflow		5.5	0.5	1.3
Previous Month Evap		6.3	6.8	6.6
Irrigation Release Estimate		116.0	109.7	104.4
Final Trigger - Yes/No		YES		
130 kAF Irrigation Supply - Yes/No		NO	NO	NO

Attachment 6: Computing Water Supplies and Consumptive Use Above Guide Rock

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
Total Main Stem VWS	Hardy gage	Superior-Courtland Diversion Dam Gage	Courtland Canal Diversions	Superior Canal Diversions	Courtland Canal Returns	Superior Canal Returns	Total Bostwick Returns Below Guide Rock	NE CBCU Below Guide Rock	KS CBCU Below Guide Rock	Total CBCU Below Guide Rock	Gain Guide Rock to Hardy	VWS Guide Rock to Hardy	Main Stem Virgin Water Supply Above Guide Rock	Nebraska Main Stem Allocation Above Hardy	Kansas Main Stem Allocation Above Hardy	Nebraska Guide Rock to Hardy Allocation	Kansas Guide Rock to Hardy Allocation
							Col F+ Col G			Col I + Col J	+ Col B - Col C+ Col K - Col H	+ Col L + Col K	Col A - Col M	.489 x Col N	.511 x Col N	.489 x Col M	.511 x Col M

Attachment 7: Calculations of Return Flows from Bureau of Reclamation Canals

Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9	Col 10	Col 11	Col 12
Canal	Canal Diversion	Spill to Waste-way	Net Diversion	Field Deliveries	Canal Loss	Average Field Loss Factor	Field Loss	Total Loss from District	Percent field and Canal Loss That Returns to the Stream	Total return to Stream from Canal and Field Loss	Return as Percent of Canal Diversion
Name Canal ∑ Irrigation Season ∑ Non-Irrigation Season	Headgate Diversion	Sum of measured spills to river	Col 2 - Col 3	Sum of deliveries to the field	Col 4 – Col 5	1 – Weighted Average Efficiency of Application System for the District*	Col 5 x Col 7	Col 6 + Col 8	Estimated Percent Loss*	Col 9 x Col 10 + Col 3	Col 11 / Col 2
Example	100	5	95	60	35	30%	18	53	82%	48.46	48.5%
	100	5	95	0	95	30%	0	95	92%	87.4	87.4%
Culbertson						30%			82%		
						30%			92%		
Culbertson Extension						30%			82%		
						30%			92%		
Meeker - Driftwood						30%			82%		
						30%			92%		
Red Willow						30%			82%		
						30%			92%		
Bartley						30%			82%		
						30%			92%		
Cambridge						30%			82%		
						30%			92%		
Naponee						35%			82%		
						35%			92%		
Franklin						35%			82%		
						35%			92%		
Franklin Pump						35%			82%		
						35%			92%		
Almena						30%			82%		
Superior						31%			82%		
						31%			92%		
Nebraska Courtland						23%			82%		
Courtland Canal Above Lovewell (KS)						23%			82%		
Courtland Canal Below Lovewell						23%			82%		

*The average field efficiencies for each district and percent loss that returns to the stream may be reviewed and, if necessary, changed by the RRCA to improve the accuracy of the estimates.

RESOLUTION OF THE REPUBLICAN RIVER COMPACT ADMINISTRATION

REGARDING REQUIRED CHANGES TO THE RRCA ACCOUNTING PROCEDURES AND REPORTING REQUIREMENTS REGARDING NON-IRRIGATION SEASON CANAL DIVERSIONS FOR GROUNDWATER RECHARGE PURPOSES

Whereas, the States of Kansas, Nebraska, and Colorado entered into a Final Settlement Stipulation ("FSS"_) as of December 15, 2002, to resolve pending litigation in the United States Supreme Court regarding the Republican River Compact ("Compact") in the case of *Kansas v. Nebraska and Colorado*, no. 126 Original;

Whereas, the FSS was approved by the United States Supreme Court on May 19, 2003;

Whereas, by memorandum dated May 14, 2015 and provided at the quarterly RRCA Engineering Committee Meeting on that same date, the state of Nebraska introduced the reformed RRCA Accounting Procedures and Reporting Requirements regarding non-irrigation season canal recharge diversions and the estimated percent loss assigned to those diversions.

Whereas, the proposed changes to the RRCA Accounting Procedures and Reporting Requirements shall be enacted for the accounting years 2016 and forward.

NOW THEREFORE BE IT RESOLVED , the Republican River Compact Administration approves and adopts the proposal set forth in Nebraska's May 14, 2015 memorandum, a copy of which is attached hereto as Exhibit A and incorporated as if the same were set forth fully herein with the exception of the following:

> *Provision*: Non-irrigation season canal recharge diversions shall be limited to 10,000 acre-feet. If canal recharge diversions exceed 10,000 acre-feet, the method established for irrigation season canal diversions shall apply.

Approved by the Republican River compact Administration this 27th day of August, 2015.

_____ _____

Gordon W. Fassett, P.E. Date
Nebraska Member

_____ _____

David Barfield, P.E. Date
Kansas Member

_____ _____

Dick Wolfe, P.E. Date
Colorado Member

ATTACHMENT 6 -Part 1 of 3

COLORADO
Division of Water Resources
Department of Natural Resources

1313 Sherman Street, Room 821
Denver, CO 80203

February 24, 2016

Bob Swanson, Director
USGS Nebraska Water Science Center
5231 South 19th Street
Lincoln, NE 68512

Dear Mr. Swanson:

In order to administer the Republican River Compact (Compact), Nebraska, Colorado, and Kansas (the States) must annually exchange and analyze hydrologic data from throughout the Republican River Basin. By April 15 each year, the States exchange data from the previous calendar year. However, the States are often unable to finalize the analyses on-time because USGS has not finalized the data from the stream gages in the basin.

The Republican River Compact Administration (RRCA) appreciates the high-quality data and service that is provided by the USGS. However, the RRCA feels that the USGS could better support Compact accounting efforts in two key ways and therefore requests: First, that preliminary data from USGS stream gages in the Republican River Basin be worked and finalized on a monthly basis to assist ongoing compliance forecasting the States are performing throughout the year. And second, that the USGS finalize all stream gage records for the Basin at the end of each calendar year and make that information available to the Compact Administration by April 1 of each year.

Given the specific responsibilities of the USGS outlined in Article IX of the Republican River Compact to collect and publish these necessary data, we ask that you please consider these requests and let us know whether you believe they are feasible. The RRCA would be happy to further elaborate or answer any questions you might have regarding this request.

Sincerely,

Dick Wolfe

Dick Wolfe, P.E.
Director/State Engineer
Chairman RRCA

Cc: Director, Nebraska Department of Natural Resources
Chief Engineer, Kansas Division of Water Resources

ATTACHMENT 6 - Part 2 of 3

United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Water Resources Discipline
Nebraska Water Science Center
5231 South 19th Street
Lincoln, NE 68512-1271

April 13, 2016

Dick Wolfe, Director/State Engineer
Colorado Division of Water Resources
1313 Sherman Street, Room 821
Denver, CO 80203

Dear Mr. Wolfe:

Thank you for your patience in waiting for the response to you letter of February 24, 2016 regarding requested changes to operation of streamgages that supporting the Republican River Compact Administration (RRCA). Jason Lambrecht (Data Chief, USGS Nebraska Water Science Center (NEWSC)) has been actively pursuing further verification of the requests, which follow:

Request 1: "…preliminary data from USGS stream gages in the Republican River Basin be worked and finalized on a monthly basis to assist ongoing compliance forecasting the States are performing throughout the year."

Request 2: "…the USGS finalize all stream gage records for the Basin at the end of each calendar year and make that information available to the Compact Administration by April 1 of each year."

Because the USGS had further questions regarding this, a phone conference was held on April 6, 2016, with Ivan Franco, Willem Schreuder, Brian Loving (Data Chief, USGS Kansas Water Science Center), Jason Lambrecht, and John Miller (North Platte Field Office Chief, USGS NEWSC) to further discuss the requests.

Discussion during the call regarding Request 1 verified that the RRCA did not require finalized (approved) daily data on a monthly basis, and preliminary (provisional) data was acceptable so long as the data on the NWIS webpage was complete and not missing any daily discharge record. Mr. Schreuder said that the main issue for the RRCA was trying to make monthly projections the USGS records didn't display estimated discharge during periods of backwater from ice (October to December).

Mr. Miller and Mr. Loving assured Mr. Schreuder that the USGS can maintain full record for the 15 Compact streamgages. Also, it was agreed that the RRCA would contact Mr. Miller regarding questions pertaining to the 13 Nebraska streamgages, or Nathan Sullivan (USGS Hays Field Office Chief) pertaining to the two Kansas streamgages.

The USGS will comply with Request 2 and provide finalized (approved) daily streamflow information for the previous calendar year (January 1 to December 31) by April 1 of the following year. Data for both requests will be available through USGS NWISWeb. Mr. Schreuder

said that the RRCA would obtain the data from the USGS NWISWeb and did not require the data to be sent to the RRCA in any other format.

Please feel free to contact me directly, if you have further questions on these two requests.

Sincerely,

Robert B. Swanson
Director, USGS Nebraska Water Science Center

Copy to: Andrew Ziegler
John Miller
Brian Loving

ATTACHMENT 6 -Part 3 of 3

COLORADO
Division of Water Resources
Department of Natural Resources

1313 Sherman Street, Room 821
Denver, CO 80203

May 16, 2016

Bob Swanson, Director
USGS Nebraska Water Science Center
5231 South 19th Street
Lincoln, NE 68512

Dear Mr. Swanson:

This office has received your letter dated April 13, 2016, and the Republican River Compact Administration (RRCA) would like to thank the U.S. Geological Survey (USGS) for working with staff to accommodate the two requests for changes in the way the USGS provides stream gage data to the RRCA. The summary of events outlined in your letter serves as an accurate record of the understanding reached by the USGS and RRCA.

The RRCA looks forward to utilizing the complete record of preliminary gage data, without gaps in daily discharge due to icing, etc., on a monthly basis. As a point of clarification, the RRCA will look for this complete (preliminary) record by the 5th of each month on USGS NWISWeb. Furthermore, the USGS's willingness to provide finalized stream gage records for the entire basin at the end of each calendar year, and make that information available through USGS NWISWeb by April 1st of each year, will be of great value in producing timely RRCA accounting.

The RRCA looks forward to continued work and collaboration with the USGS in administering the Republican River Compact. Should you have any further questions or comments please feel free to contact me directly.

Sincerely,

Dick Wolfe

Dick Wolfe, P.E.
Director/State Engineer
Chairman RRCA

Cc: Director, Nebraska Department of Natural Resources
Chief Engineer, Kansas Division of Water Resources

ATTACHMENT 7

NDNR's Approach to Estimate Non-Federal Reservoirs Evaporation for RRCA Accounting

Amy Zoller

November 13, 2015

For the purposes of RRCA accounting, the net evaporation from non-federal reservoirs within the boundaries of Nebraska's portion of the Republican River Basin is estimated once a year. As the compact specifies, the estimates should be based on the presumptive average annual surface area of the non-federal reservoirs, as well as the calculated net evaporation from the nearest climate and evaporation station to the reservoir. The state may provide actual data in lieu of the presumptive criteria.

For several years, the state of Nebraska's Department of Natural Resources (NDNR) estimated presumptive annual surface area by interpreting the physical extent of reservoirs using Farm Service Agency (FSA) aerial imagery. The imagery showed the extent of reservoir surface area at a fine $(1m)^2$ or $(2m)^2$ cell resolution during the growing season for most years. FSA has only contracted to acquire imagery every three years, but because the aerial imagery is in a high demand by multiple agencies, the FSA is often able to obtain additional funds and can fill in certain years. As such, there were only a couple of years (2008 and 2011) that imagery was not available. In these cases, NDNR used the previous year's imagery to estimate average annual surface area. This was considered the best available data, as actual surveys of reservoirs do not exist for small water bodies that do not require a surface water permit or a or dam safety plan.

In 2009 and 2012, the Natural Resources Conservation District acquired LiDAR (Light detection and Ranging) digital elevation data (DEMs) that together covered nearly all of the extent of the Republican River Basin within the boundaries of Nebraska. The NDNR IT and dam safety sections performed tests on the LiDAR data with respect to known reservoir volumes and areas, and ultimately developed a program that could use the LiDAR data to estimate reservoir volume and surface area for those reservoirs that had not been physically surveyed. The estimated volumes and surface areas were linked to GIS point data layers (i.e. Nebraska inventory of dams) that represent the intersection of the dam and the outflow stream, for water bodies across the state.

The refined Nebraska dams GIS dataset has enabled NDNR to improve their method of estimating net evaporation for compact accounting purposes. The updated Nebraska dams GIS dataset has completely populated attributes that show Normal Surface Area (principle spillway) and Normal Storage Volume of each reservoir, based off of actual surveys, where available, or from calculations derived from LiDAR analysis/processing as discussed above. NDNR's dam safety section updates the dataset annually on a rotating basis across basins. As such, the number of non-federal reservoirs that NDNR includes in compact accounting may vary slightly year to year due to updates to the database (e.g. some reservoirs do not hold water anymore, or recon shows a previously undetected reservoir, etc.). To summarize, the general approach that NDNR currently implements to estimate net evaporation from non-federal reservoirs follows:

1. Query the Nebraska dams GIS dataset for reservoirs that have a normal storage capacity of 15 AF or greater, but less than 200 AF.
2. Calculate the presumptive average annual surface area as 0.25 * the surface area at the principle surface area, interpreted as “normal surface area” in Nebraska inventory of dams (presumptive criteria specified in the compact).
3. Use climate and pan evaporation measurements from the nearest Federal reservoir to estimate net evaporation.
4. Multiply the net evaporation from the nearest Federal reservoir by the presumptive average annual surface area on non-federal reservoirs to estimate net evaporation from these small water bodies
5. For reservoirs 200AF or greater, NDNR field staff perform on-site check(s) of the reservoirs during the year, and report their observations on how reservoir storage. For these larger reservoirs, the presumptive criteria is “full at the principle spillway”, so calculations are performed in the same way as #3-5, but assuming these are full, unless field staff have noted they are empty or only partially full.
6. Summarize net-evaporation estimates for all non-federal reservoirs by sub-basin for accounting purposes.

This is a general description of the methods that NDNR uses to calculate net evaporation from non-federal reservoirs. NDNR is committed to using the best available science, methods and data for compact accounting. If further information is needed please do not hesitate to contact me. Thank you.

Amy L. Zoller, MS
Integrated Water Management Coordinator
State of Nebraska
Department of Natural Resources
301 Centennial Mall South
P.O. Box 94676
Lincoln, NE 68509-4676
Office: (402) 471-0625
amy.zoller@nebraska.gov