

Slattery Water Engineering, LLC

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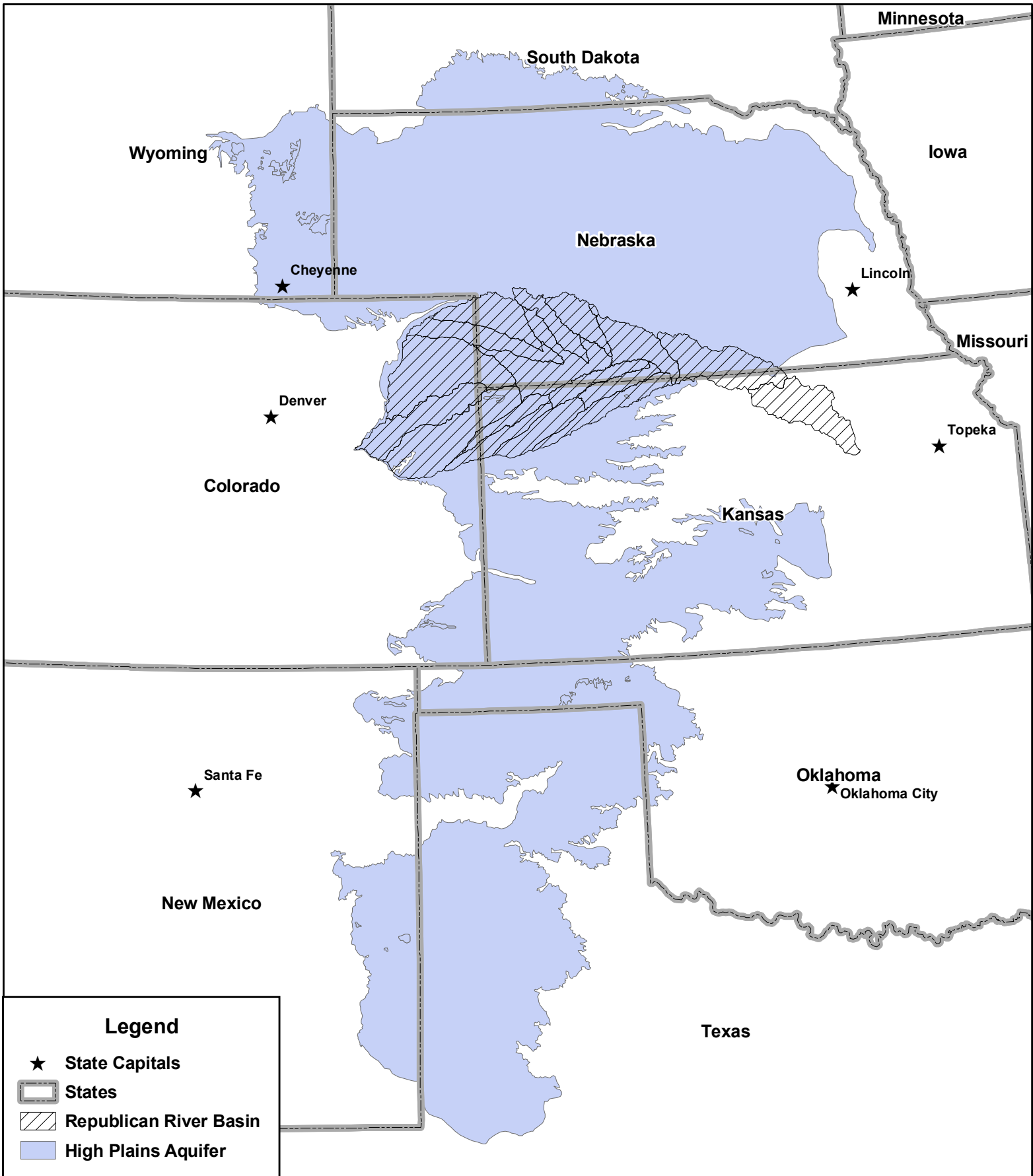
RRWCD Budget Committee

Budget Fee Options

February 22, 2018

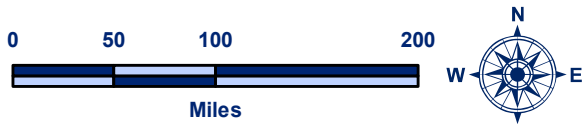
Wray, Colorado

**Presented by
James E. Slattery, P.E.**



Legend

- ★ State Capitals
- ▭ States
- ▨ Republican River Basin
- High Plains Aquifer



Job No.
P2501

File:
Fig 2 - RRB.mxd

Date:
05/17/10

Prepared For:
RRWCD

Figure 2

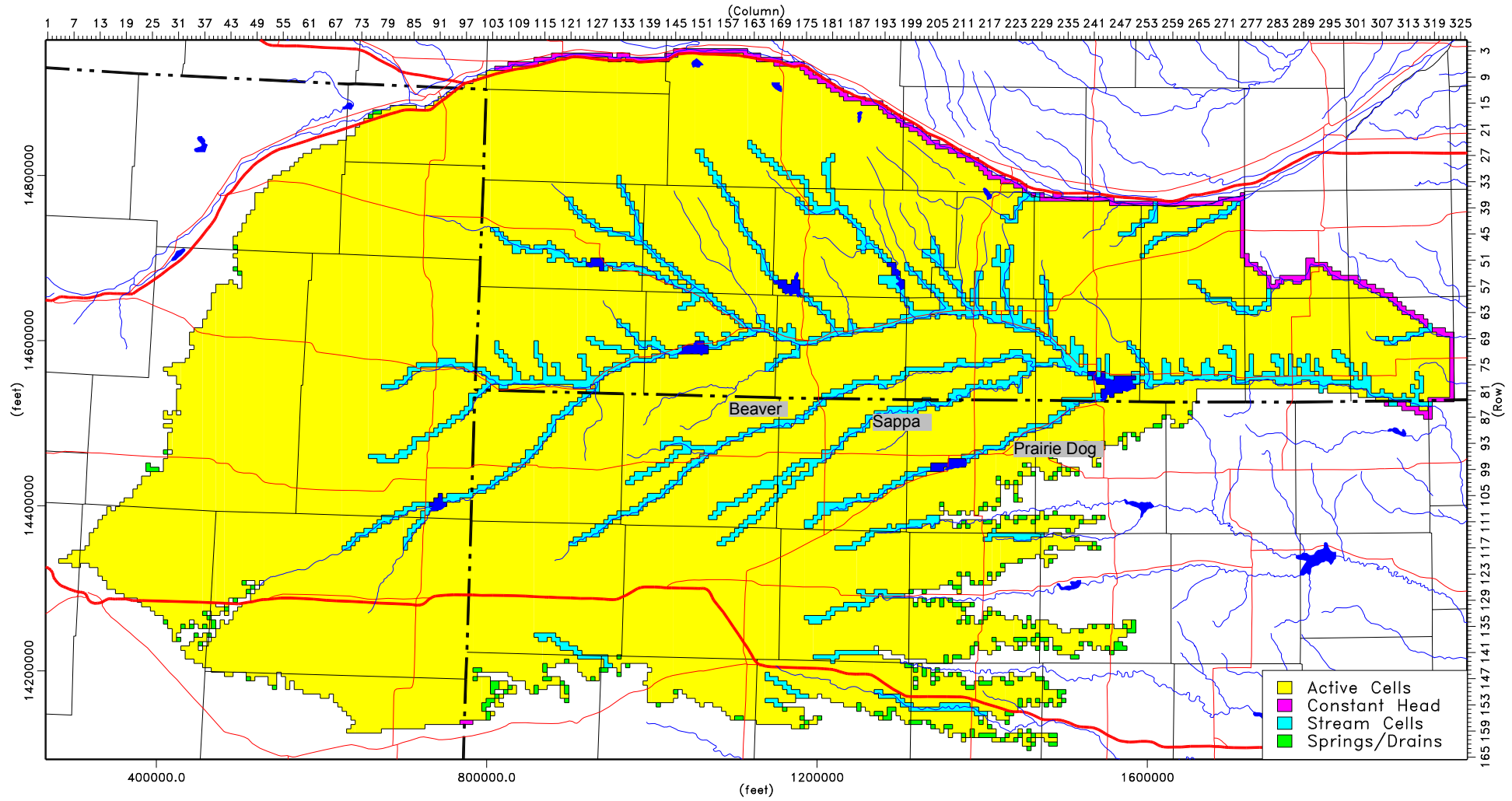
**High Plains Aquifer and
Republican River Basin**

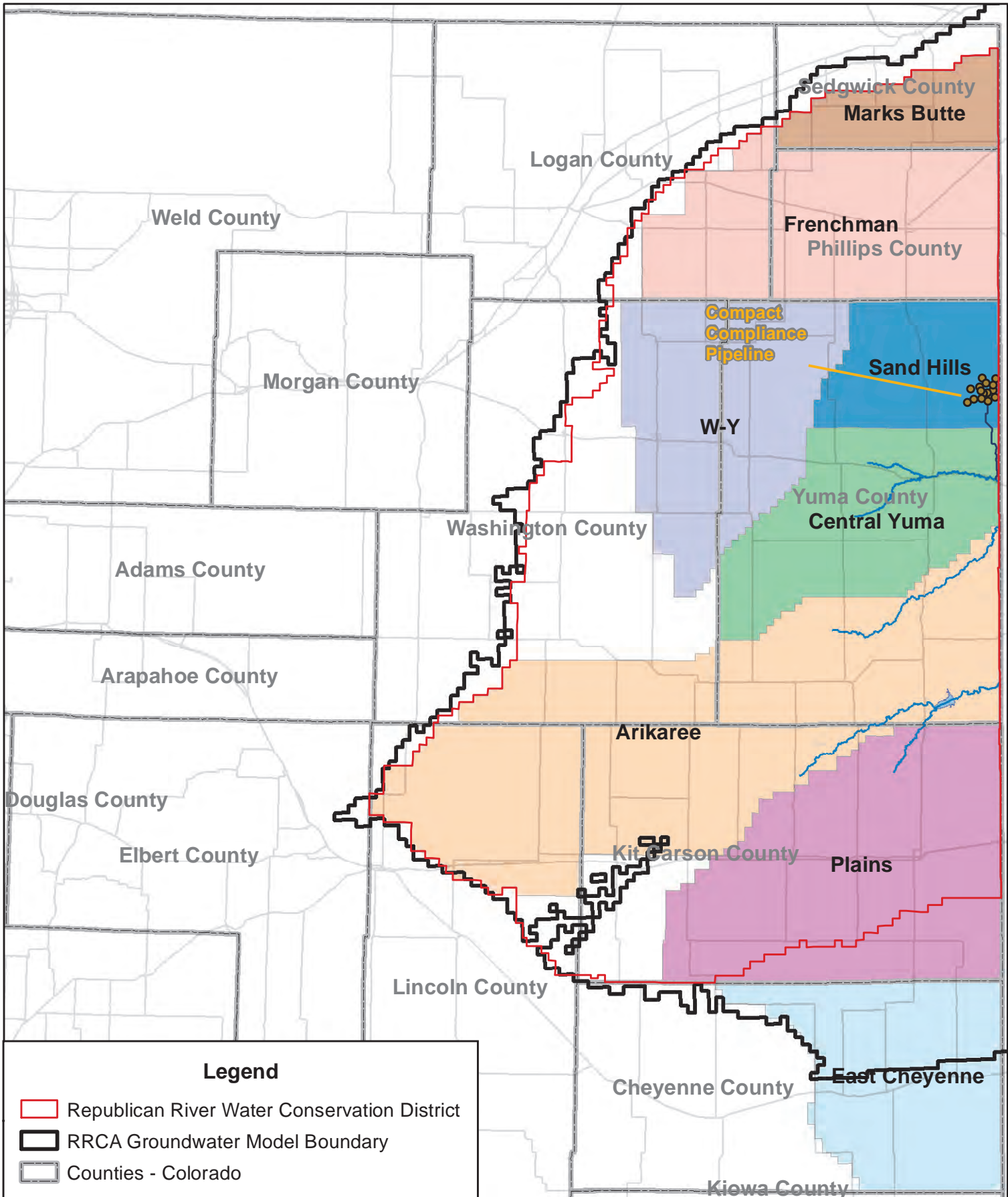


REPUBLICAN RIVER COMPACT

- 1. Republican River Basin Compact Signed in 1942**
- 2. Colorado Allocation estimated at 54,100 ac-ft/yr (current allocation about 23,000)**
- 3. May 1998 Kansas filed complaint against Nebraska in the United States Supreme Court**
- 4. Nebraska countersued Kansas naming Colorado as a formal party in November 2000.**
- 5. December 15, 2002 Final Settlement Stipulation**
 - a. All claims through 2002 waived**
 - b. Moratorium on Future Groundwater development**
 - c. Groundwater model used to calculate stream depletions**
 - d. 2003 represents first year of five year accounting period**
 - e. Allows for Augmentation Wells**

RRCA Ground Water Model Domain





Legend

- Republican River Water Conservation District
- RRCA Groundwater Model Boundary
- Counties - Colorado

0 10 20 40

Miles



**Hendrix Wai
Engineering, Inc.**

Job No.
R1601

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Presentation
Figure 1.mxd

Date:
02/21/2018

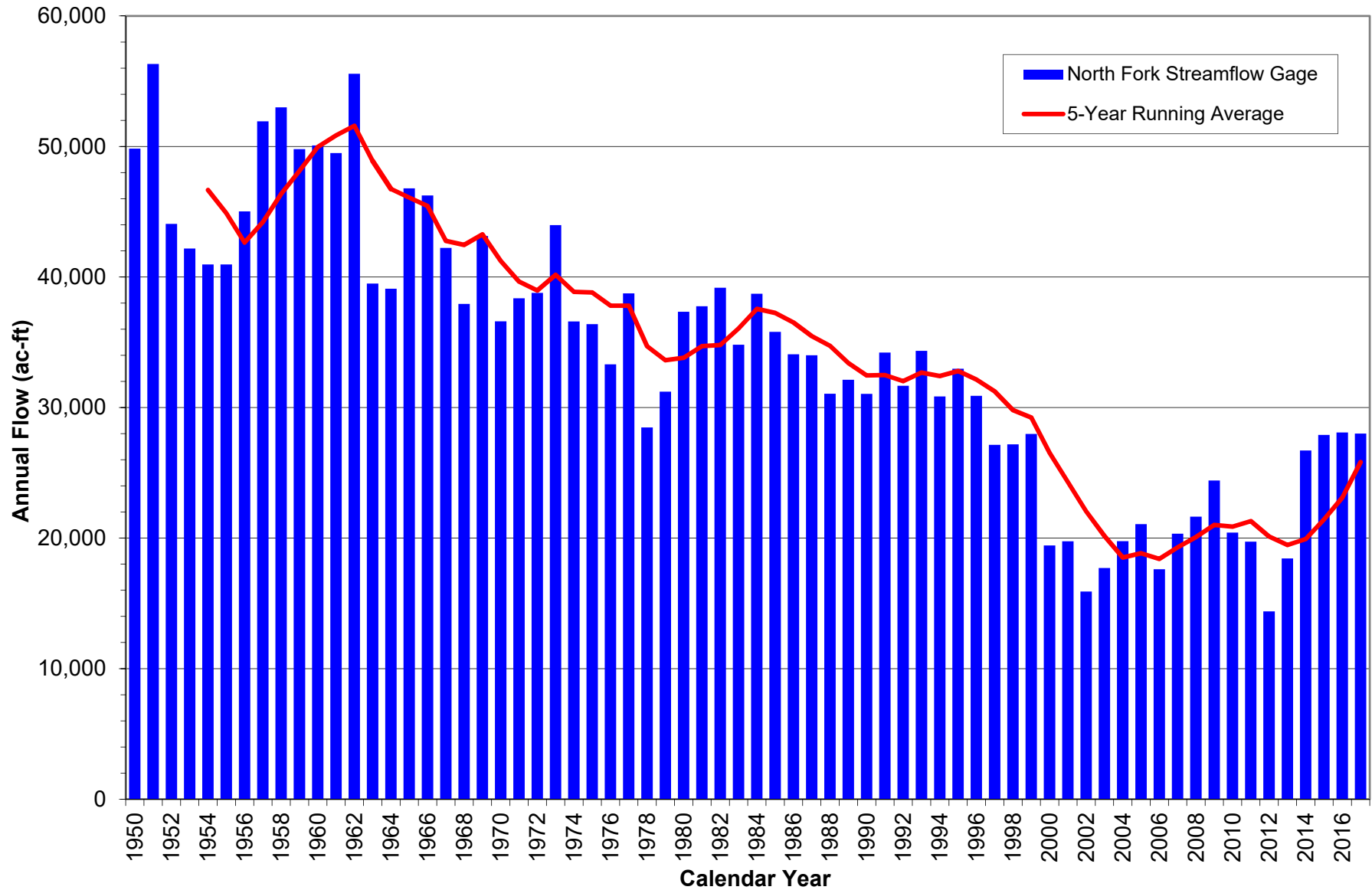
Prepared For:
RRWCD

Figure 1

Colorado Republican River Basin

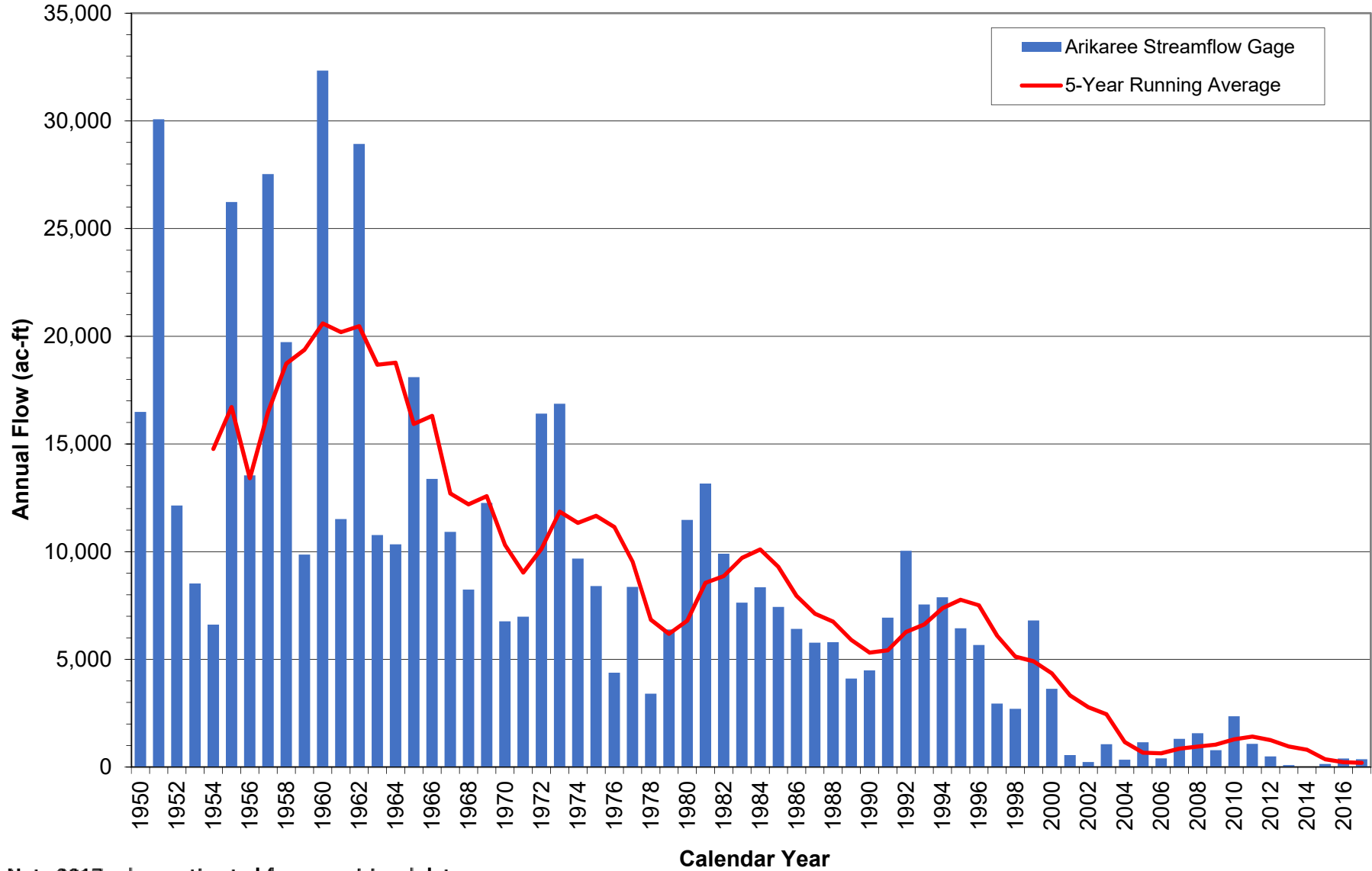
**Republican River Ground Water Model
and
Groundwater Management District Boundaries**

North Fork of Republican River at Colorado-Nebraska Stateline 22.4% of Flow Allocated to Colorado



Note 2017 values estimated from provisional data

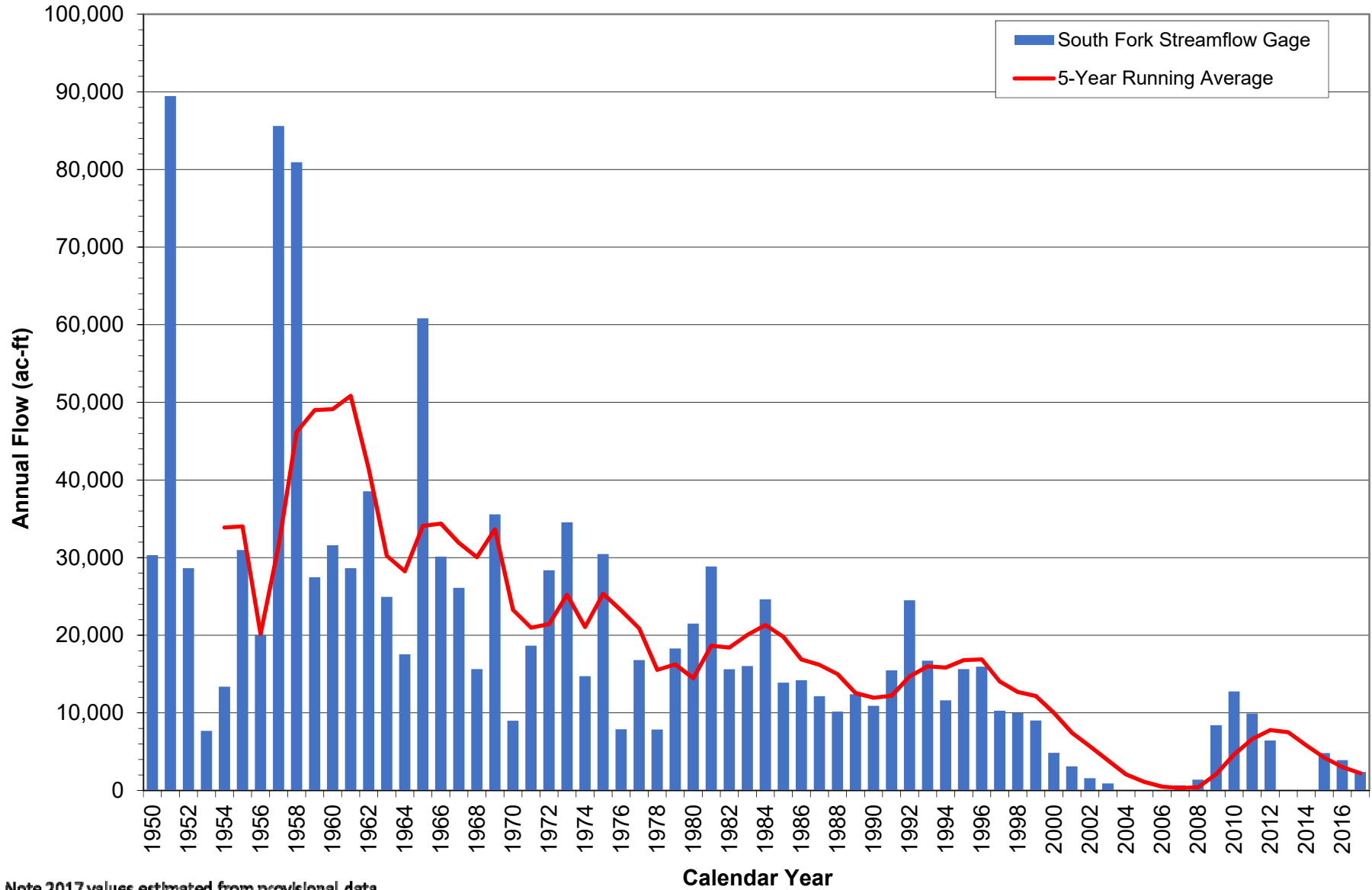
Arikaree River at Haigler, Nebraska Gage 78.5% of Flow Allocated to Colorado



Note 2017 values estimated from provisional data

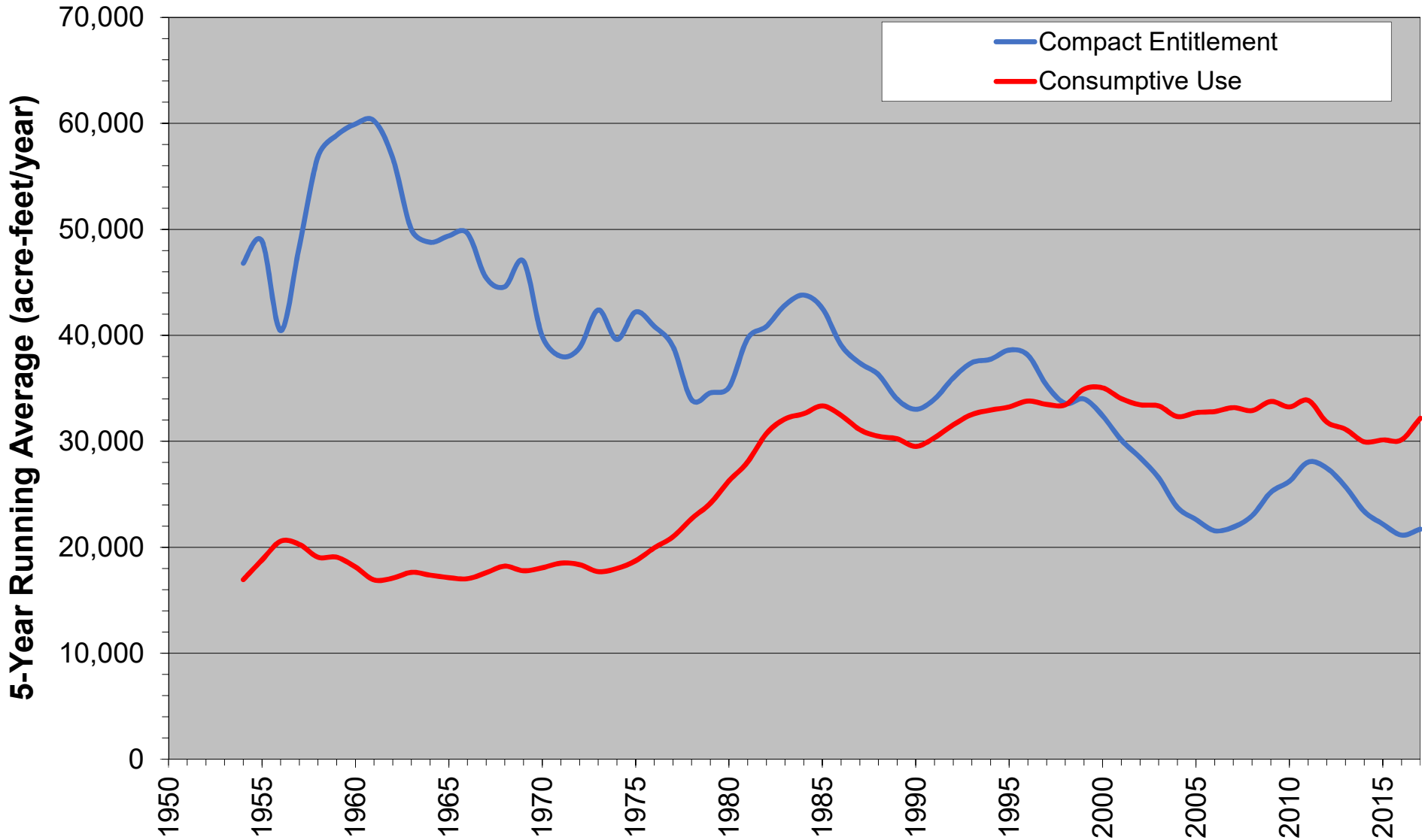
South Fork Republican near Benkleman, Nebraska Gage

44.4% of Flow Allocated to Colorado



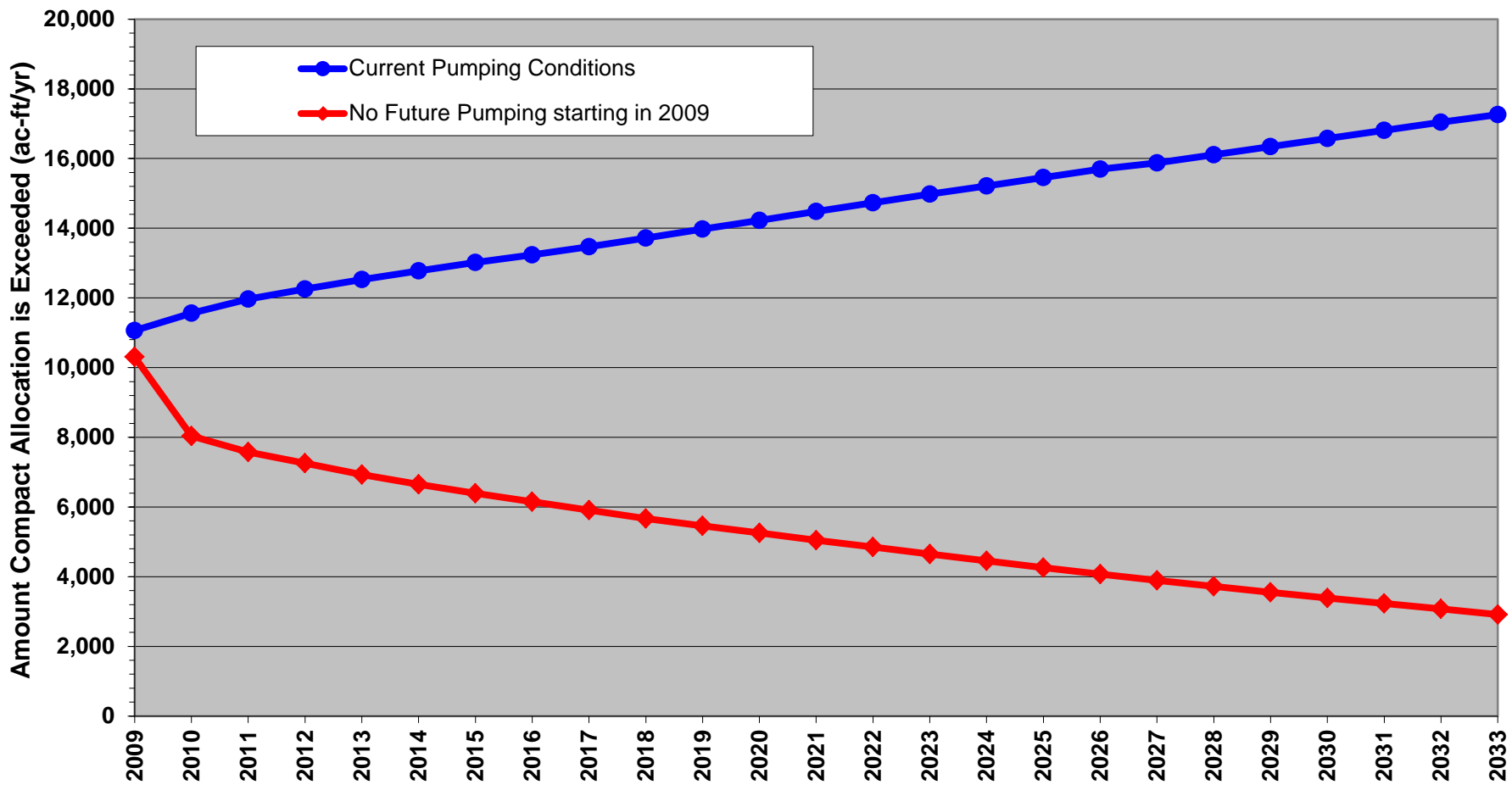
Note 2017 values estimated from provisional data

Colorado Consumptive Use and Compact Entitlement (5-Year Running Average)



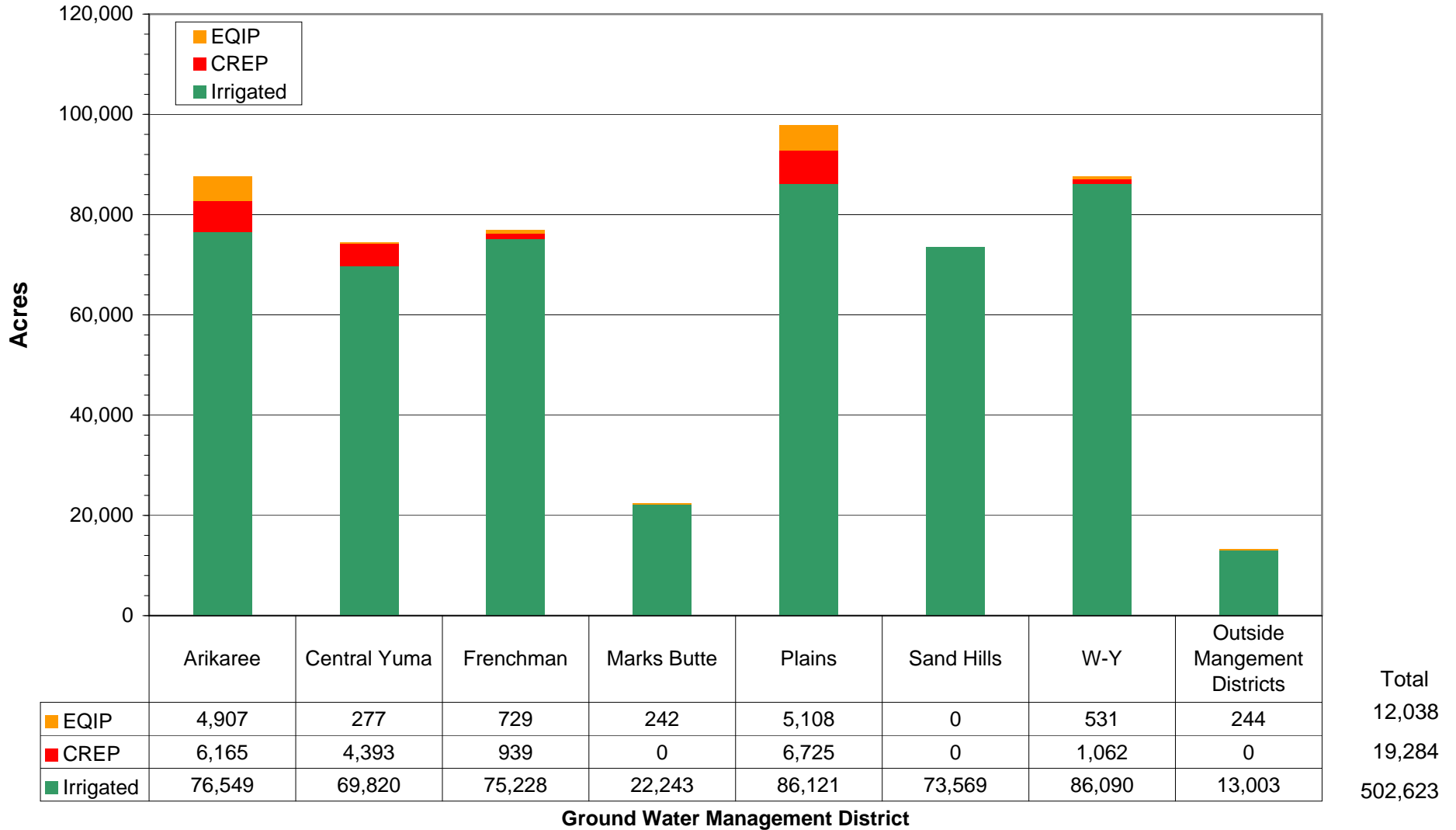
Note 2017 values estimated from provisional data

Figure 9 Projected Compact Compliance under Current Pumping and No Pumping Conditions



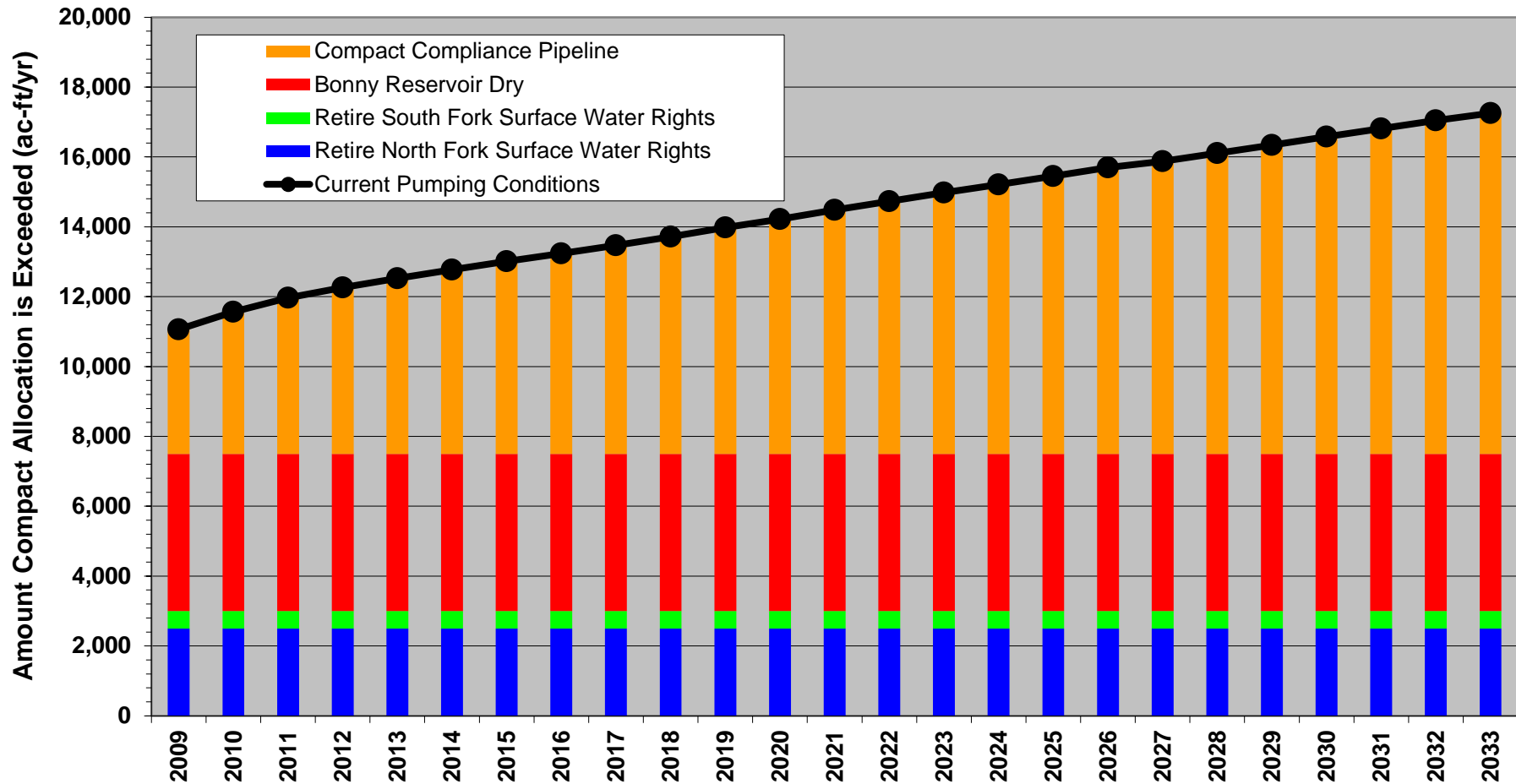
Note: The current pumping conditions projection assumes projected pumping conditions are equal to the average pumping for the 1999-2008 period and the precipitation recharge is equal to the 1918-2008 average. The amount the compact allocation is exceeded is based on the average value for the 2003-2007 period and does not reflect the 2,500 ac-ft/yr reduction in Colorado's consumptive use from the surface water rights purchased by Colorado.

**Republican River Water Conservation District
Crop Reduction Programs by Ground Water Management District in 2008**

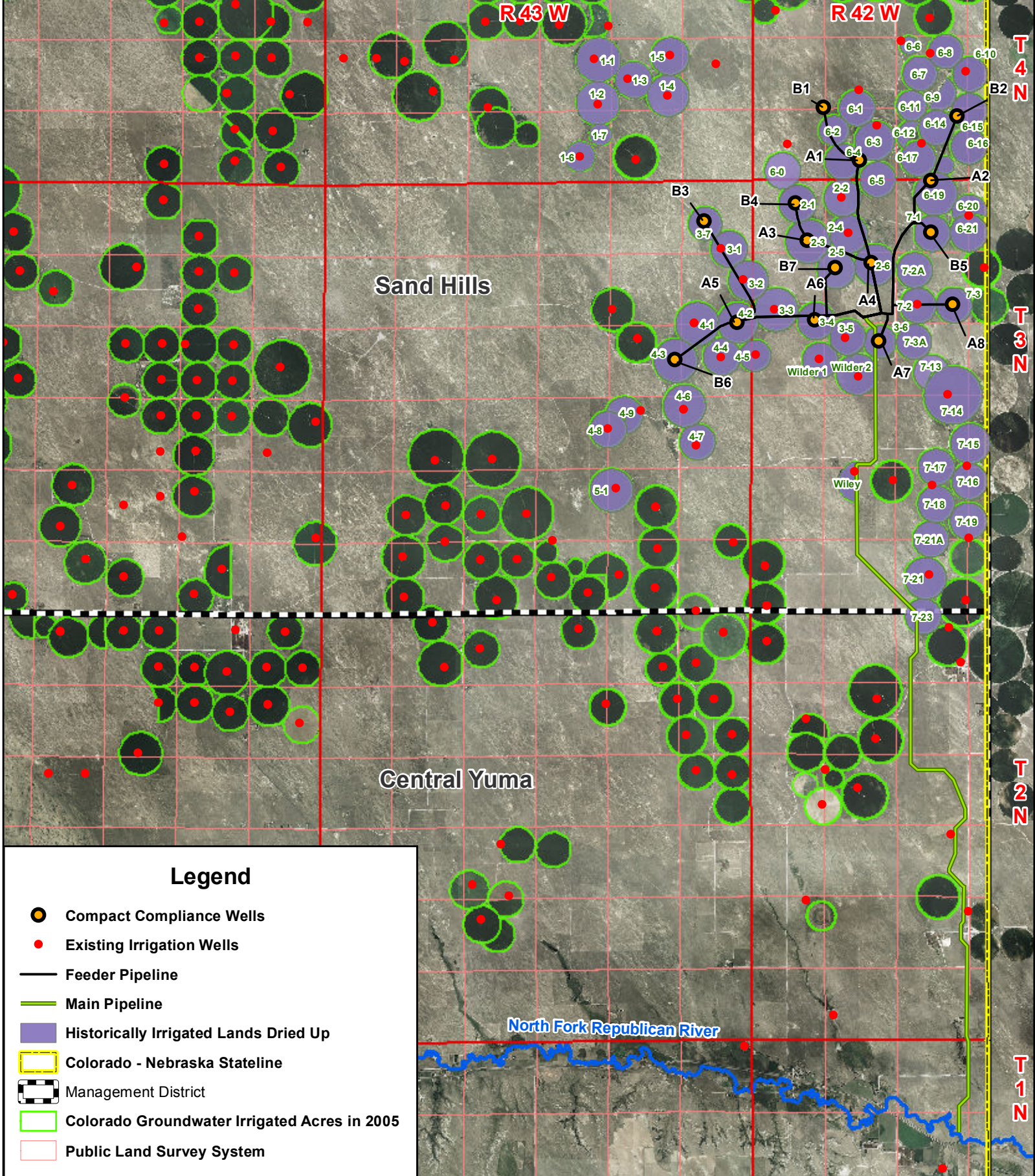


Note: Plains acreage does not include 36,013 irrigated acres outside the boundaries of the RRWCD.

Figure 10 Projected Compact Compliance with Compact Compliance Pipeline in Operation

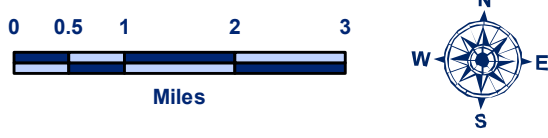


Note: The current pumping conditions projection assumes projected pumping conditions are equal to the average pumping for the 1999-2008 period and the precipitation recharge is equal to the 1918-2008 average. The amount the compact allocation is exceeded under current pumping conditions is based on the average value for the 2003-2007 period and does not reflect the 2,500 ac-ft/yr reduction in Colorado's consumptive use from the surface water rights purchased by Colorado.



Legend

- Compact Compliance Wells
- Existing Irrigation Wells
- Feeder Pipeline
- Main Pipeline
- Historically Irrigated Lands Dried Up
- Colorado - Nebraska Stateline
- Management District
- Colorado Groundwater Irrigated Acres in 2005
- Public Land Survey System



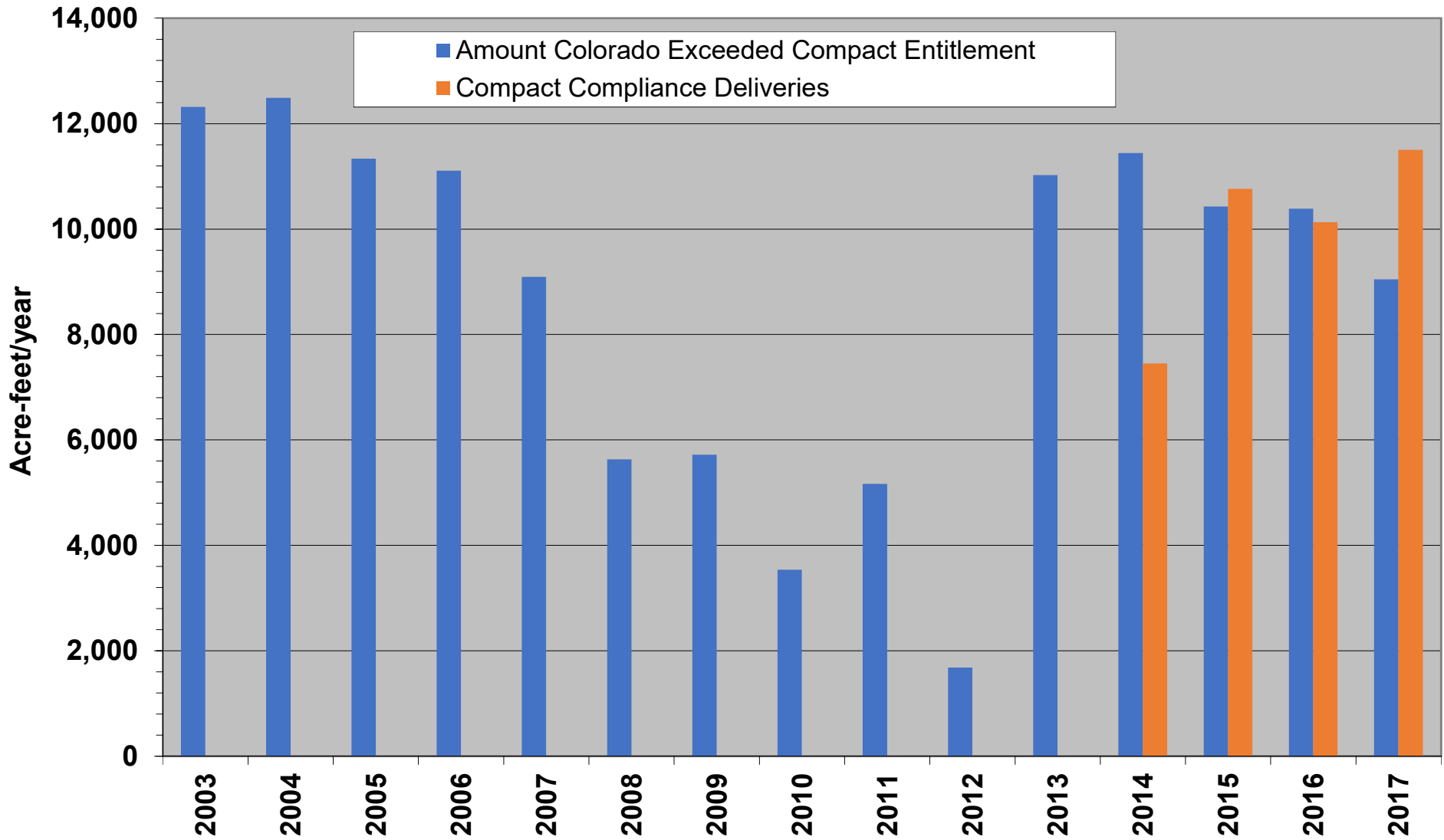
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Date: 05/18/10
Prepared For: RRWCD

Figure 4
Location of Compact Compliance Wells and Historically Irrigated Lands Dried Up for the Compact Compliance Pipeline



Slattery & Hendrix Engineering LLC

Amount Colorado Exceeded Compact Entitlement



Note: Total underdelivery for the first four years of operation of the CCP for 2014-2018 was approximately 1,500 ac-ft.

GROUNDWATER MODEL FOR NON-LINEAR HYDROLOGIC SYSTEM

- A Non-Linear System greatly complicates the Engineering Analysis
- A Non-Linear System Means sum of the individual parts do not equal the sum of the whole
- Example below assumes all pumping impacts stream by 100%

Stream with flow of 8 prior to any well pumping



Well A – Pumps 6



Well B – Pump 7

- If only Well A is turned on Stream Depletion is 6 →
 - If only Well B is turned on Stream Depletion is 7 →
 - If Well A and Well B are turned on Stream Depletion is 8 ←
- Sum of the individual impacts is $6 + 7 = 13$ which is incorrect because there is only 8 in the stream.
- Correct Answer is 8. In this non-linear system, pumping impacts can only be determined by analyzing all pumping impacts simultaneously.



Saturated Thickness 2017

Republican River Compact Administration Groundwater Model

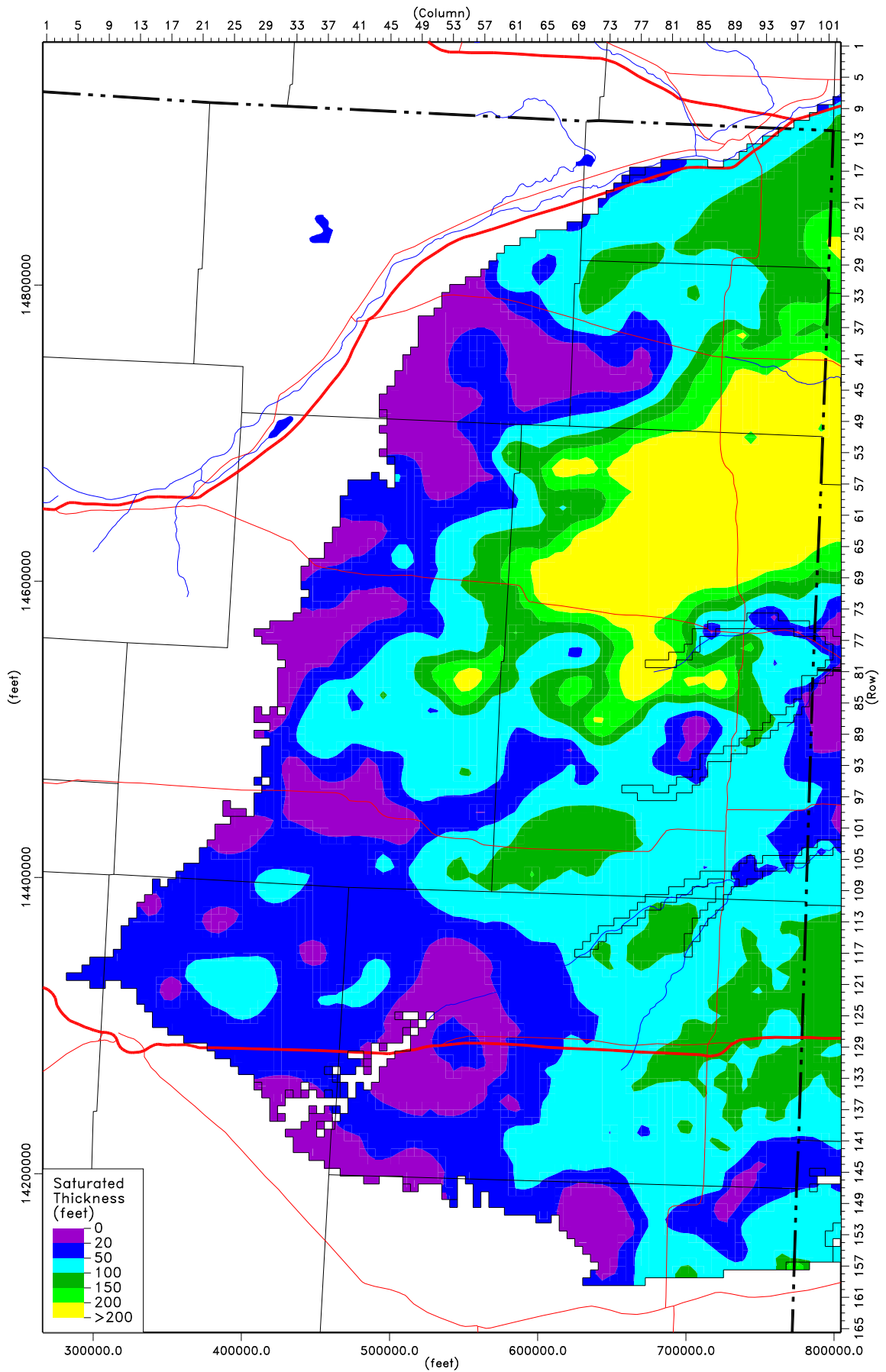
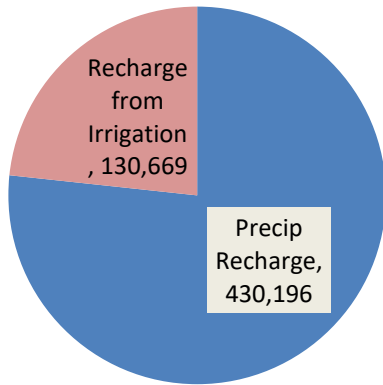
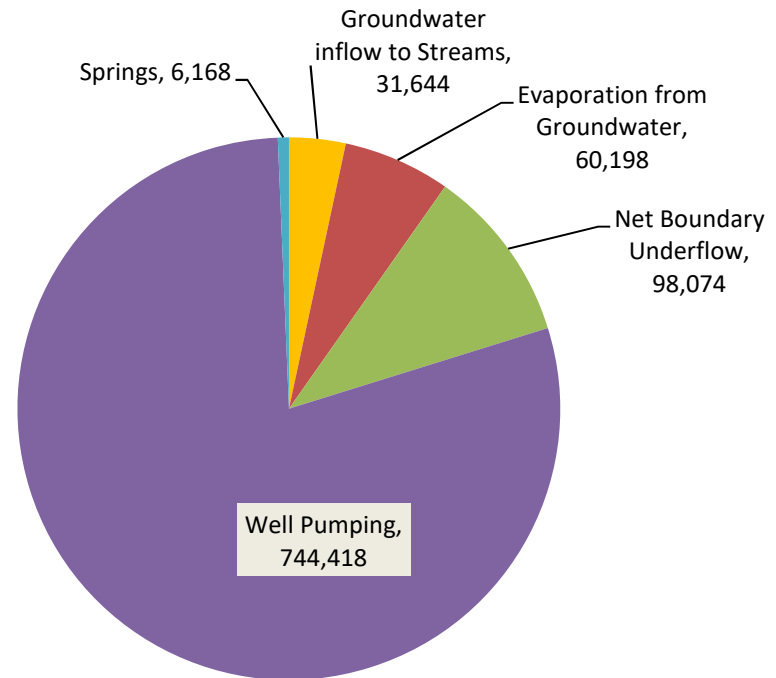
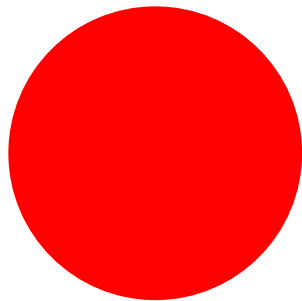


Exhibit 1 - Water Balance for the High Plains Aquifer in Colorado 1996-2015 Average Annual Values in ac-ft/yr



Aquifer Inflow = 560,865

Ground Water Storage Loss = 379,637



Aquifer Outflow = 940,503

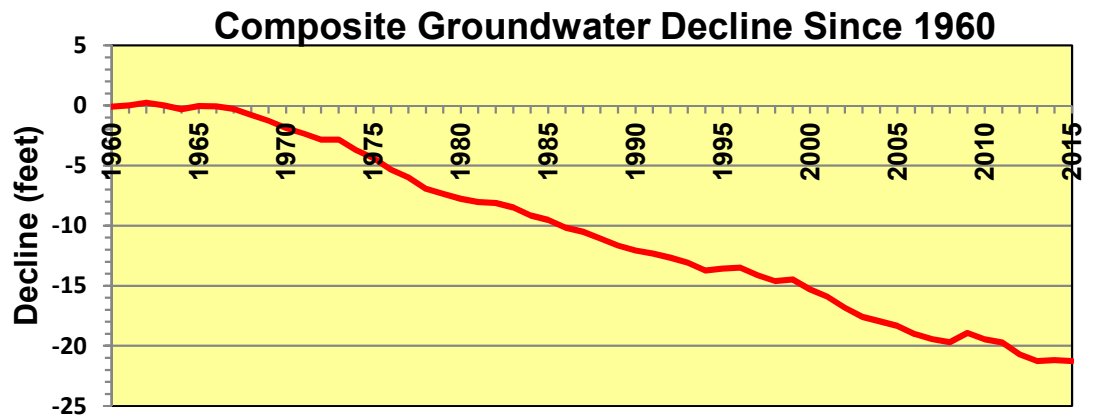
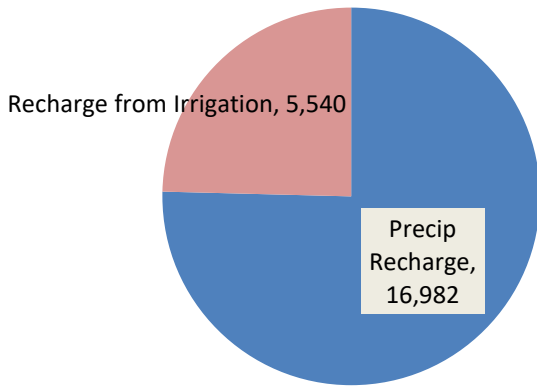
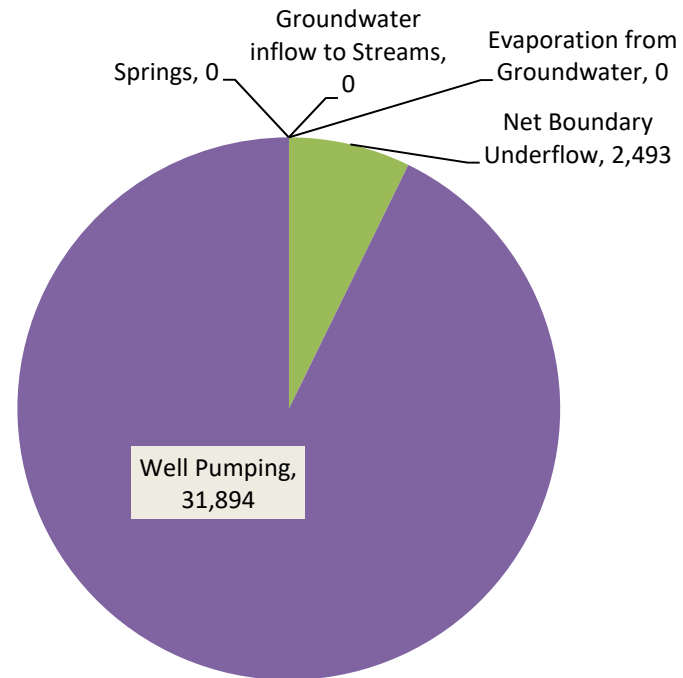
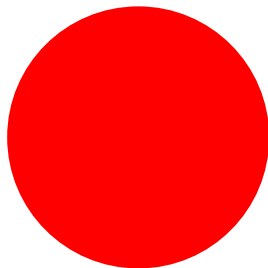


Exhibit 2 - Water Balance for the Marks Butte GMD 1996-2015 Average Annual Values in ac-ft/yr



Aquifer Inflow = 22,522

**Ground Water Storage Loss =
11,865**



Aquifer Outflow = 34,387

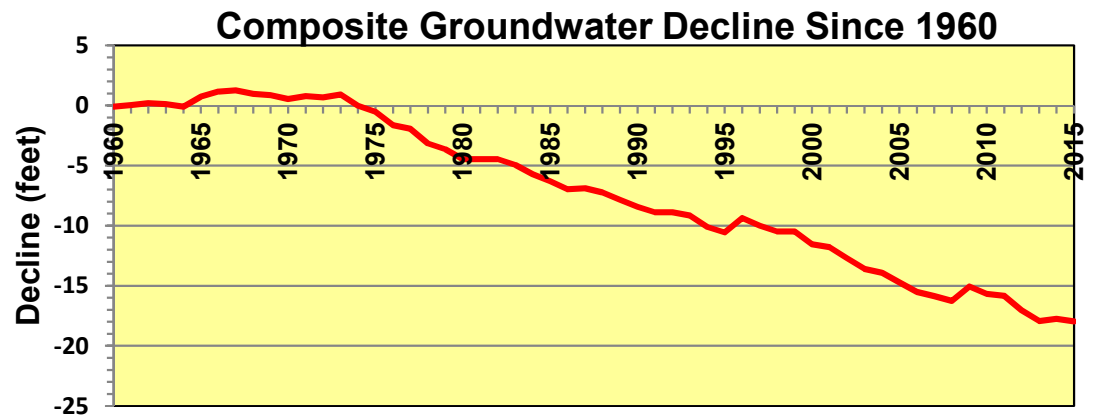
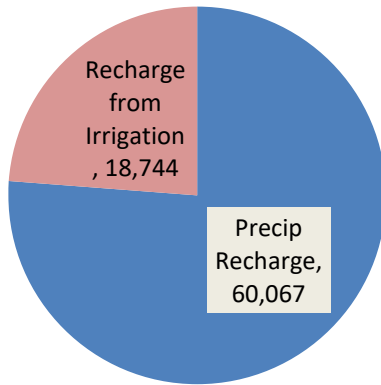


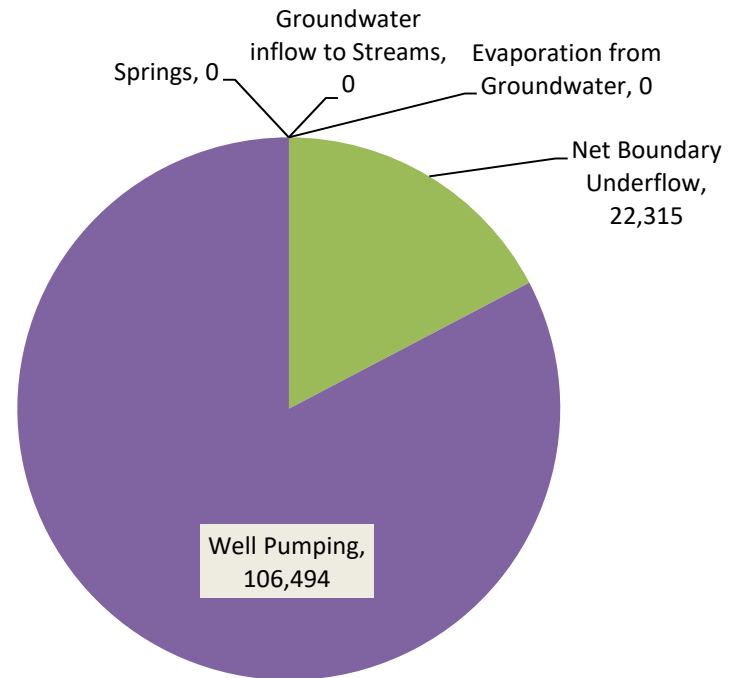
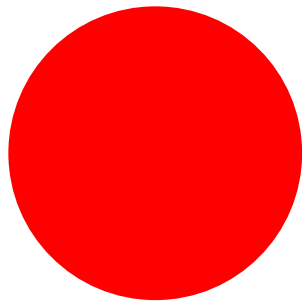
Exhibit 3 - Water Balance for the Frenchman GMD

1996-2015 Average Annual Values in ac-ft/yr



Aquifer Inflow = 78,811

Ground Water Storage Loss = 49,999



Aquifer Outflow = 128,810

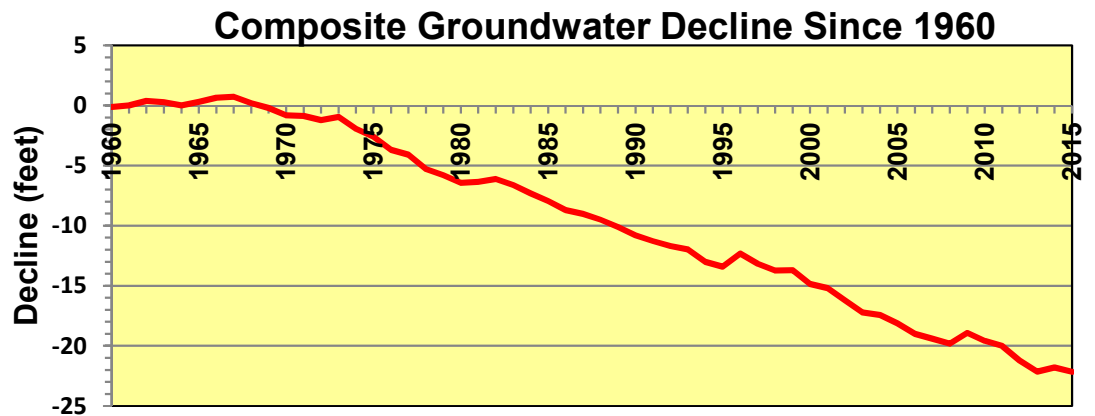
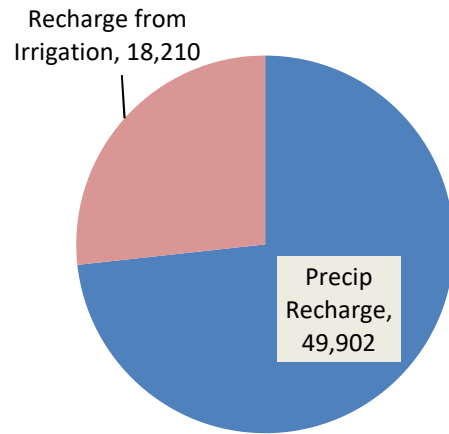
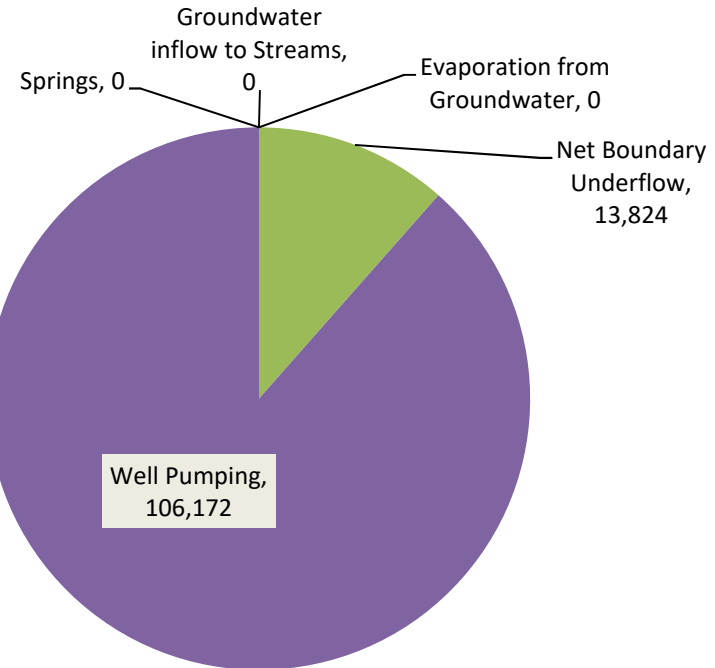
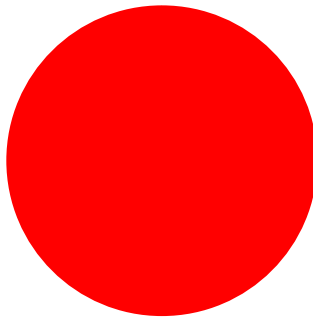


Exhibit 4 - Water Balance for the W-Y GMD 1996-2015 Average Annual Values in ac-ft/yr



Aquifer Inflow = 68,112

Ground Water Storage Loss = 51,883



Aquifer Outflow = 119,995

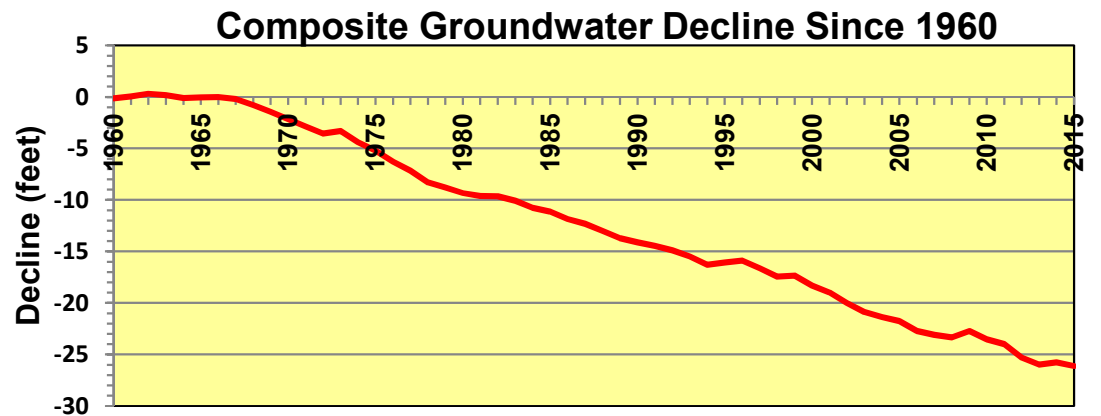
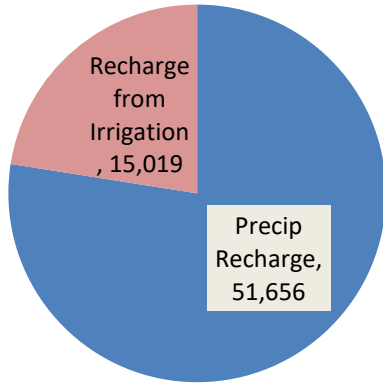


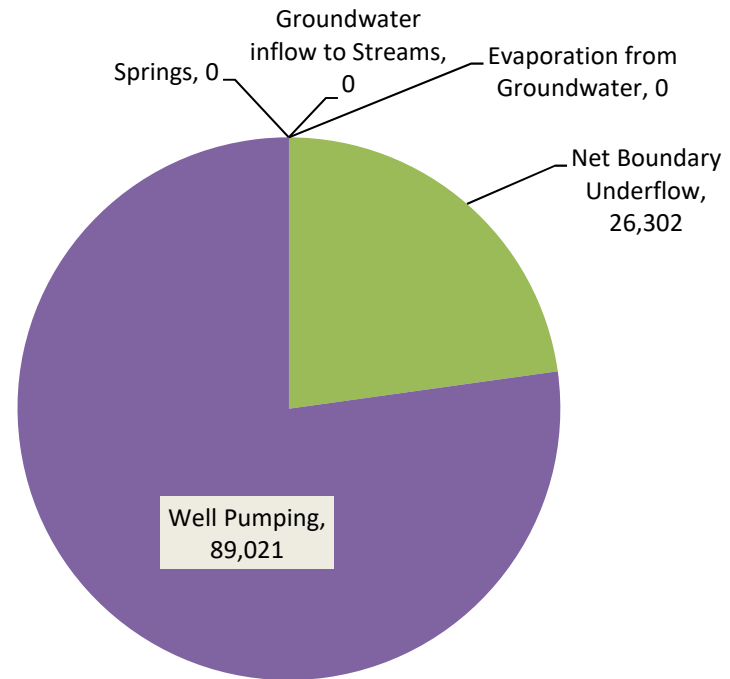
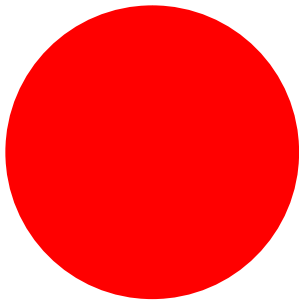
Exhibit 5 - Water Balance for the Sandhills GMD

1995-2015 Average Annual Values in ac-ft/yr



Aquifer Inflow = 66,675

Ground Water Storage Loss = 48,648



Aquifer Outflow = 115,323

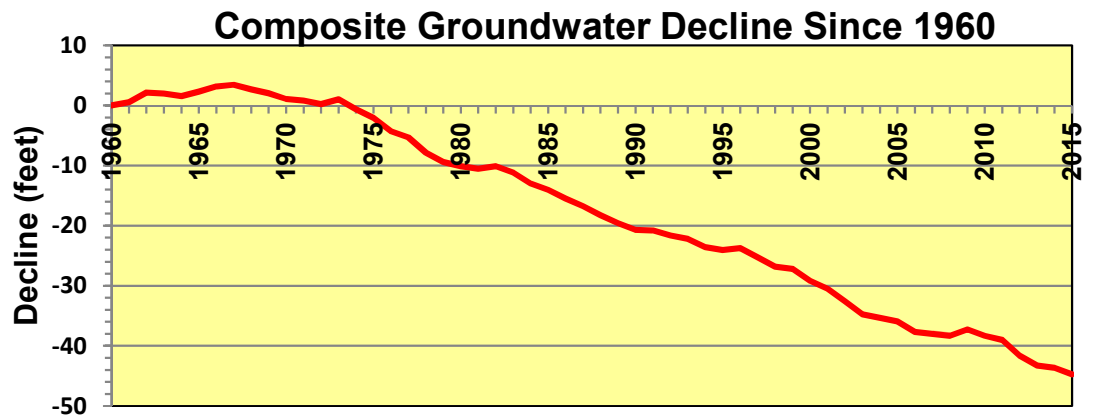
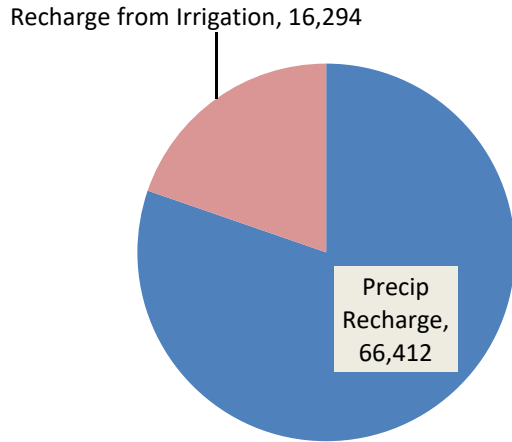


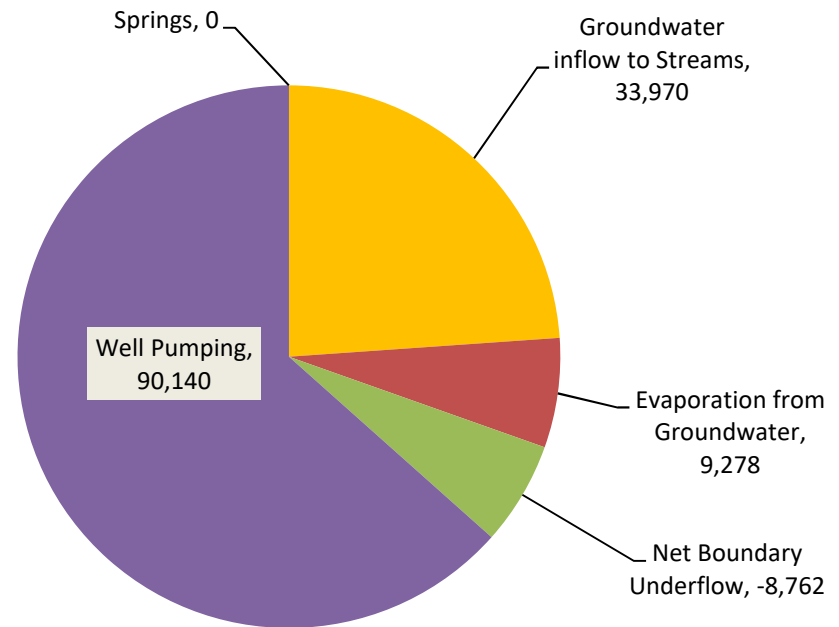
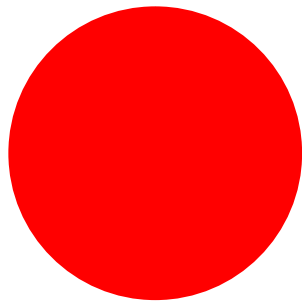
Exhibit 6 - Water Balance for the Central Yuma GMD

1996-2015 Average Annual Values in ac-ft/yr



Aquifer Inflow = 82,705

Ground Water Storage Loss = 41,920



Aquifer Outflow = 124,626

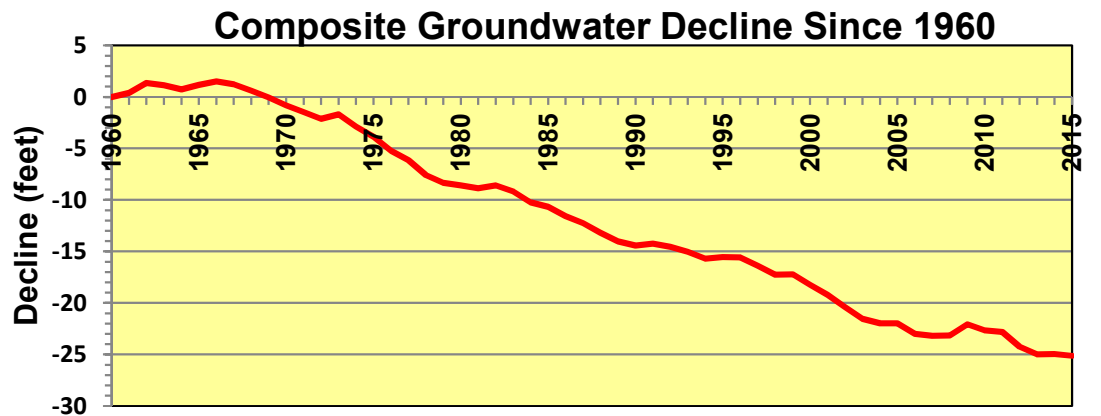
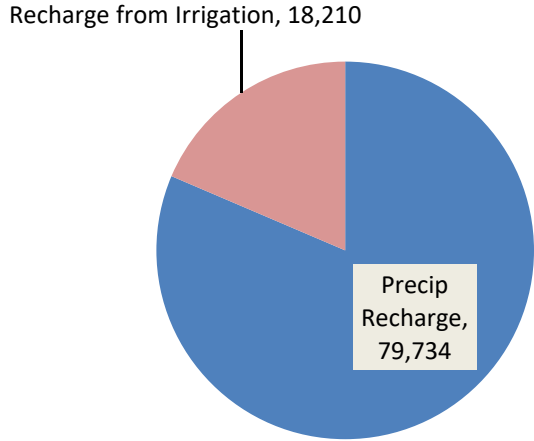


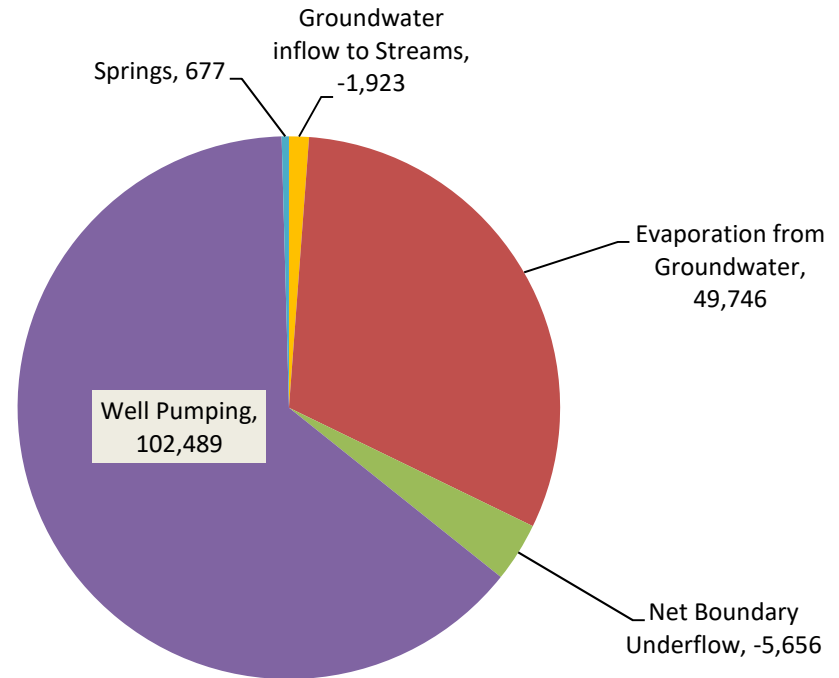
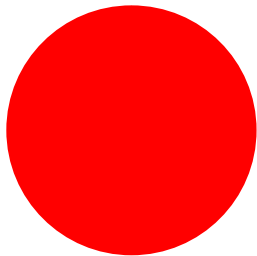
Exhibit 7 - Water Balance for the Arikaree GMD

1996-2015 Average Annual Values in ac-ft/yr



Aquifer Inflow = 97,945

Ground Water Storage Loss = 47,388



Aquifer Outflow = 145,333

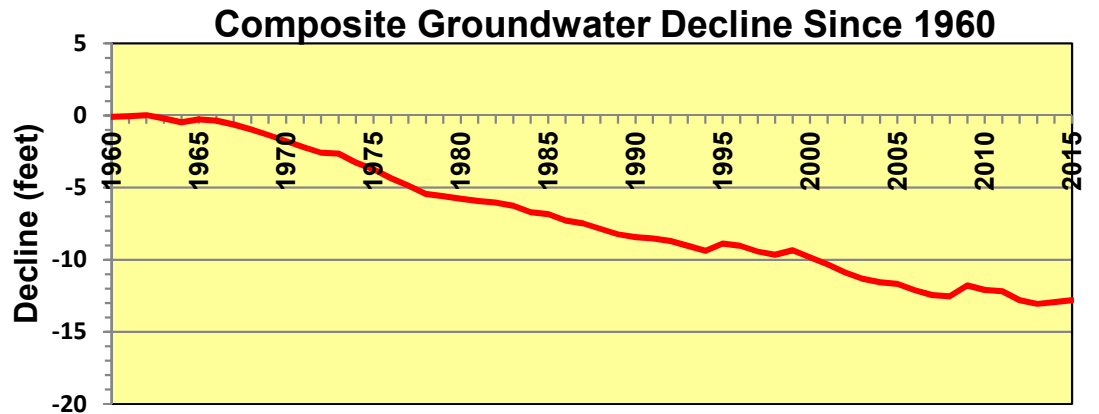
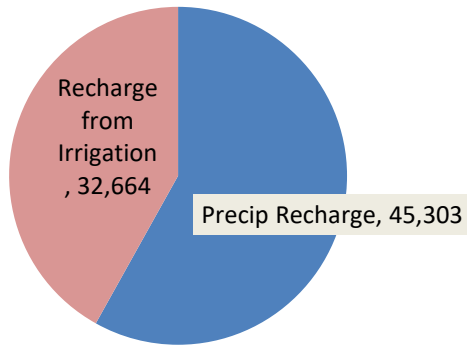


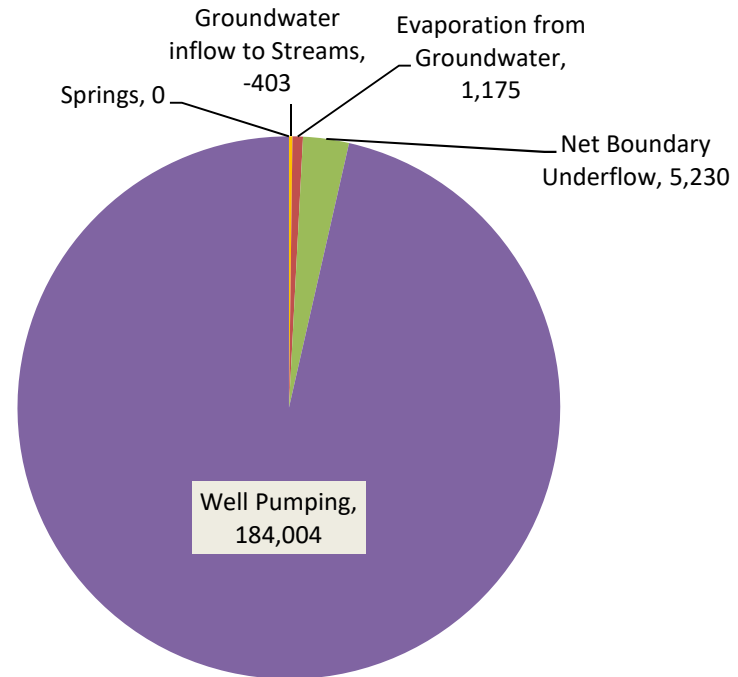
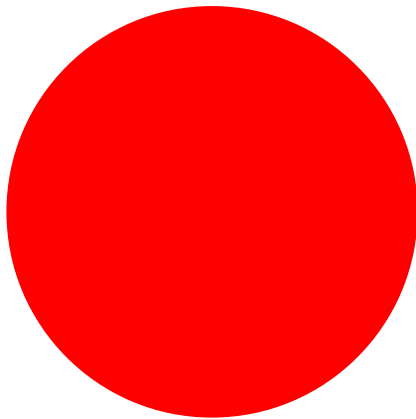
Exhibit 8 - Water Balance for the Plains GMD

1996-2015 Average Annual Values in ac-ft/yr



Aquifer Inflow = 77,967

Ground Water Storage Loss = 112,039



Aquifer Outflow = 190,006

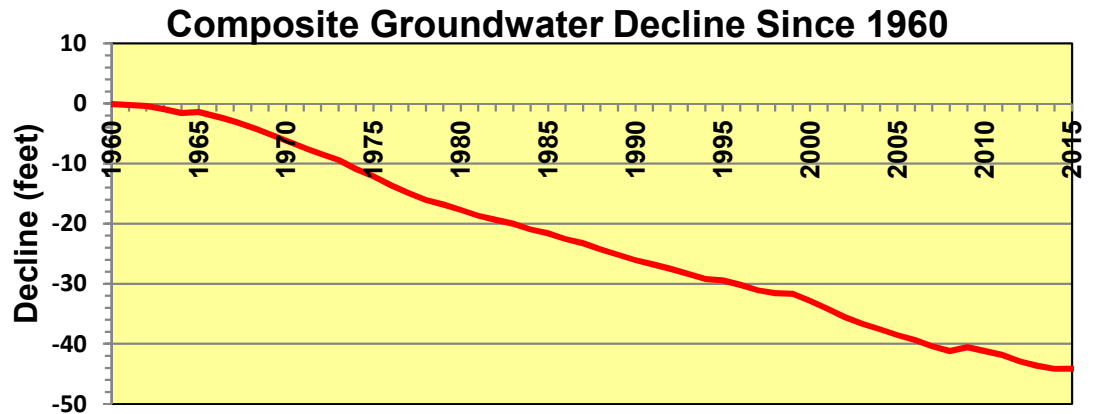
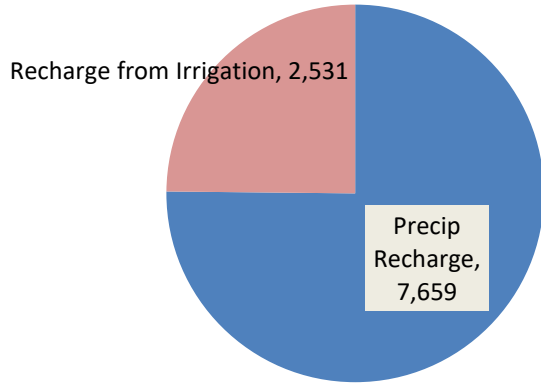


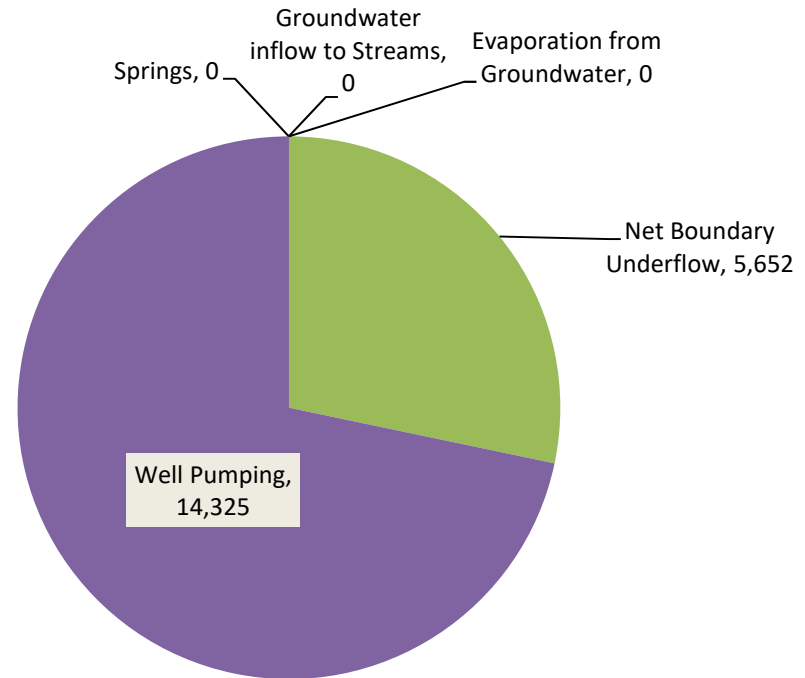
Exhibit 9 - Water Balance for the East Cheyenne GMD

1996-2015 Average Annual Values in ac-ft/yr

Note, the most southern portion of the GMD is not included in this water balance

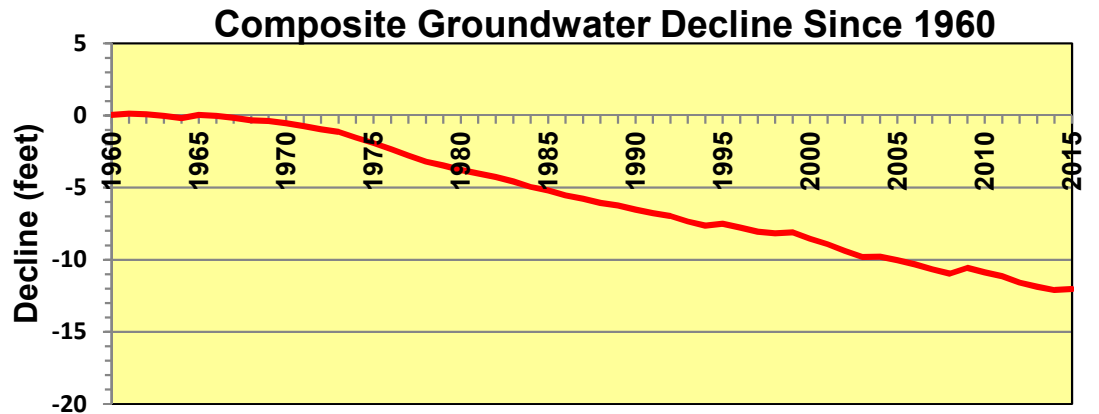
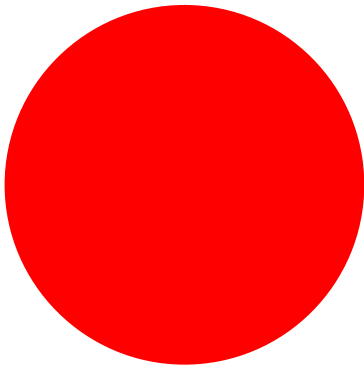


Aquifer Inflow = 10,190

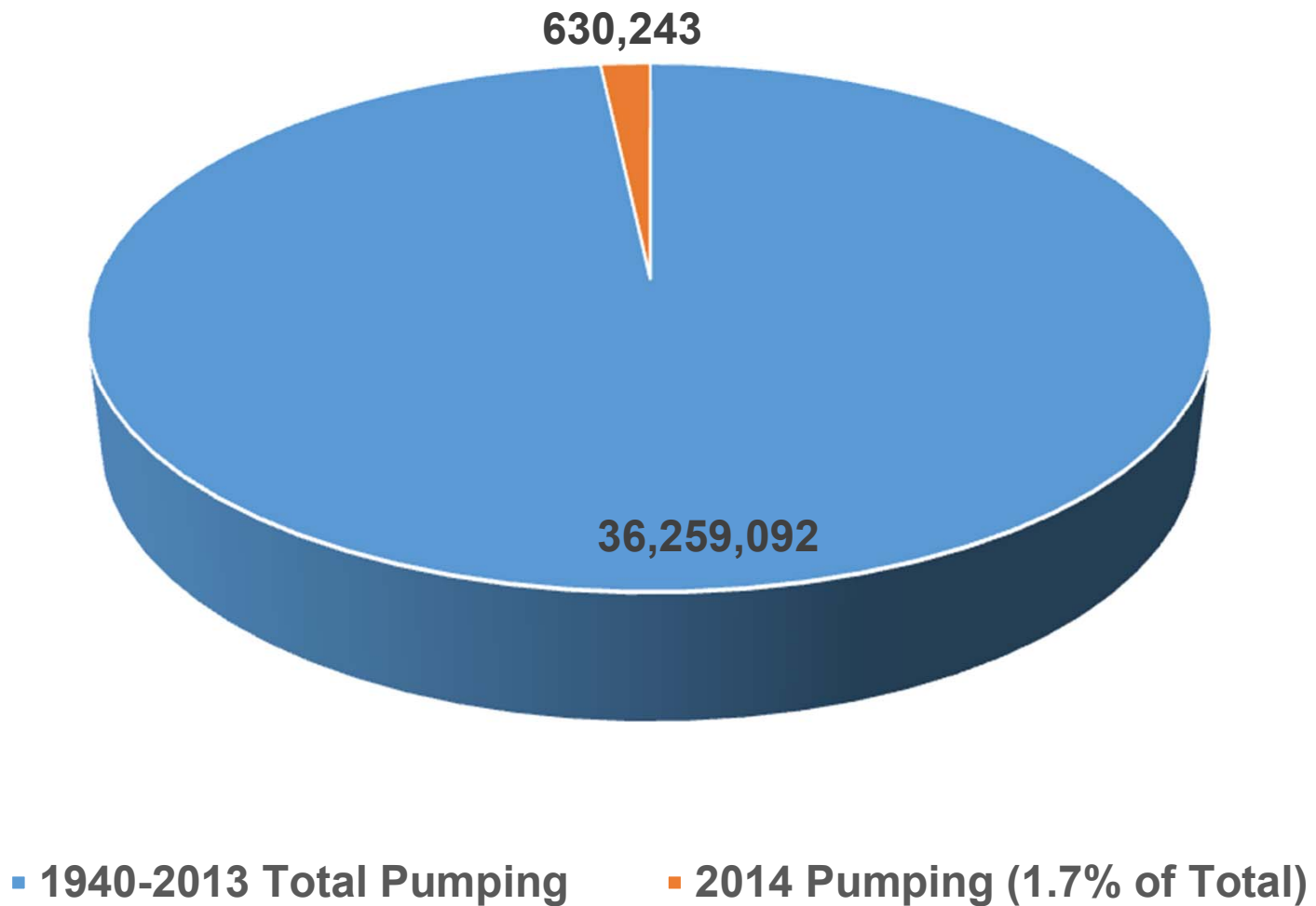


Aquifer Outflow = 19,997

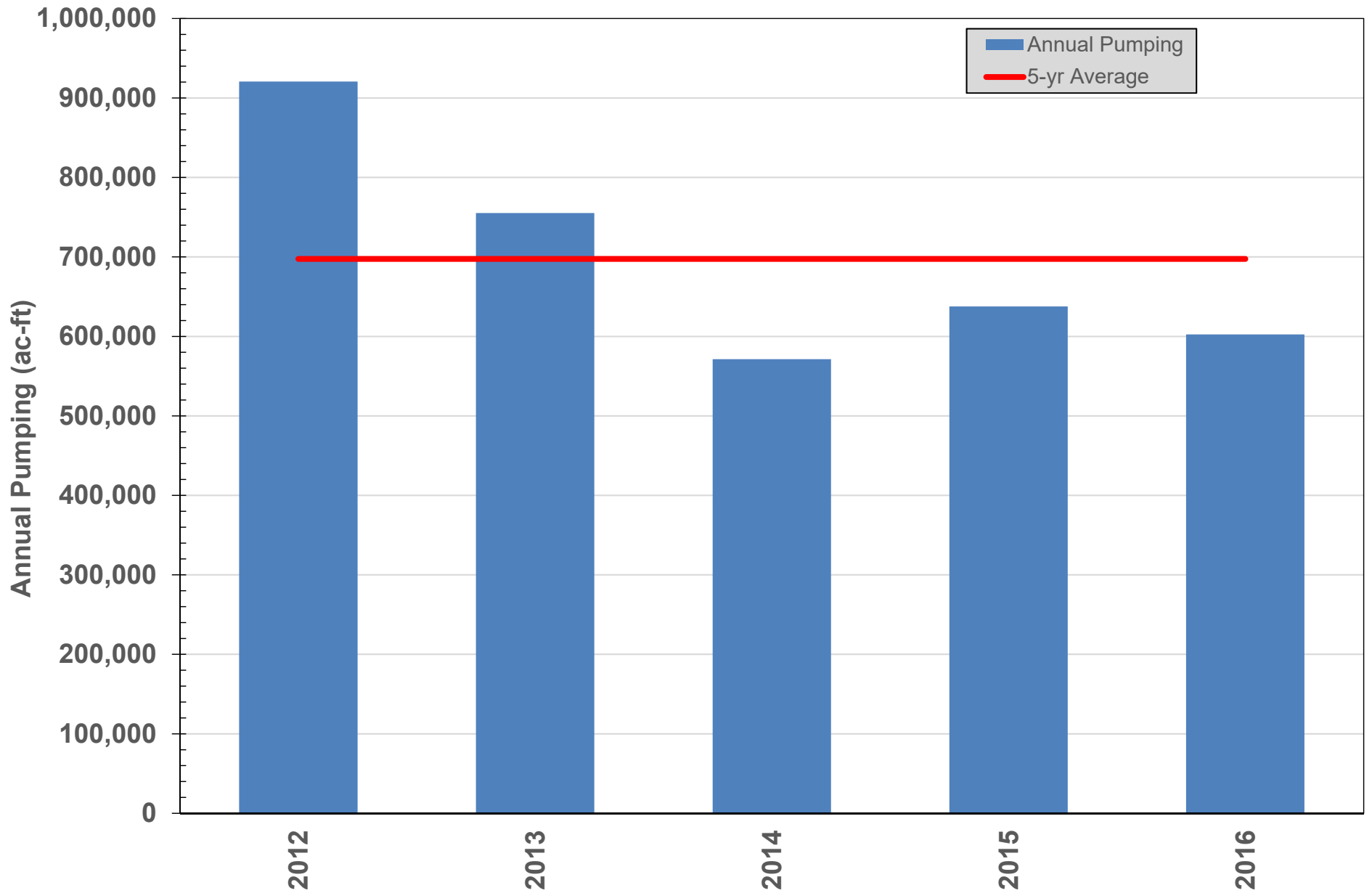
Ground Water Storage Loss = 9,788



Total Groundwater Pumping in Colorado (acre-feet)

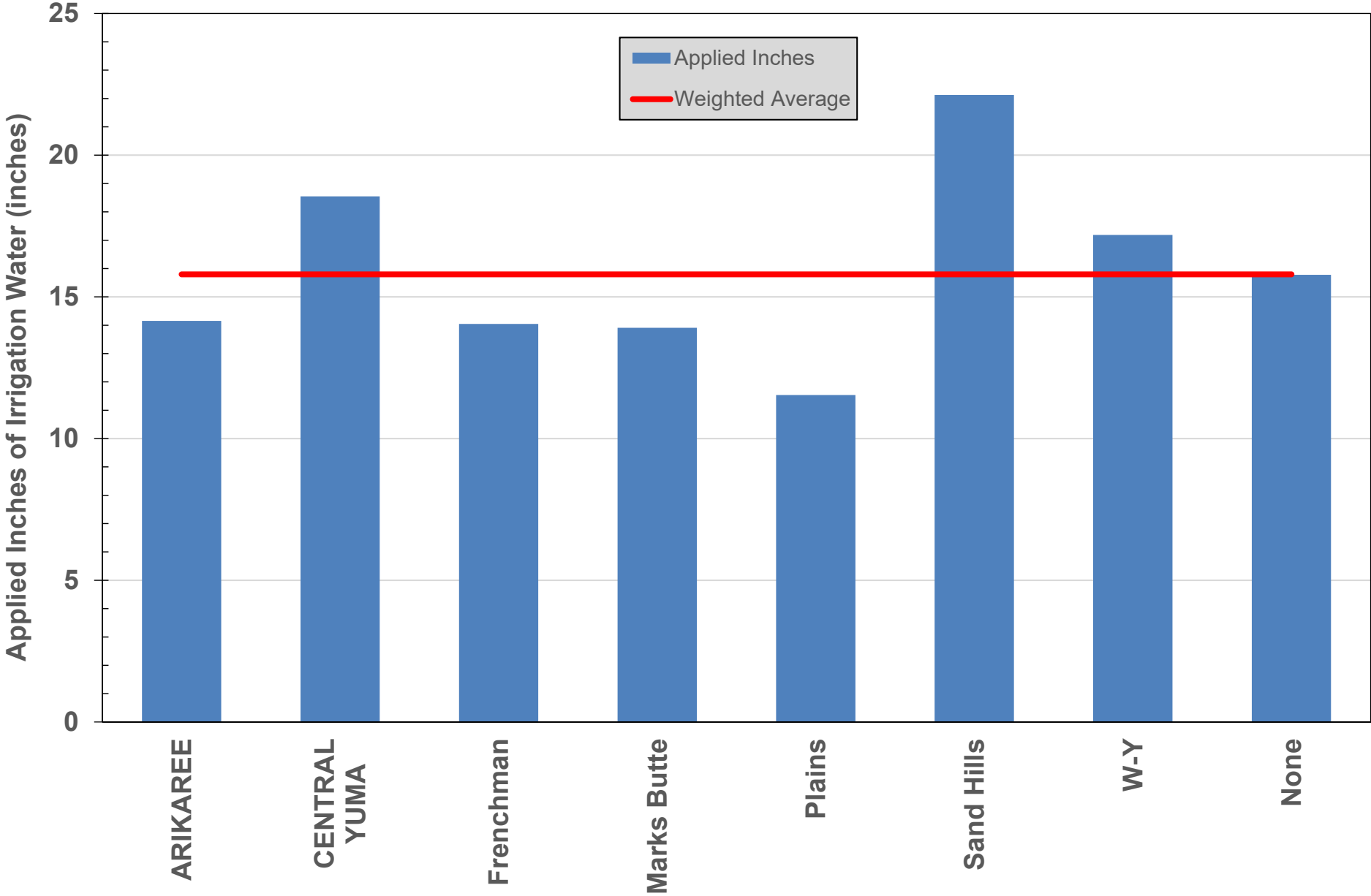


RRWCD Total Agricultural Pumping



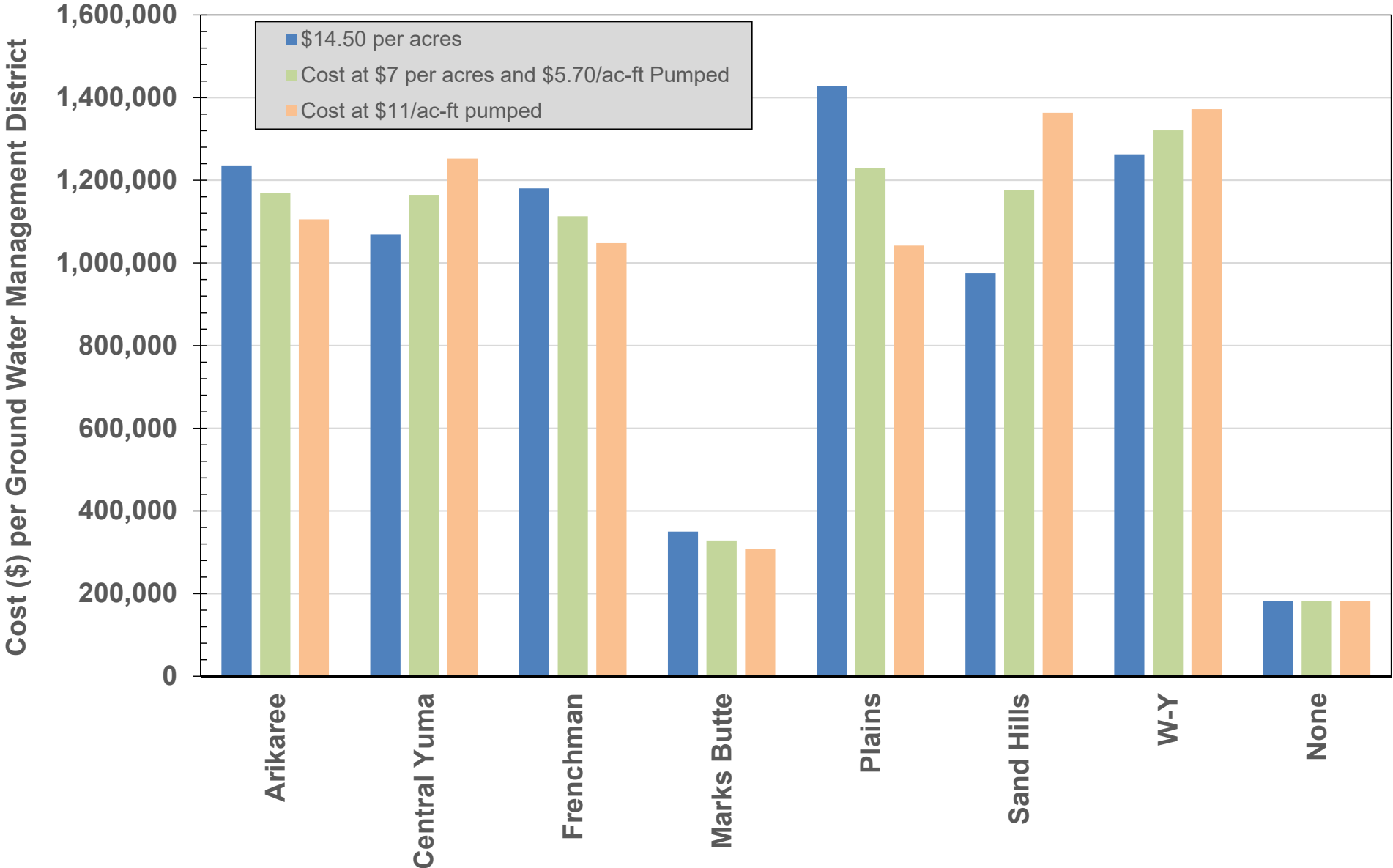
Applied Inches by Ground Water Management District

2011-2016 Average Pumping and 2016 Assessed Acres



Applied Inches by Ground Water Management District

2011-2016 Average Pumping and 2016 Assessed Acres



Note: Each of the cost options raised approximately the same amount of money which was \$14.50 times the assessed irrigated acreage. The Plains GWMD only includes the portion of the management district currently within the RRWCD Boundaries.

Cost for a Farm for Different Options

(only change values in yellow for your farm)

1,000 <----- Assessed Acreage

1,800 <----- 5-Year Average Pumping

\$14,500 Option 1 (existing \$14.50/acre)

\$17,260 Option 2 (\$7/acre and \$5.70/ac-ft pump)

\$19,800 Option 3 (\$11/ac-ft pump)

