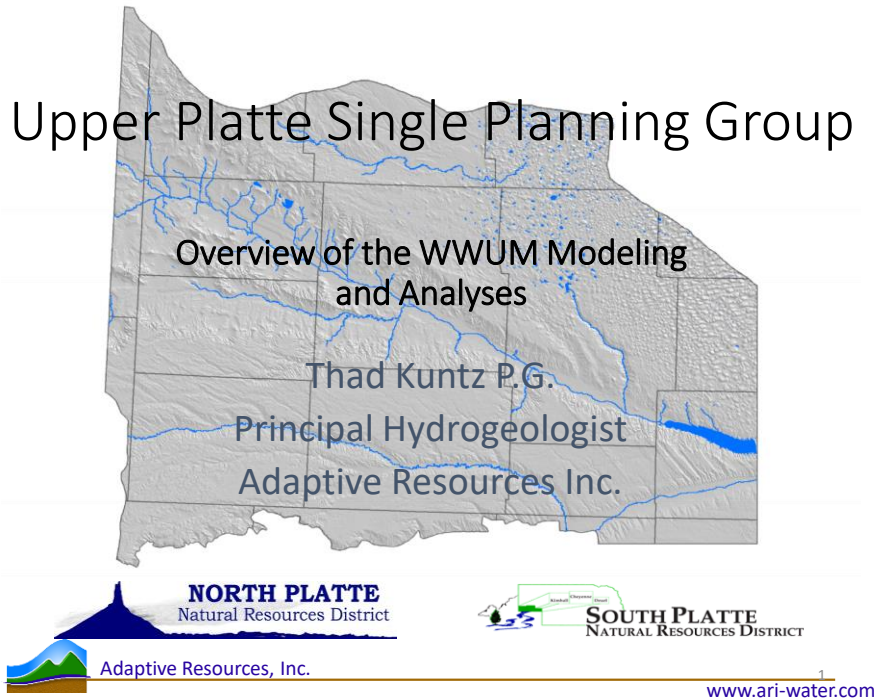


Upper Platte Single Planning Group



History of Modeling for NPNRD and SPNRD

- The COHYST Western Model Unit was the first generation of modeling – Completed in 2006
 - First cut at modeling the area.
- WWUM Modeling 1953 – 2010 was the second generation of modeling – Completed 2013
 - A complete rework of the COHYST model with numerous new and improved datasets
- WWUM Modeling 1953 -2013 is the third generation – Completed 2016
 - Extension of 2011 through 2013 and additional calibration to several components.

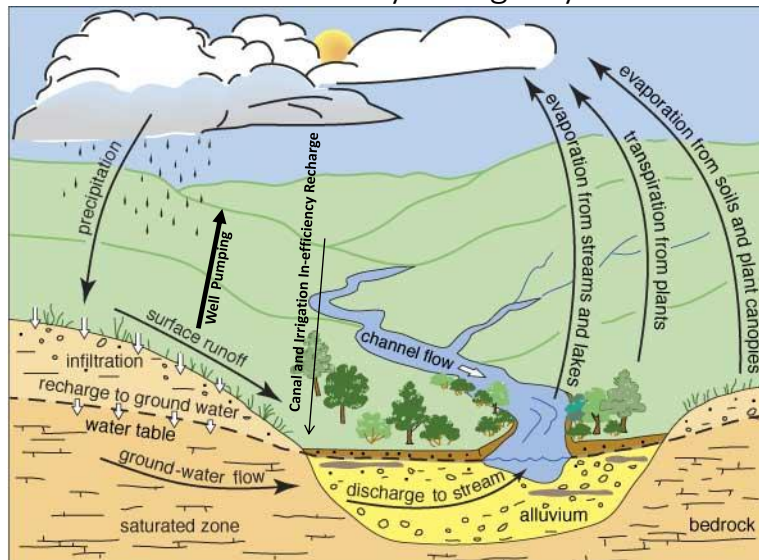
What are we trying to model?



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A Schematic Similar to the North Platte and South Platte River's Hydrologic System



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What is the Western Water Use Management Modeling?

- **Purpose:** Data centered modeling package to aid the North Platte NRD and South Platte NRD in water management decisions.
- Uses Three Models:
 - Surface Water Operations Model (NPNRD Only)
 - Simulates the prior appropriations system
 - Provides commingled ground water pumping and canal recharge
 - Regionalized Soil Water Balance Model
 - Uses climate and soil characteristics
 - Provides crop water use, irrigation water requirement, and ground only water pumping
 - Ground Water Model (MODFLOW)
 - Timing and movement of water through the aquifer



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Modeling Dataset Review



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Modeling through 2013

- Land Use within NRDs – Annual 1953 - 2013
 - Aerial Photo Snap Shot Years
 - 1950s, 1970s, 1980s, 1993, 1997, 2001, 2003, 2005, 2009, 2010, 2012
 - Drew Circles and Squares Around Each Parcel for Each Snapshot
 - Attributed With:
 - Crop Type Information
 - Irrigation Water Source from NPNRD and SPNRD
 - Flood or Sprinkler Irrigation Method
 - Metered Pumping Information from Each NRD



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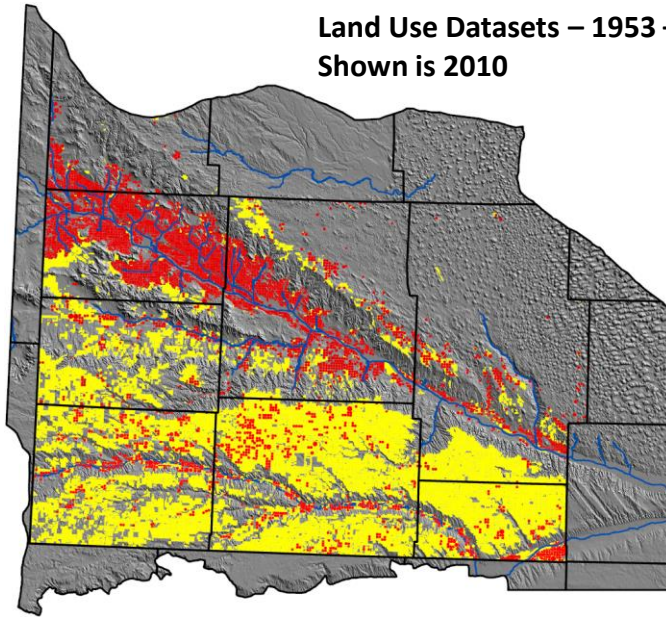
Land Use Datasets – 1953 - 2013



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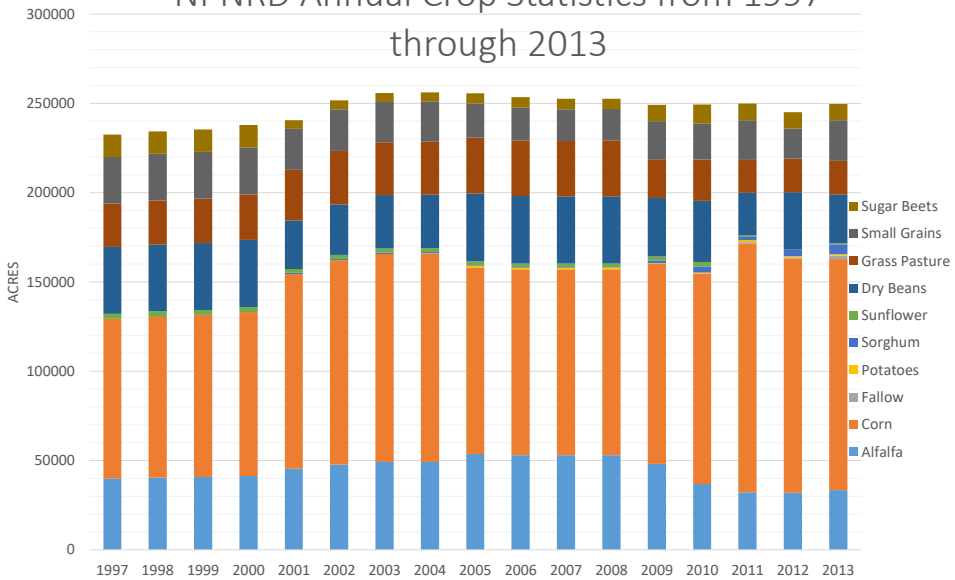
**Land Use Datasets – 1953 – 2013
Shown is 2010**



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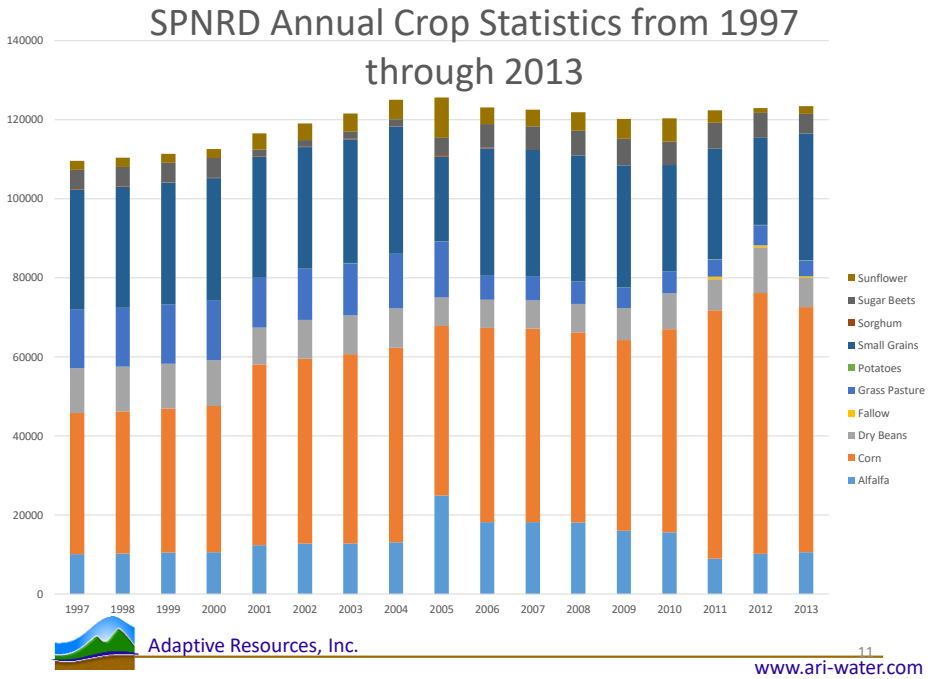
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**NPNRD Annual Crop Statistics from 1997
through 2013**

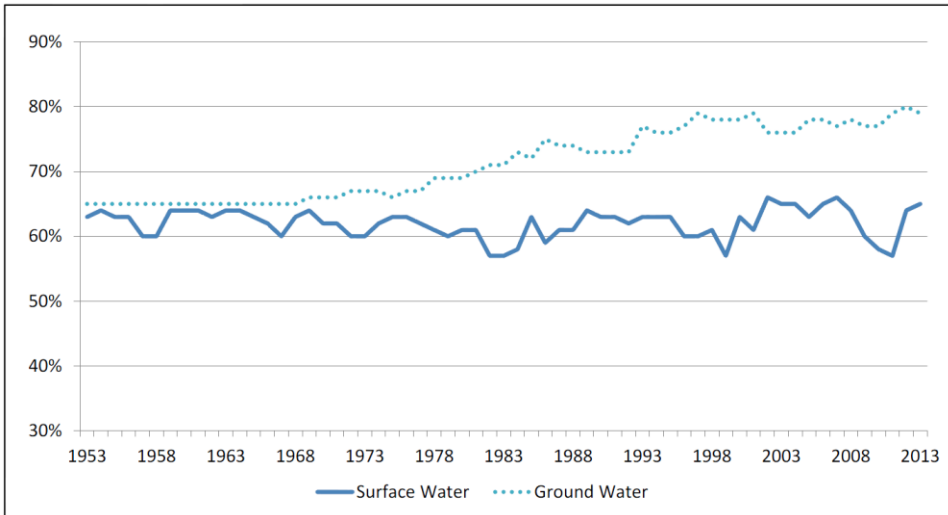


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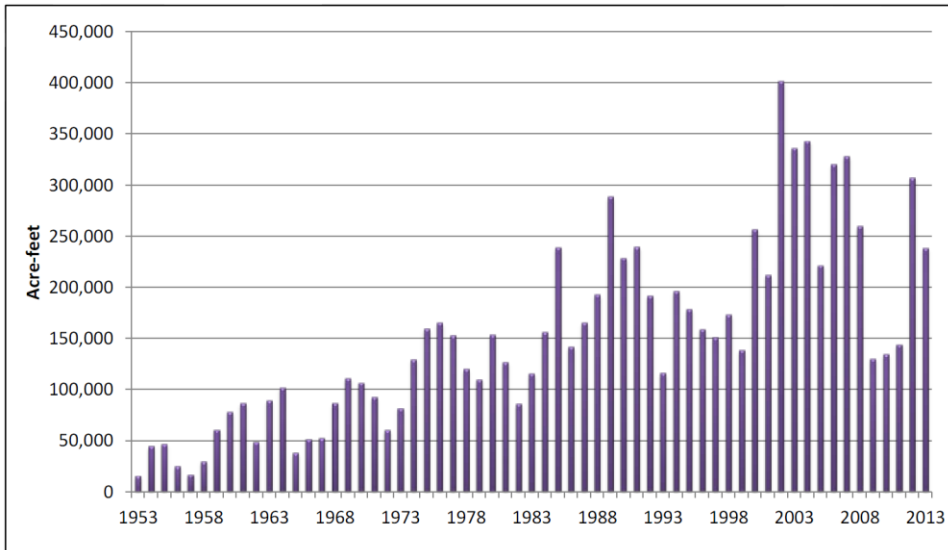
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NPNRD Irrigation Efficiency – 1953 - 2013



NPNRD Ground Water Pumping– 1953 - 2013



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Modeling through 2013

- Land Use outside NPNRD and SPNRD
 - Wyoming - Used existing land use dataset
 - 2005 Image
 - Colorado – Used information from the SPDSS modeling
 - UNWNRD – Used data from UNW Ground Water Model
 - COHYST – Used land use information from their modeling



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Modeling Datasets

- Hydrology – Data Range from 1953 - 2013
 - Diversion, Stream Gage, and Monitor Well Information
 - NE DNR and US Bureau of Reclamation
 - Storage and Natural Flow Diversion Information
 - NE DNR and WY State Engineers Office
 - Stream Gage Information
 - NP and SP NRDs
 - Monitor Well Information
 - 874 Head Observation Points Were Used in the GW Model

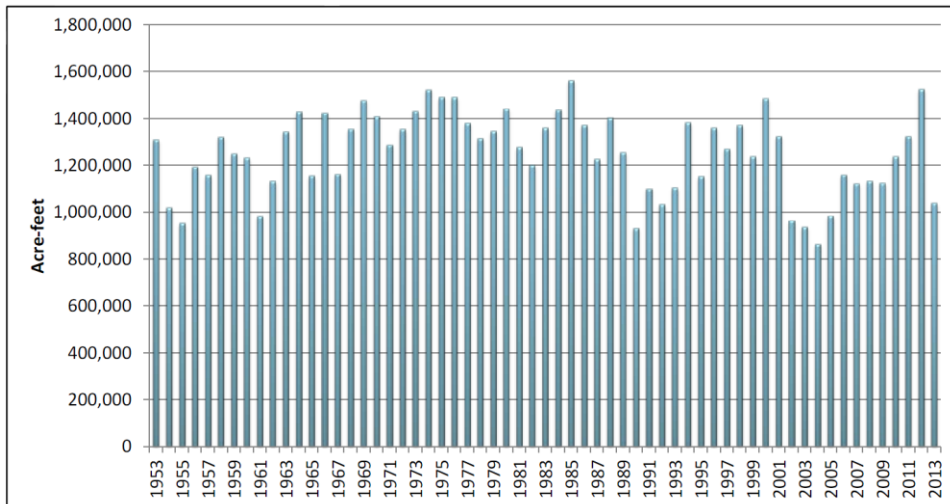


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Hydrologic Datasets – 1953 - 2013

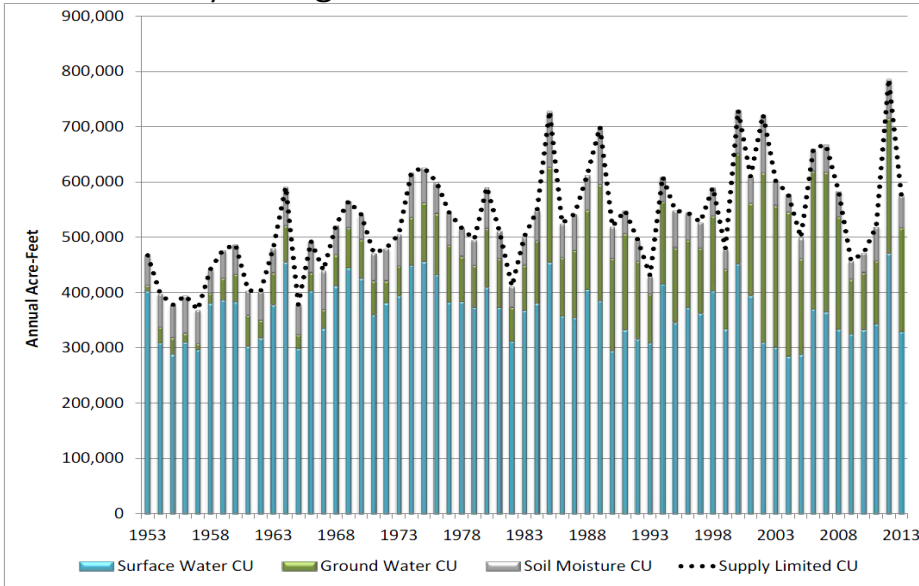
Total Annual Diversions (AF) within NPNRD



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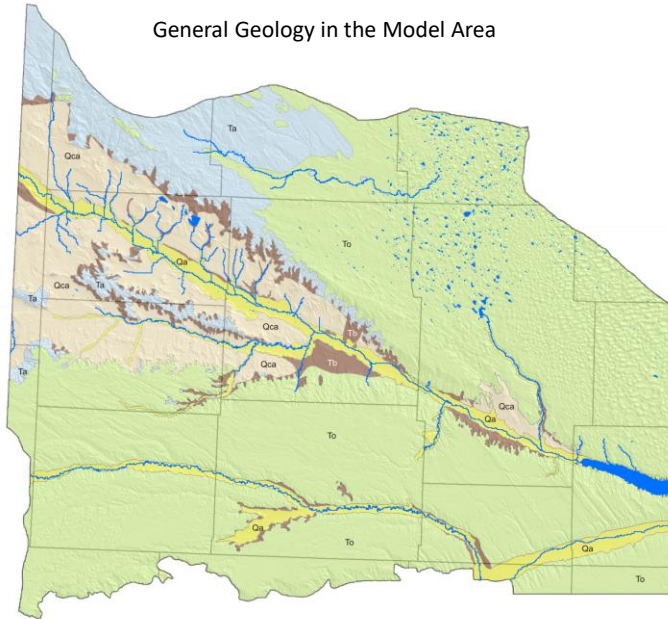
NPNRD Hydrologic Dataset – 1953 - 2013



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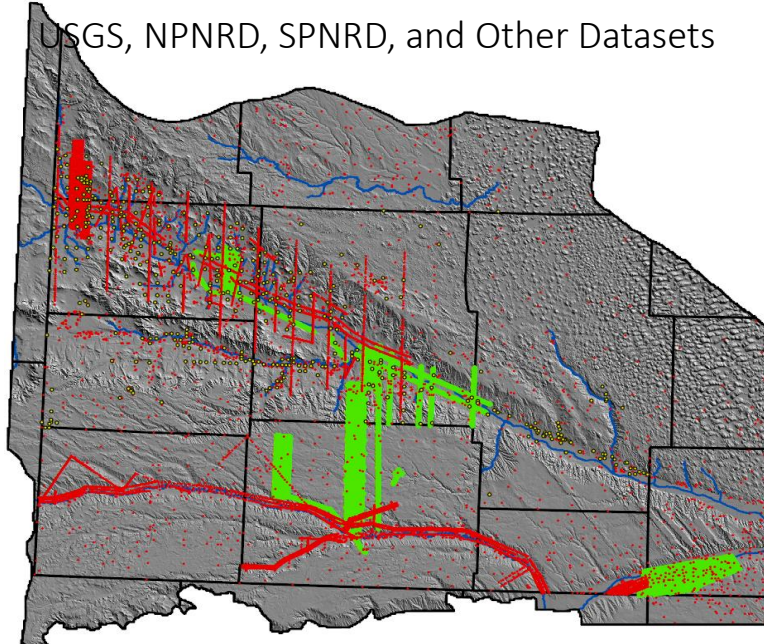
General Geology in the Model Area



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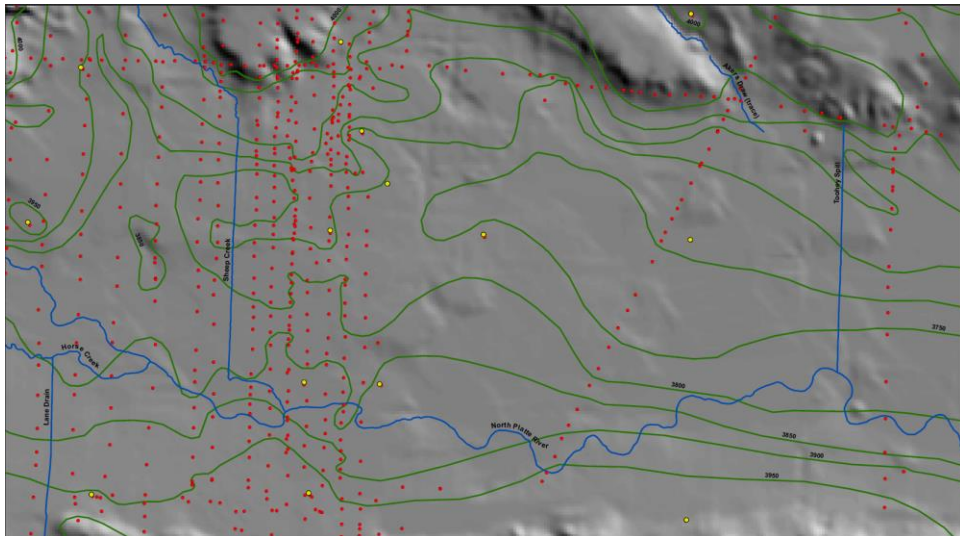
USGS, NPNRD, SPNRD, and Other Datasets



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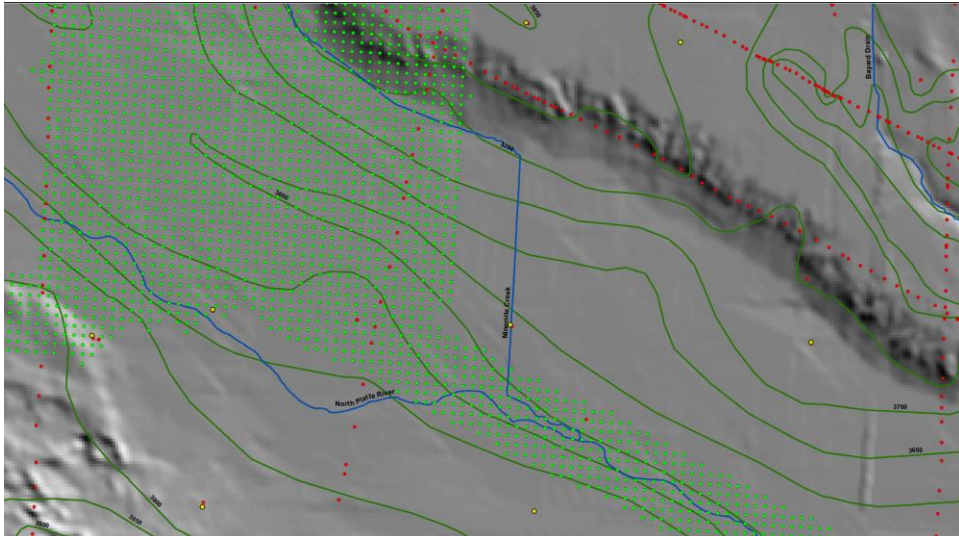
USGS, NPNRD, SPNRD, and Other Datasets



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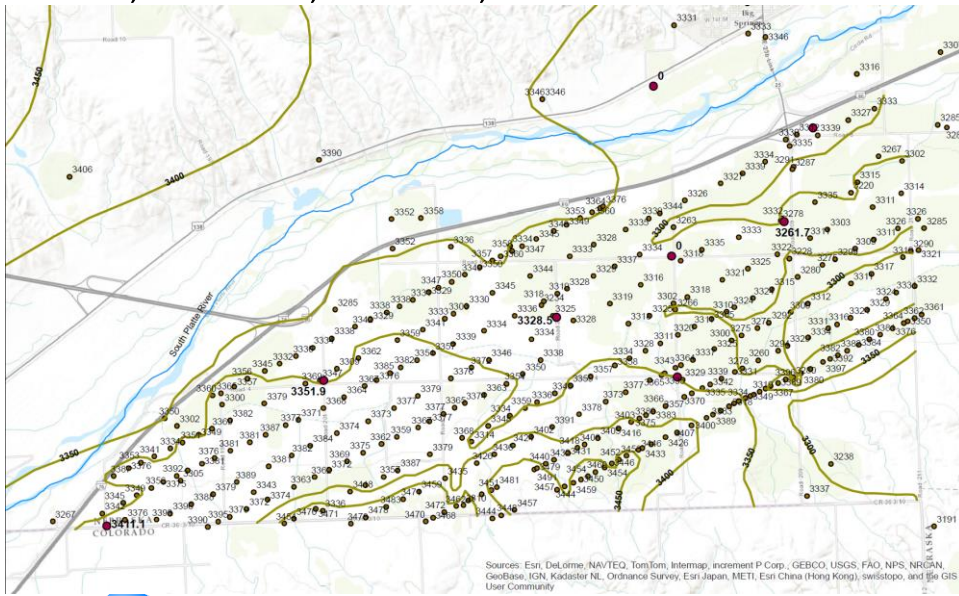
USGS, NPNRD, SPNRD, and Other Datasets



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USGS, NPNRD, SPNRD, and Other Datasets



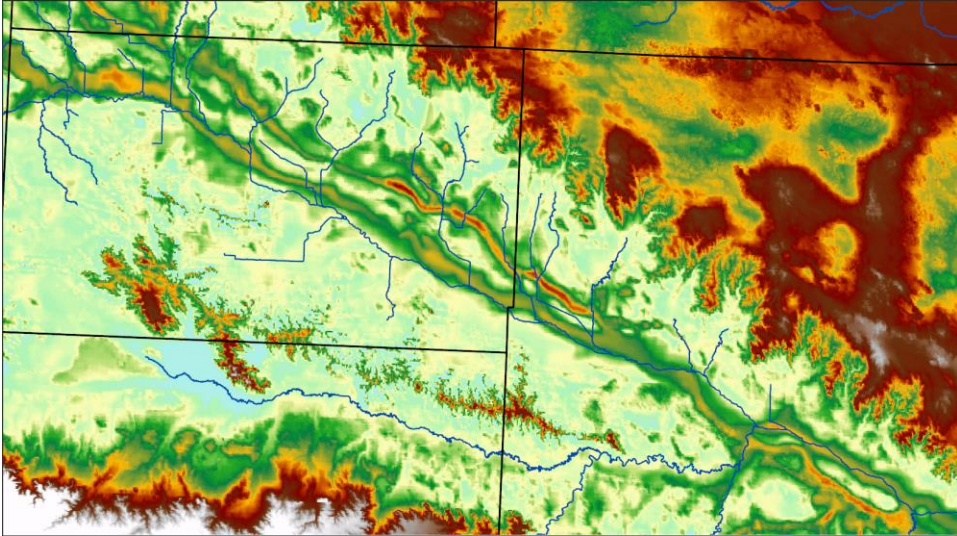
Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRGAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), Swisstopo, and the GIS User Community



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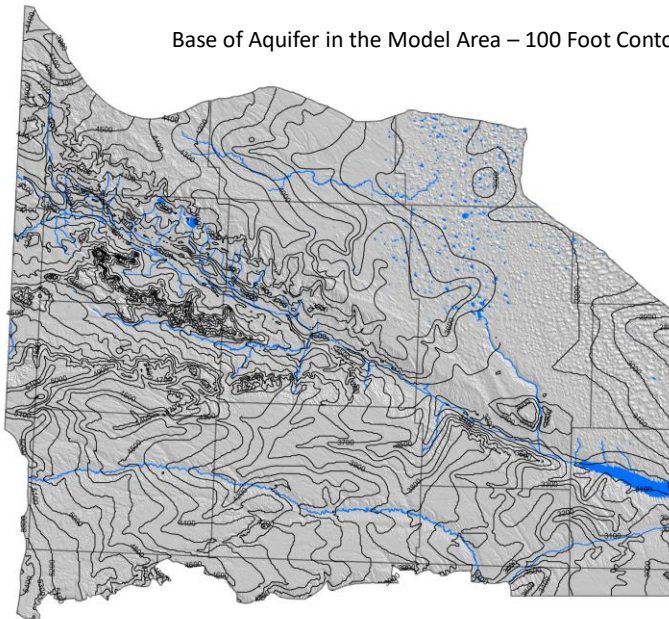
Saturated Thickness Map NPNRD



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Base of Aquifer in the Model Area – 100 Foot Contours



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Regionalized Soil Water Balance Model



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Current Modeling

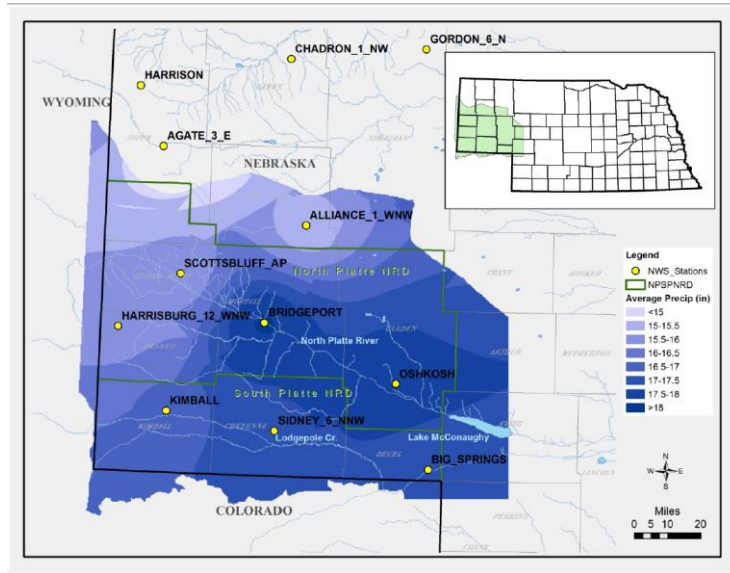
- Regionalized Soil Water Balance Model
 - Crop Consumptive Use (CROPSIM)
 - Soil Water Balance
 - Determines Net Irrigation Requirement (Water Needed by Crops)
 - Provides Ground Water Only Land Pumping (Pre-Metered)
 - Provides Recharge from Irrigation Inefficiency and Precipitation



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Weather Stations

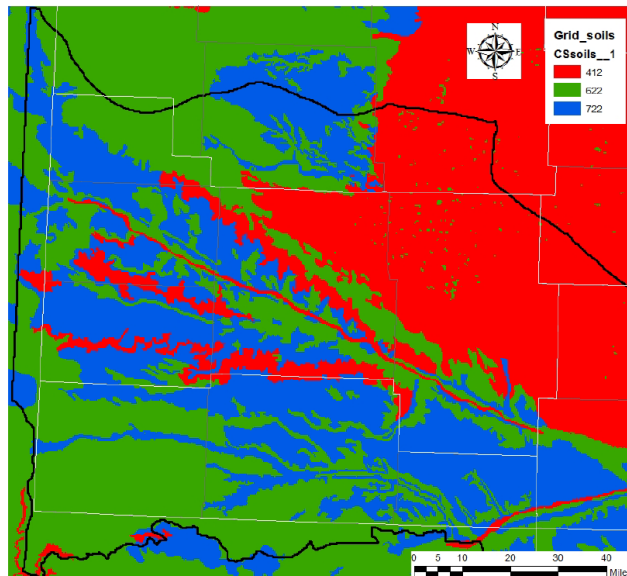


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Soil Classifications for CROPSIM

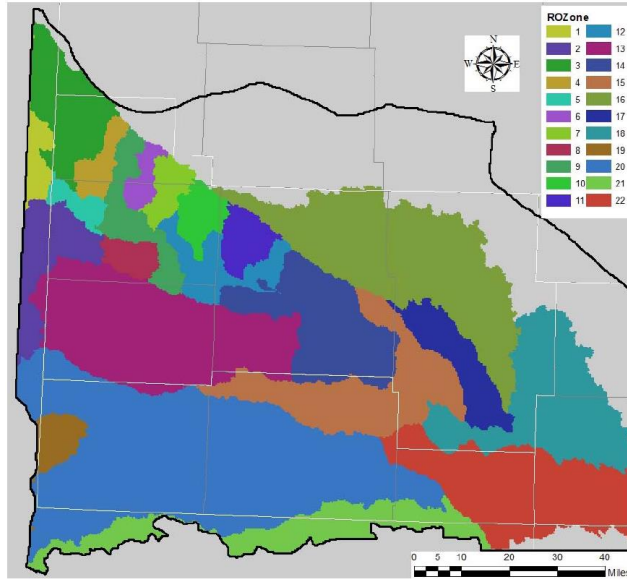


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Runoff Zones



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Surface Water Operations Model



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Surface Water Operations Model

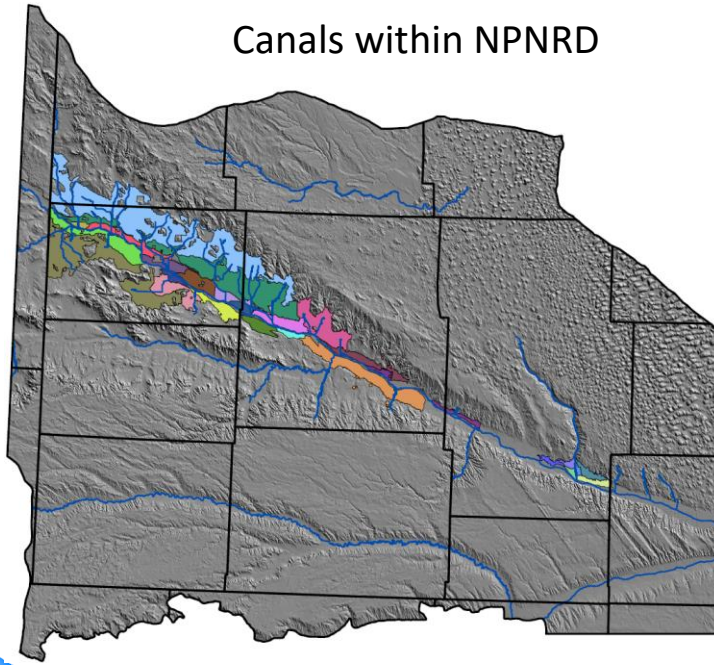
- Model's Surface Water Deliveries Based on:
 - Prior Appropriation System
 - Crop Water Demands
 - System Operations
- Model is from Whalen Diversion Dam in WY to Lewellen North Platte River Gage
- Provides Ground Water Model with:
 - Commingled Pumping Estimates Prior to Meters
 - Canal Recharge



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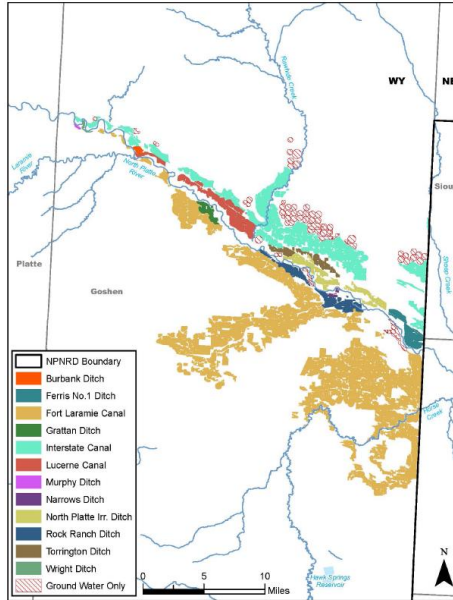
Canals within NPNRD



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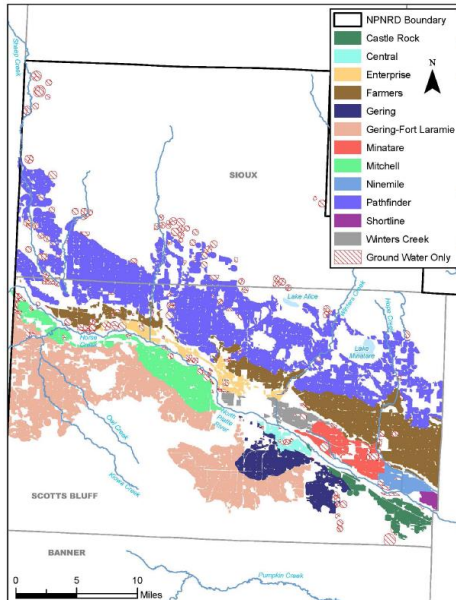
Wyoming Land Use by Water Source



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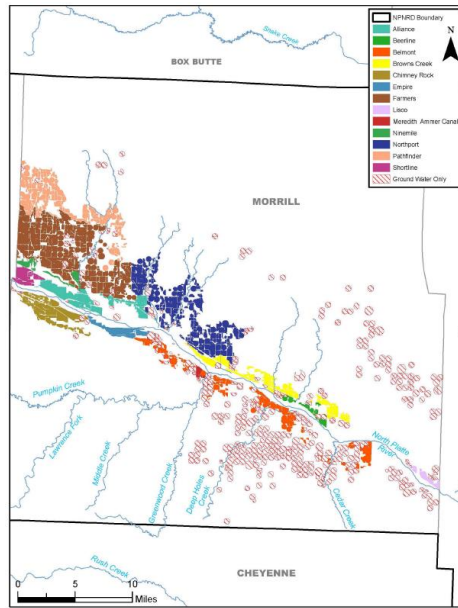
Scotts Bluff and Sioux Counties Land Use by Water Source



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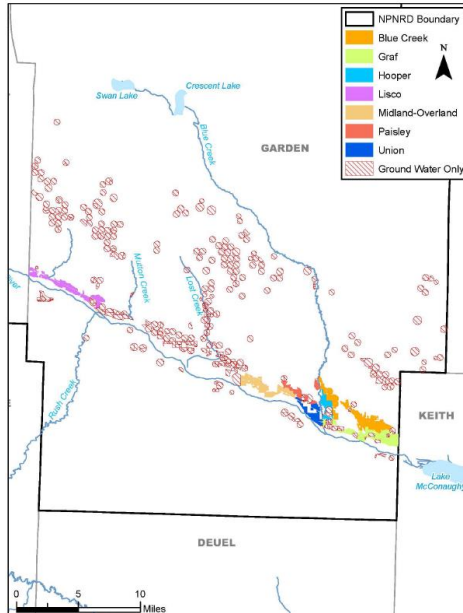
Morrill County Land Use by Water Source



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Garden County Land Use by Water Source



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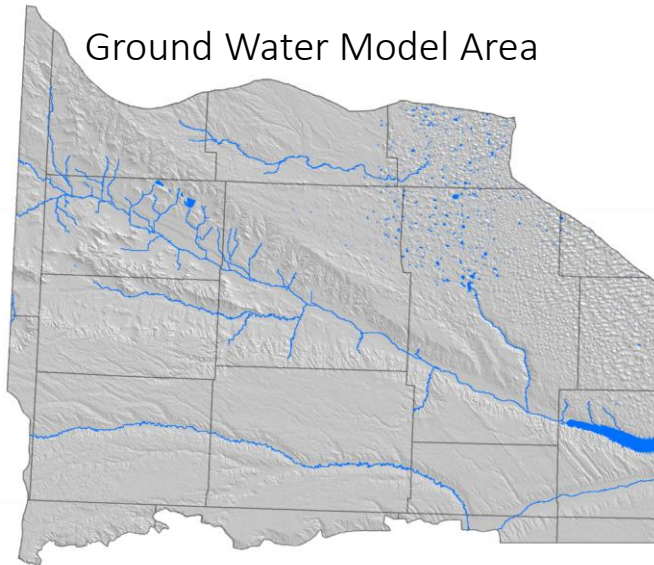
Ground Water Model



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Ground Water Model Area



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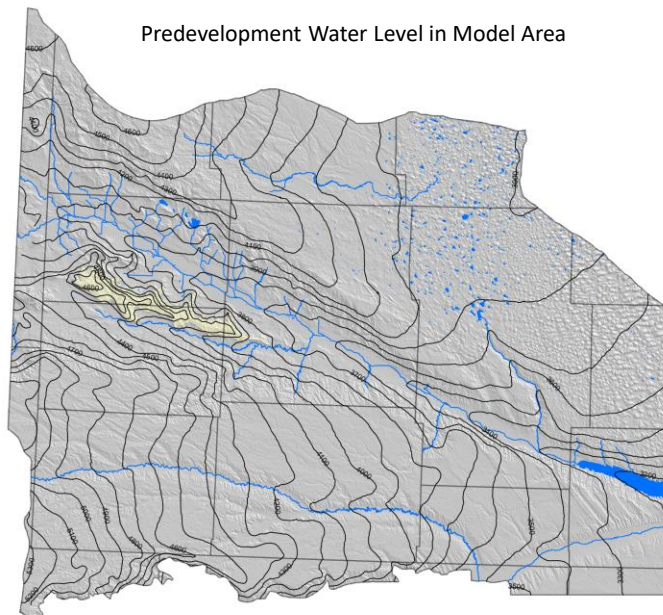
Current Modeling

- Ground Water Modeling
 - 40 Acre Cell Size
 - 177,780 Active Model Cells
 - 874 Head Calibration Targets
 - Mostly within NPNRD and SPNRD



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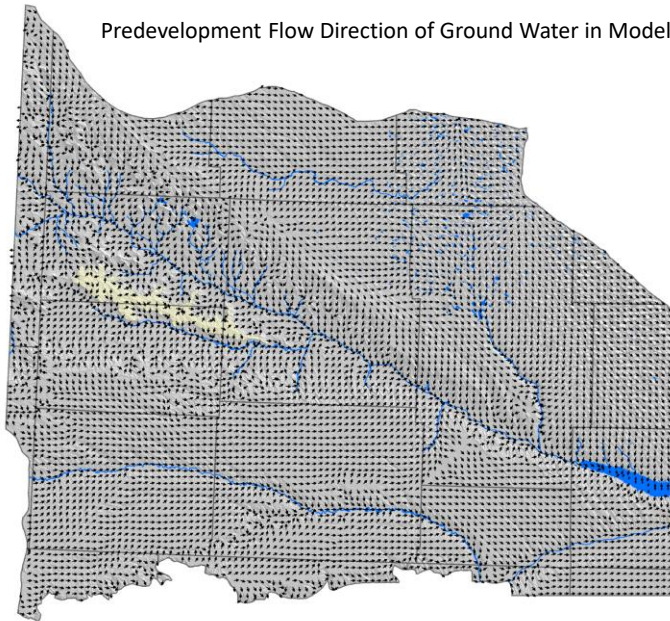
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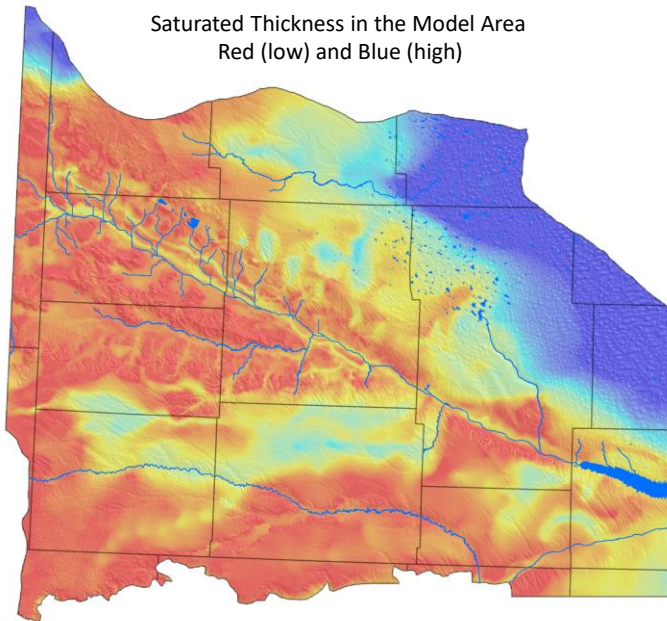
Predevelopment Flow Direction of Ground Water in Model Area



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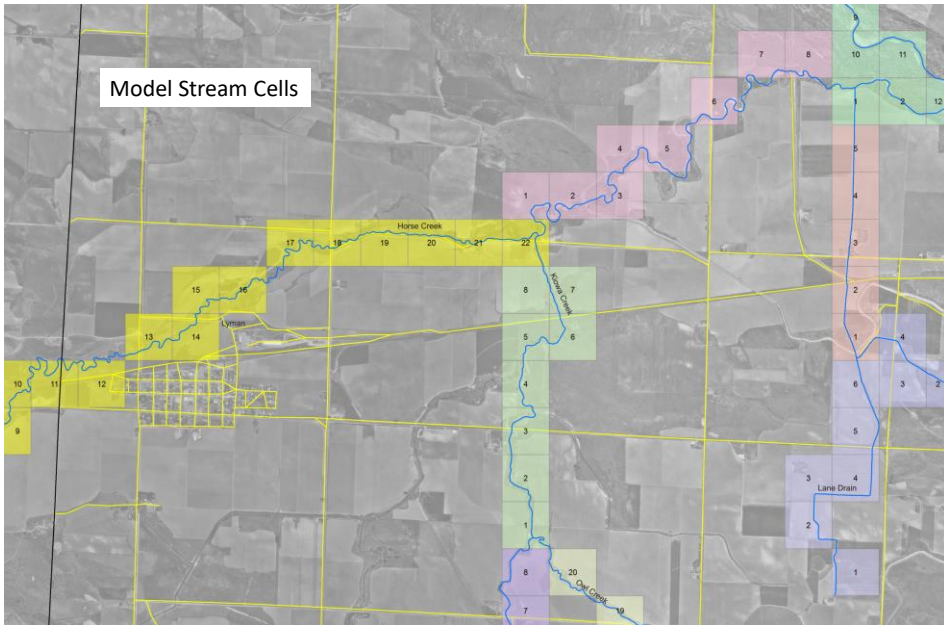
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Saturated Thickness in the Model Area
Red (low) and Blue (high)



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CROPSIM Calibration



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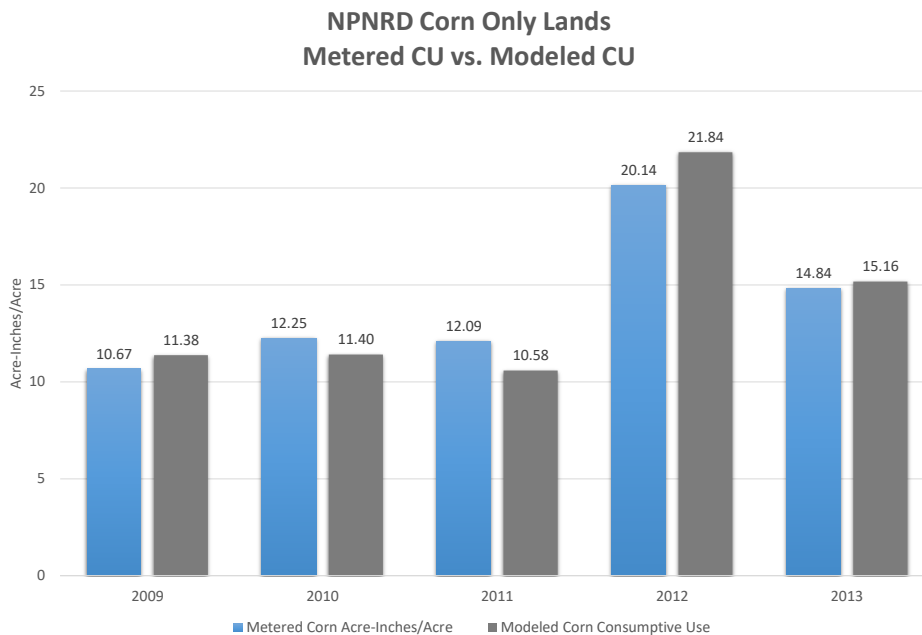
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CROPSIM Calibration

- Completed a QC check on the estimates of crop consumptive use predicted by CROPSIM using metered pumping data
 - Only on single crop only lands in each NRD



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CROPSIM Calibration

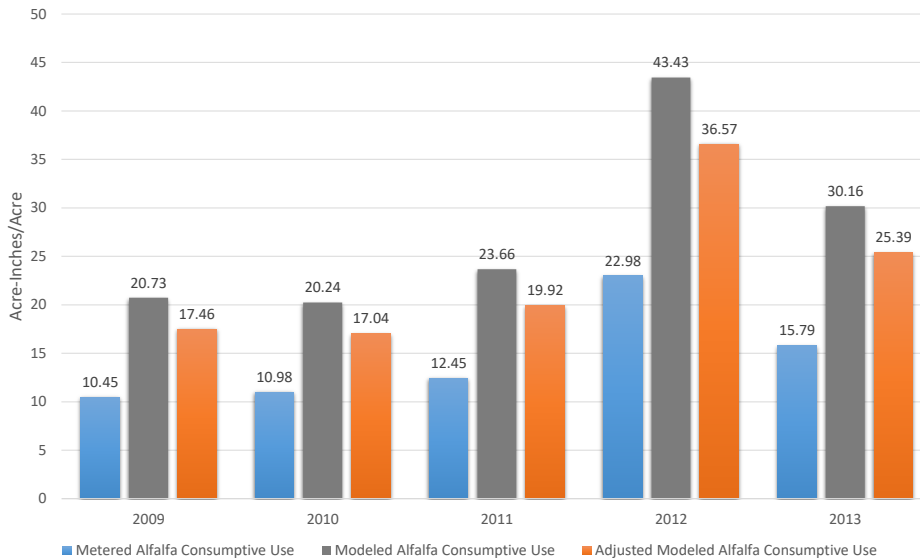
- Adjusted irrigated alfalfa, small grains, and grass pasture to 80% of full NIR



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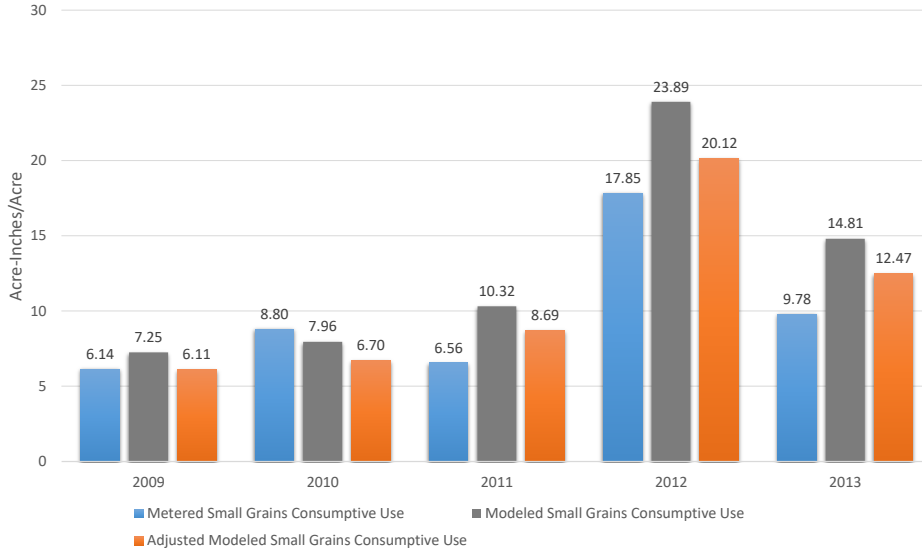
**NPNRD Alfalfa Only Lands
Metered CU vs. Modeled CU**



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NPNRD Small Grains Only Lands Metered CU vs. Modeled CU



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Modeling Results



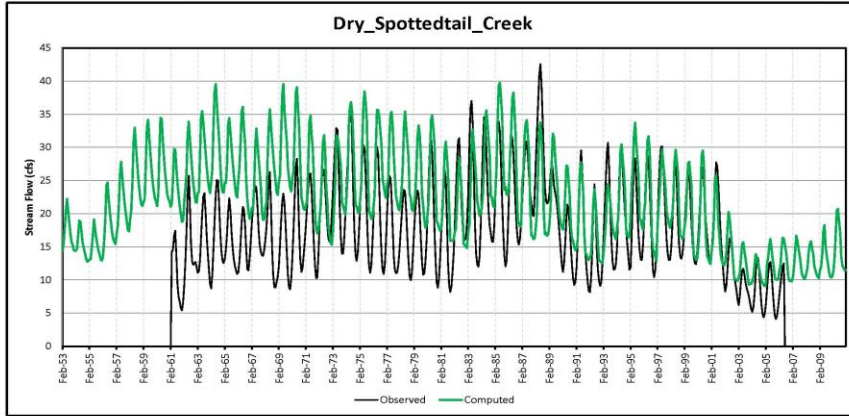
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Ground Water Model vs. Ground Water Baseflow (1953 – 2010)



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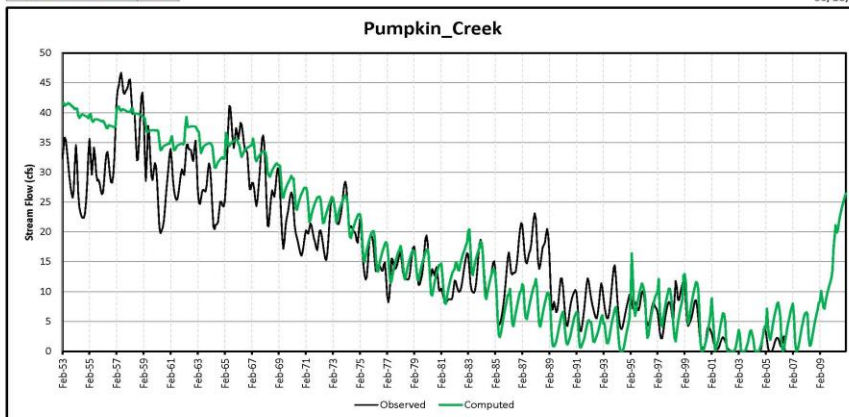
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Ground Water Model vs. Ground Water Baseflow (1953 – 2010)



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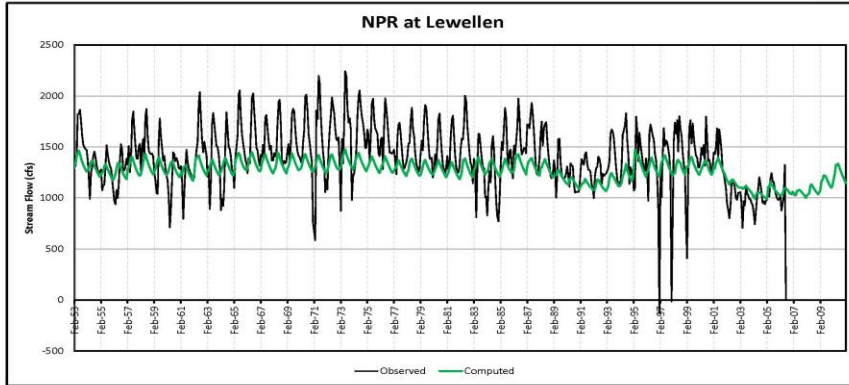
Adaptive Resources, Inc.

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Ground Water Model vs. Ground Water Baseflow (1953 – 2010)



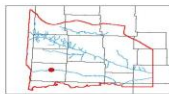
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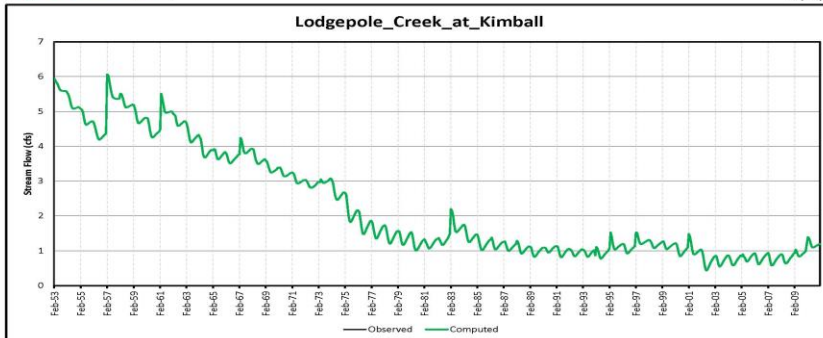
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Modeled Lodgepole Creek Flow Hydrographs



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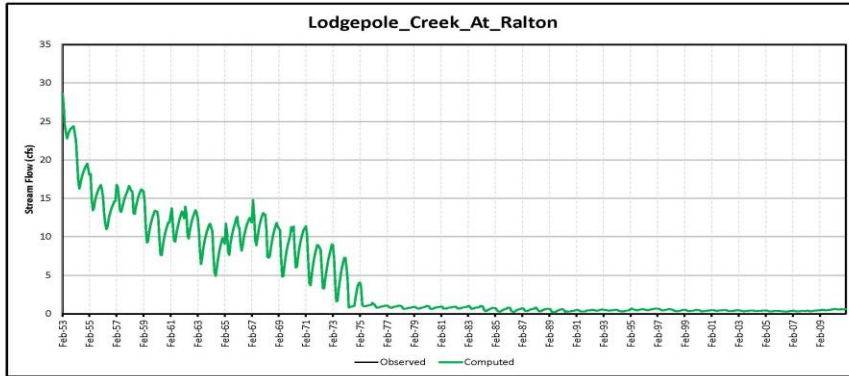
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Lodgepole Creek Flow Hydrographs



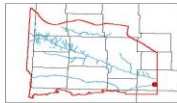
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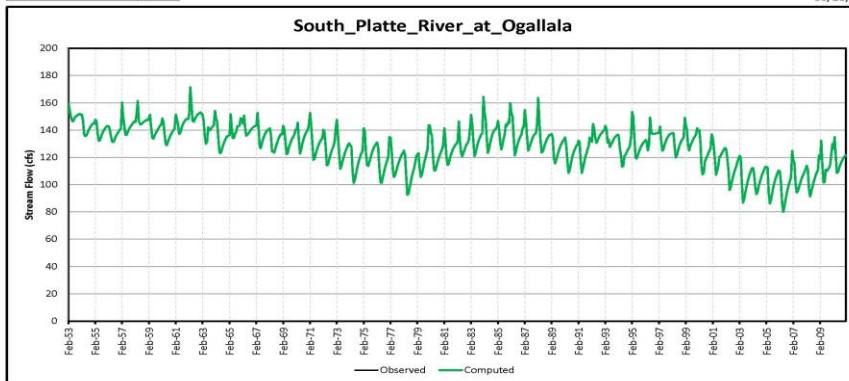
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South Platte River Flow Hydrographs

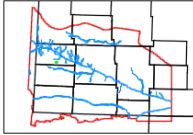


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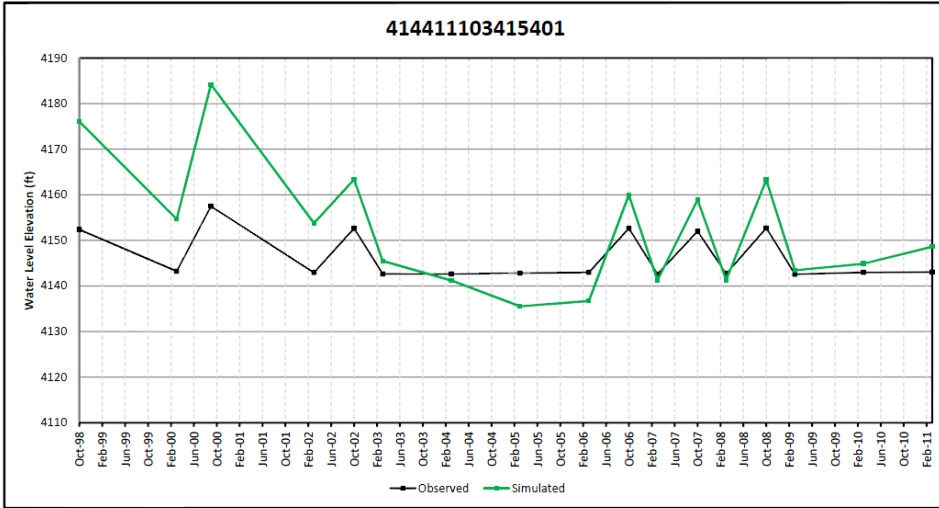


Head Observation Target

Monitor Well Hydrograph – South of Mitchell near NPR

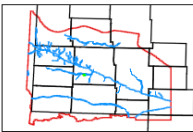
Page 625
17
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20N55W06ADBD 104-221



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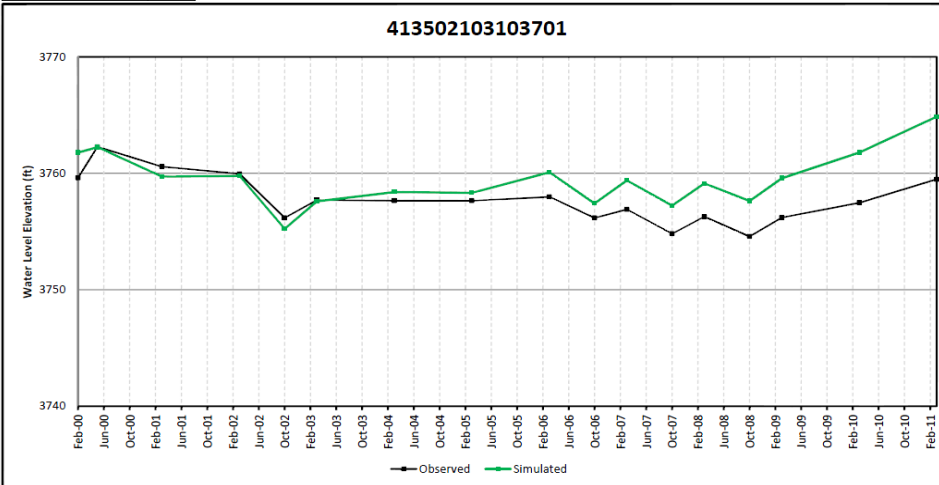


Head Observation Target

Monitor Well Hydrograph – Lower Pumpkin Creek Area

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17
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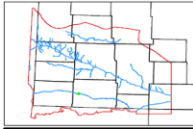
19N51W27DDDD 210-267



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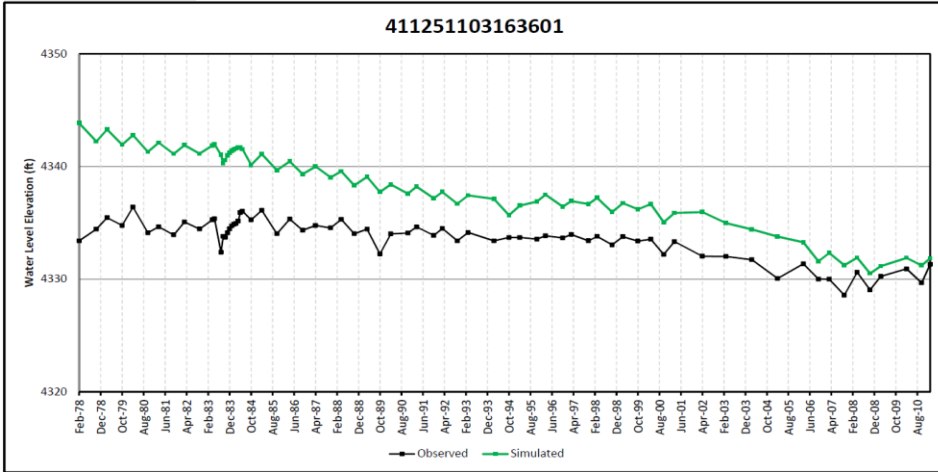
Head Observation Target



Monitor Well Hydrograph Near Dix

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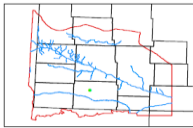
14N52W03CBA 185-368



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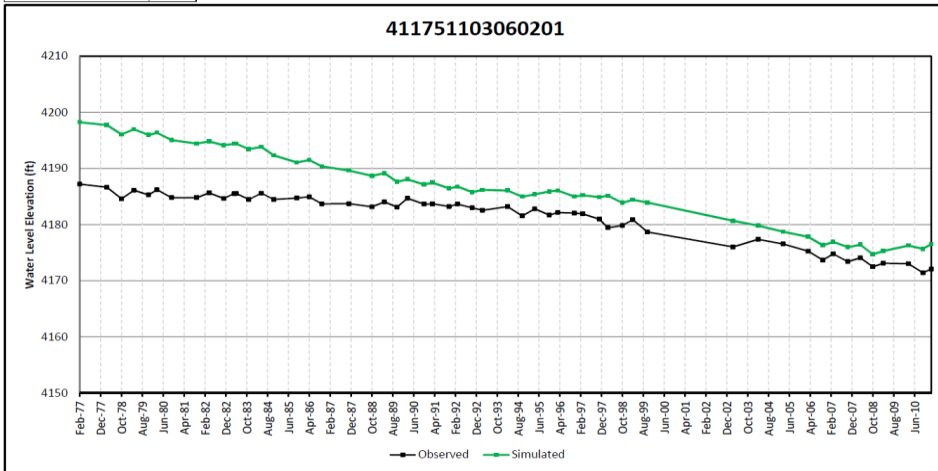
Head Observation Target



Monitor Well Hydrograph - North Cheyenne County Tablelands

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15N50W06CD 223-347



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How do we use the models?



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Change Modeling Discussion



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Change Modeling Discussion

- Modeling Design
 - Baseline Model
 - Typically the historic model with everything that actually happened
 - Modified Model
 - Modify one feature of the model
 - Example: Remove irrigated lands from the model to determine the depletive affects
 - Analysis
 - Baseline Model – Modified Model = Change
 - Change is typically streamflow or baseflow
- Discussion about the analyses and the WWUM Modeling and COHYST Modeling overlap area



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Ground Water Irrigated Acreage Retirement Analyses



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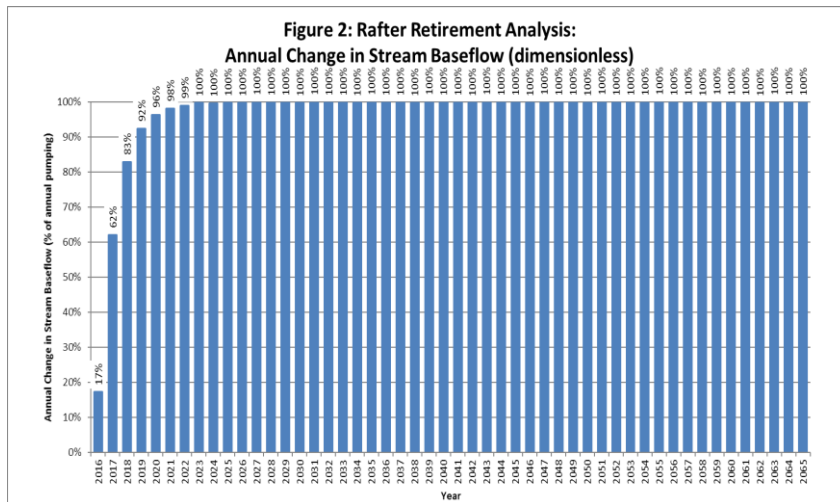
Ground Water Irrigated Acreage Retirement Analyses

- Analyses
 - Determine accretive impacts from retiring ground water irrigated acres
 - Help NRDs determine if a property has sufficient impacts to a stream to purchase the ground water certified acres
 - Completed upwards of 40 to 50 analyses for NPNRD and SPNRD



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Post-1997 Depletions Analysis



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Post-1997 Depletions Analysis

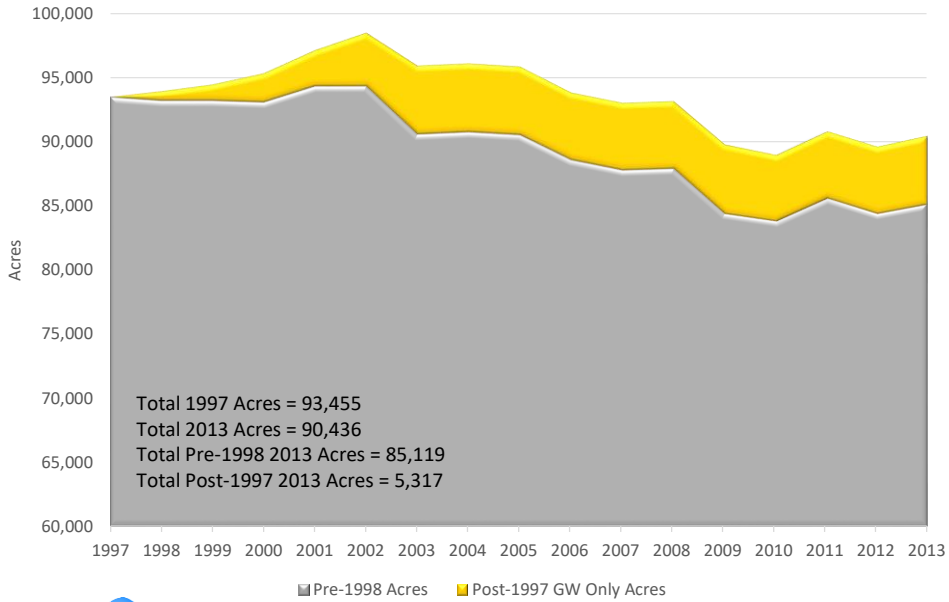
- Analysis
 - Determine Depletions Due to Irrigated Lands Developed after 1997
 - Analysis Repeated the 2009 – 2013 Model Time Period for 50 Years into the Future



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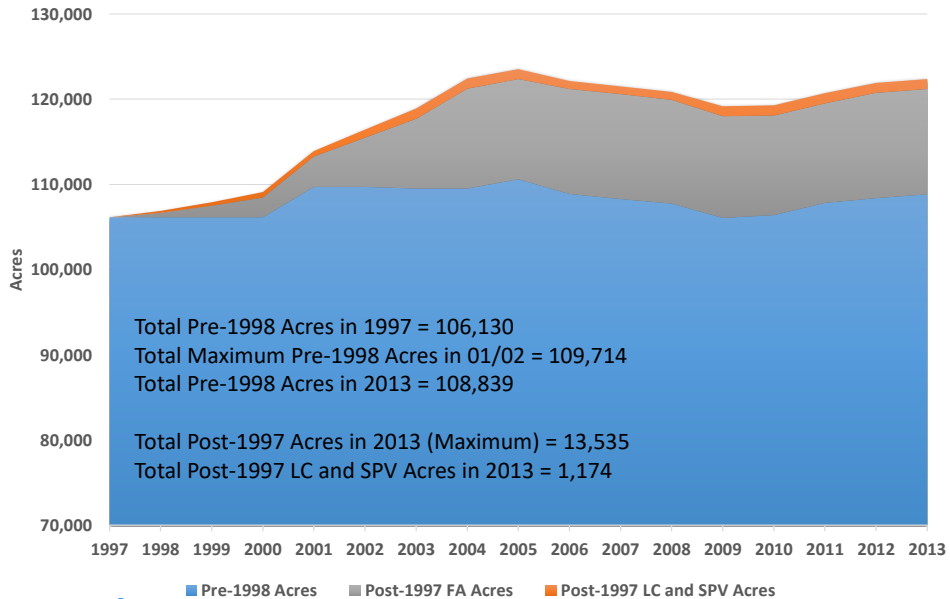
NPNRD All Active Ground Water Only Land Use Development in OA Area



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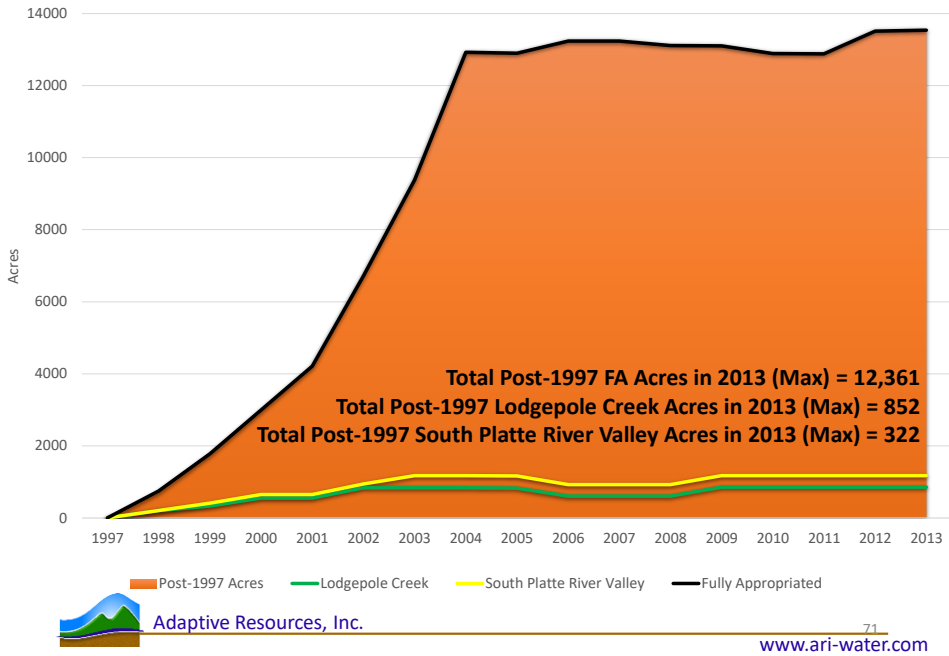
Preliminary SPNRD All Ground Water Only Land Use Development



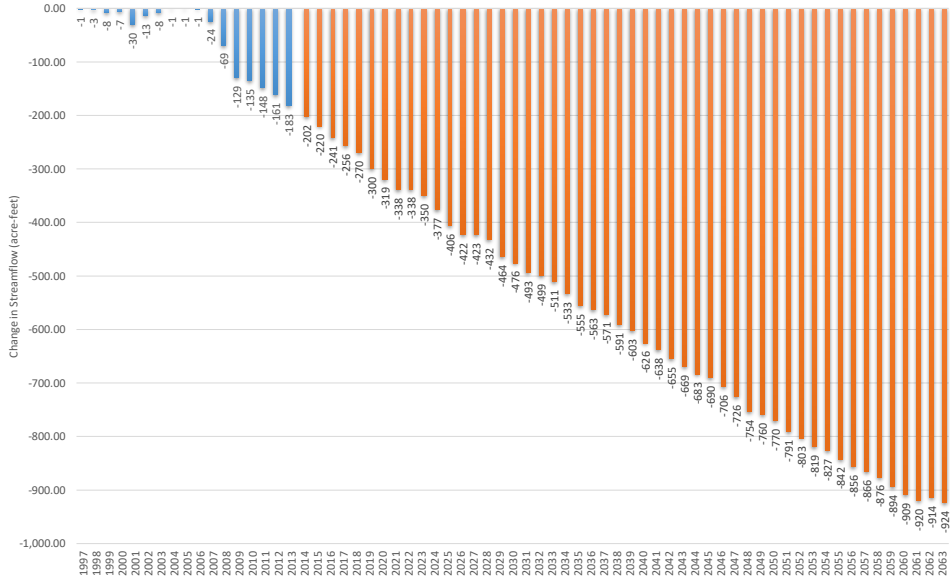
Adaptive Resources, Inc.

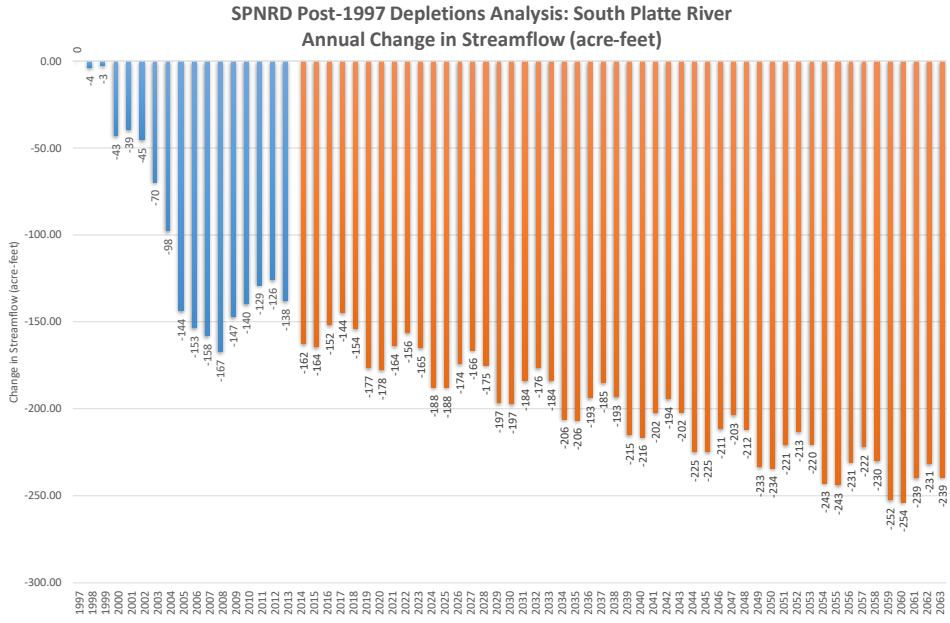
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Preliminary SPNRD Post-1997 Ground Water Only Land Use Development



SPNRD Post-1997 Depletion Analysis: All Lodgepole Creek Annual Change in Streamflow (acre-feet)





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Allocation Analysis



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DRAFT

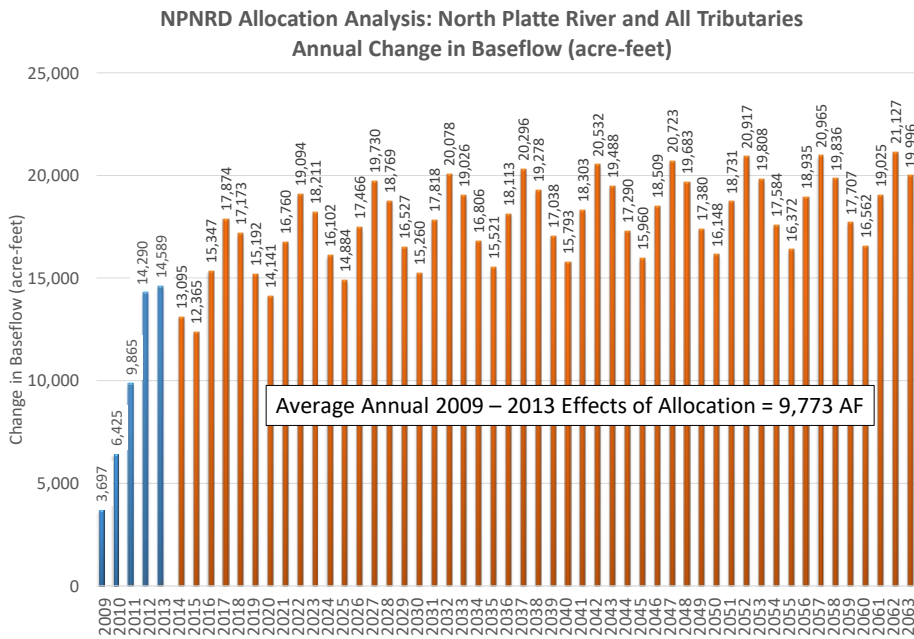
Allocation Analysis

- Analysis
 - Difference between Modeled and Metered Pumping Information
 - Considered Savings on Consumptive Use through Allocations
 - Only On Pre-1998 Lands
 - Run with 2009 to 2013 Repeated through 2063



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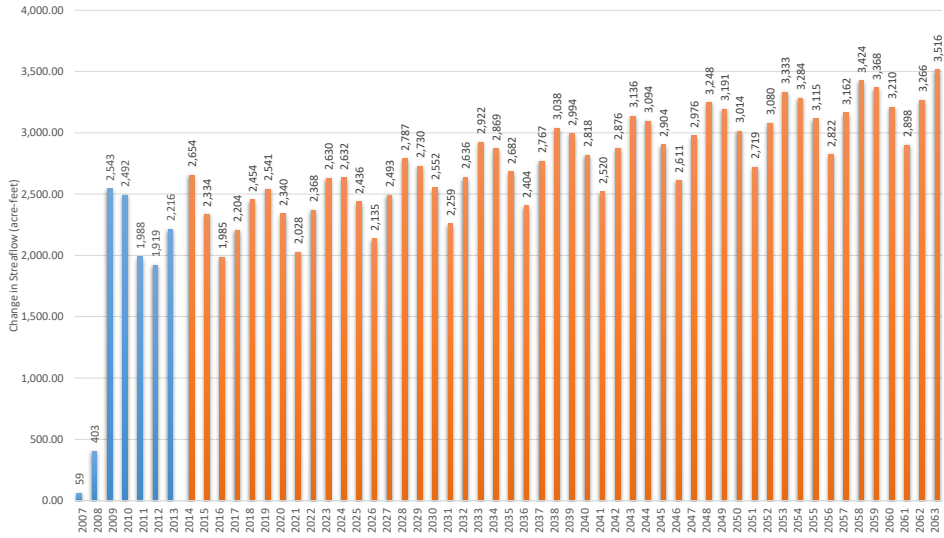
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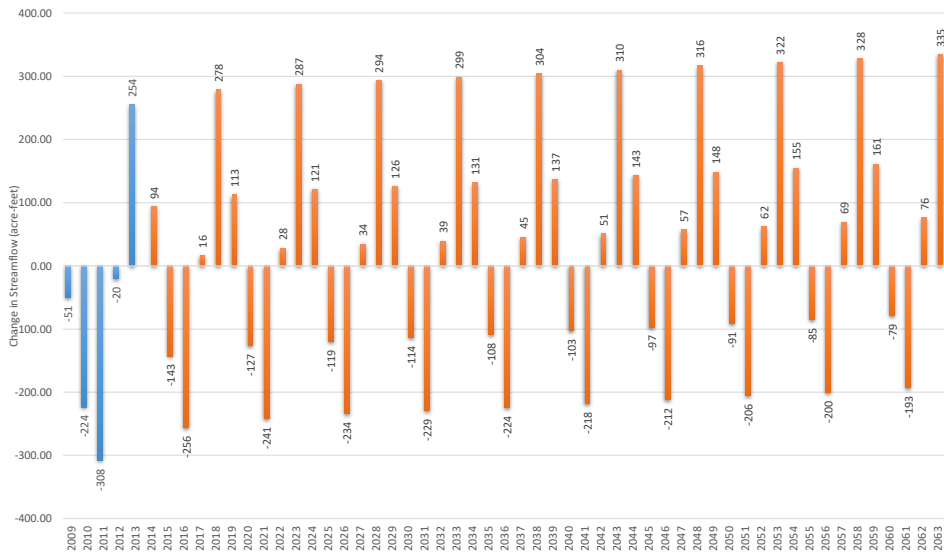
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SPNRD Allocation Analysis: All Lodgepole Creek Annual Change in Streamflow (acre-feet)



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SPNRD Allocation Analysis: South Platte River Annual Change in Streamflow (acre-feet)



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South Platte River Canal and Pit Recharge Analysis



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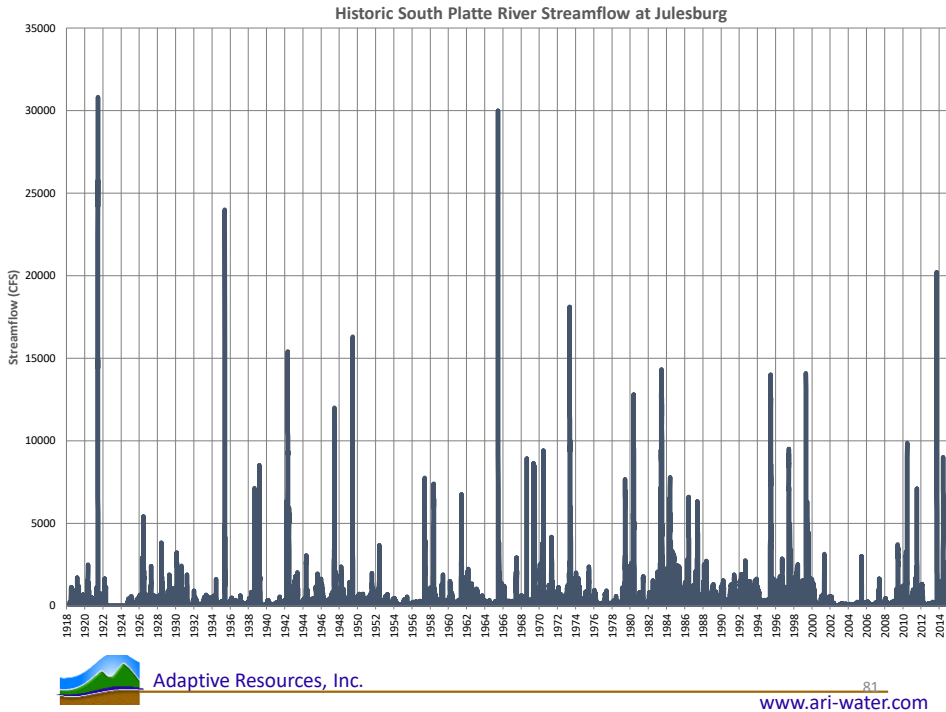
South Platte River Canal and Pit Recharge Analysis

- Analysis
 - Determine the Accretive Effects of the Canal and Pit Recharge Projects
 - Analysis on the South Platte River on Western Canal
- Projection of Events in Future
 - Use Historic Streamflow



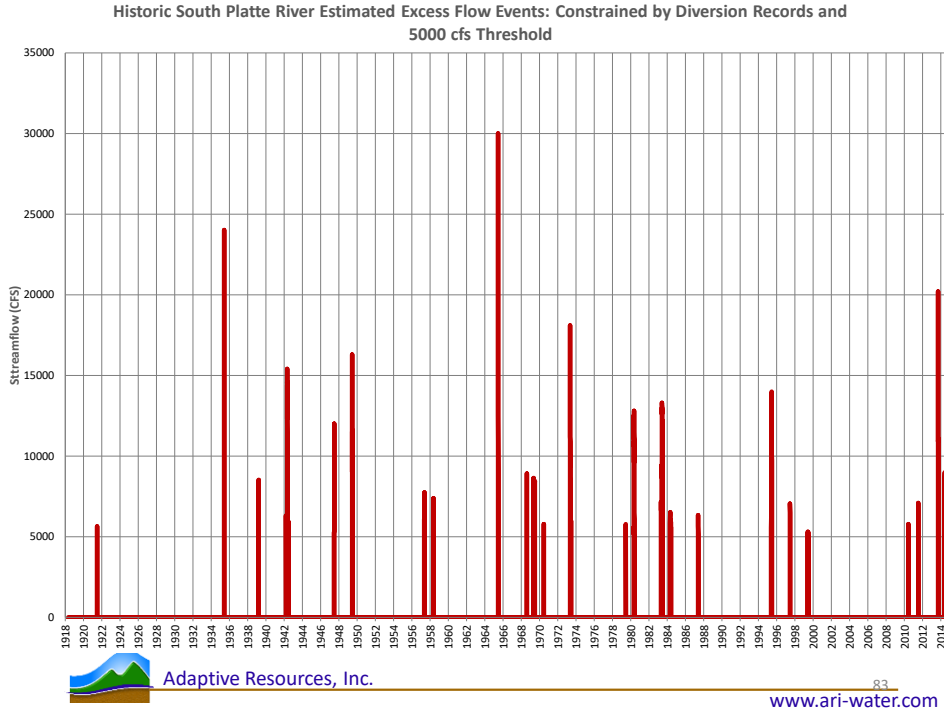
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South Platte River Canal and Pit Recharge Analysis

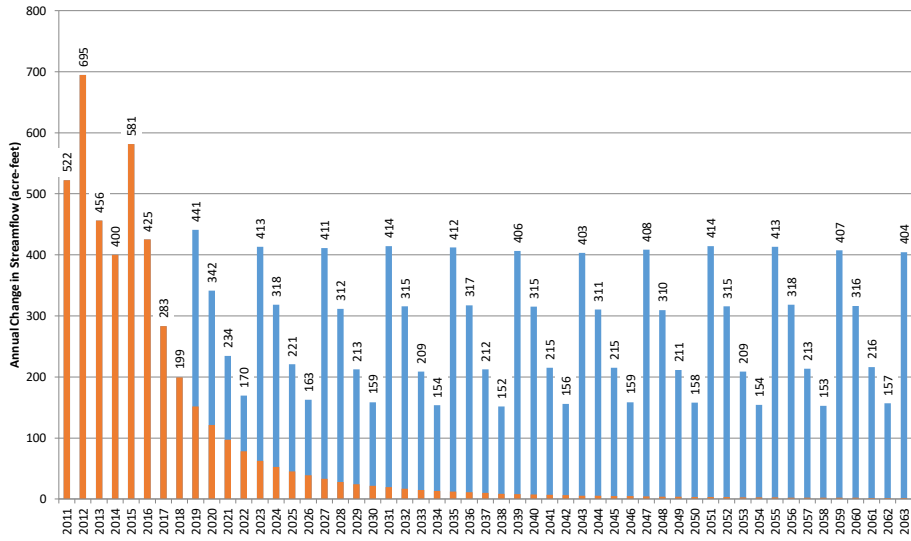
- Analysis Projection
 - Limit to 5000 CFS
 - Limit to Time Periods when Western Canal is Not Diverting for Irrigation
 - Use Diversion Records



South Platte River Canal and Pit Recharge Analysis

- Analysis Projection
 - Found 25 Excess Flow Events from 1918 through 2014
 - Results
 - Average Excess Flow Event Every 4 Years

**SP Natural Resources District Canal Recharge Analysis:
Annual Instantaneous Change in Stream Baseflow (acre-feet)**



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Overall SPNRD Management Activities Analysis



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Overall Comparison

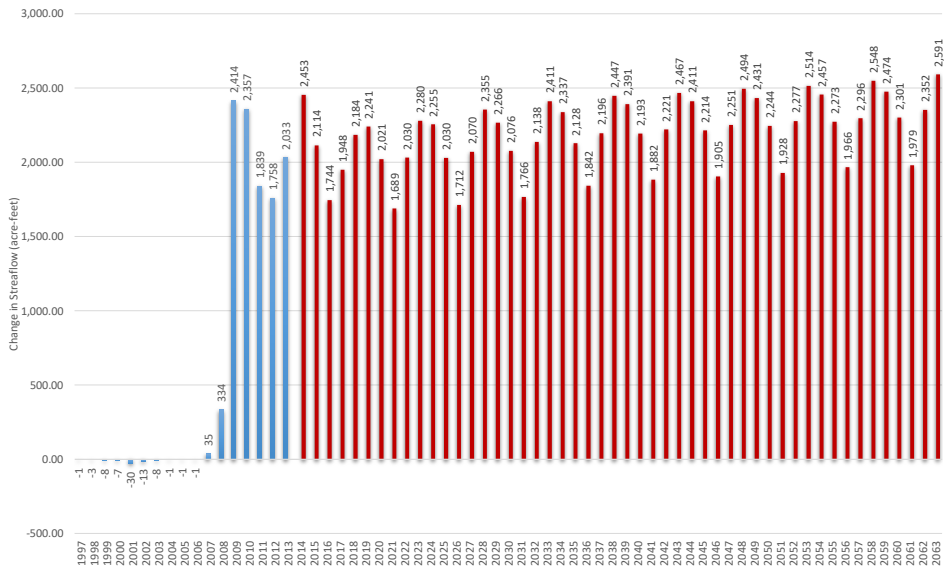
- Comparison
 - Post-1997 Depletions
 - Allocation Effects
 - Canal and Pit Recharge (South Platte River Only)



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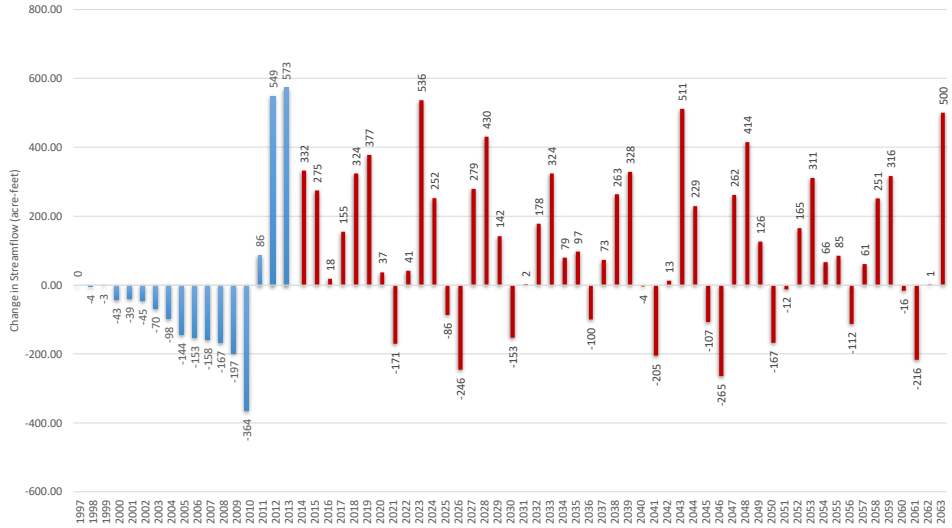
SPNRD Overall Comparison: All Lodgepole Creek
Annual Change in Streamflow (acre-feet)



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SPNRD Overall Comparison: South Platte River
Annual Change in Streamflow (acre-feet)



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Thanks!

- Questions
- Comments



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