URGWOM

Development of Physically Based Model for the Middle Rio Grande Valley

Michael Roark, USGS

Nabil Shafike, ISC

Technical Review - October 14, 2010

Area of Significant GW/SW Interaction

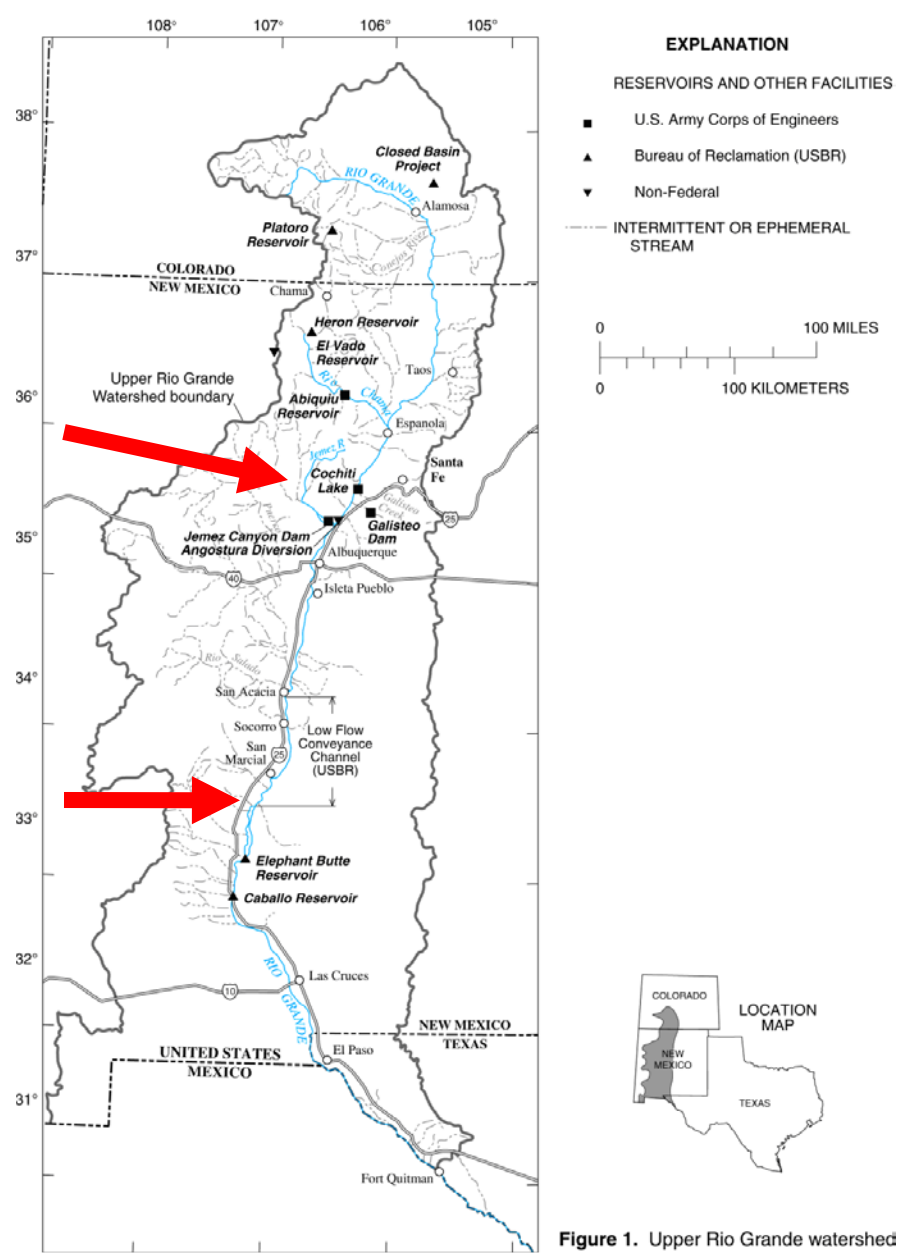


Figure 1. Upper Rio Grande watershed

URGWOM

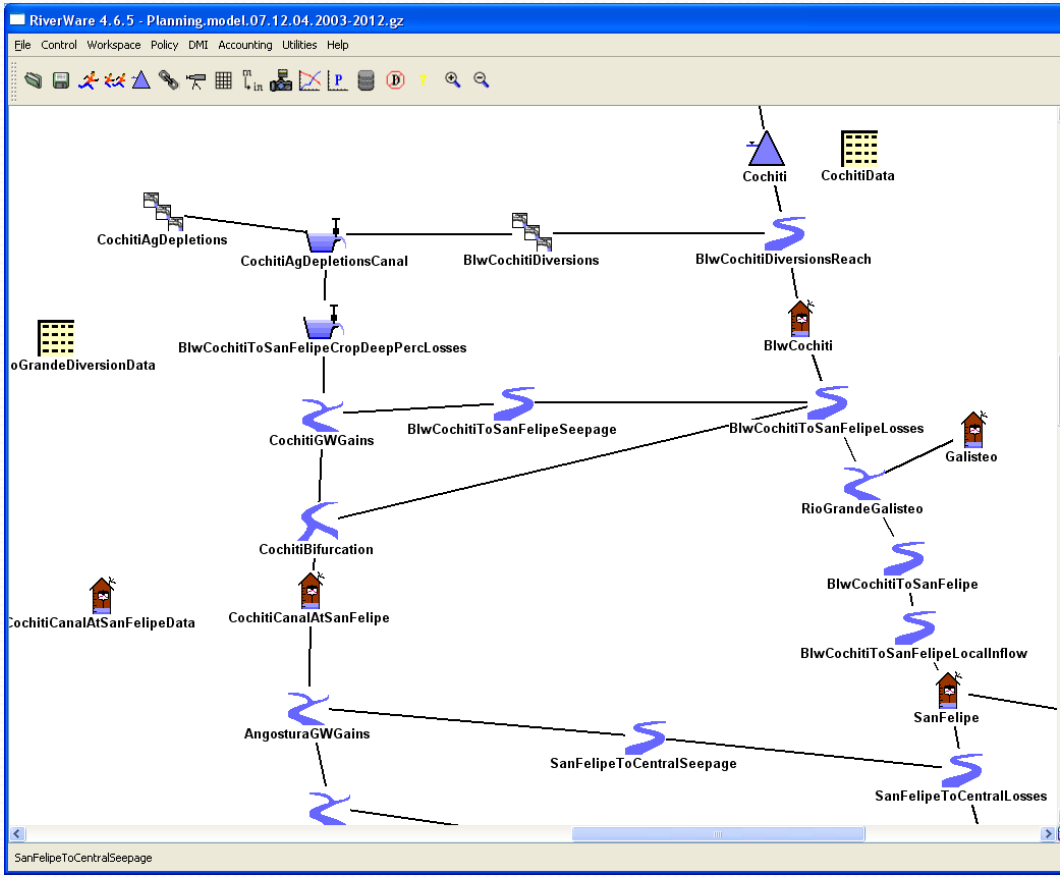
Middle Valley System

- Several diversion structures divert river flows to a system of canals.
- Drains capture agricultural returns.
- Head dependent seepage between shallow groundwater aquifer and river (and drains)
  - affected by riparian evapotranspiration

URGWOM

Physical Simulation GW/SW Interaction

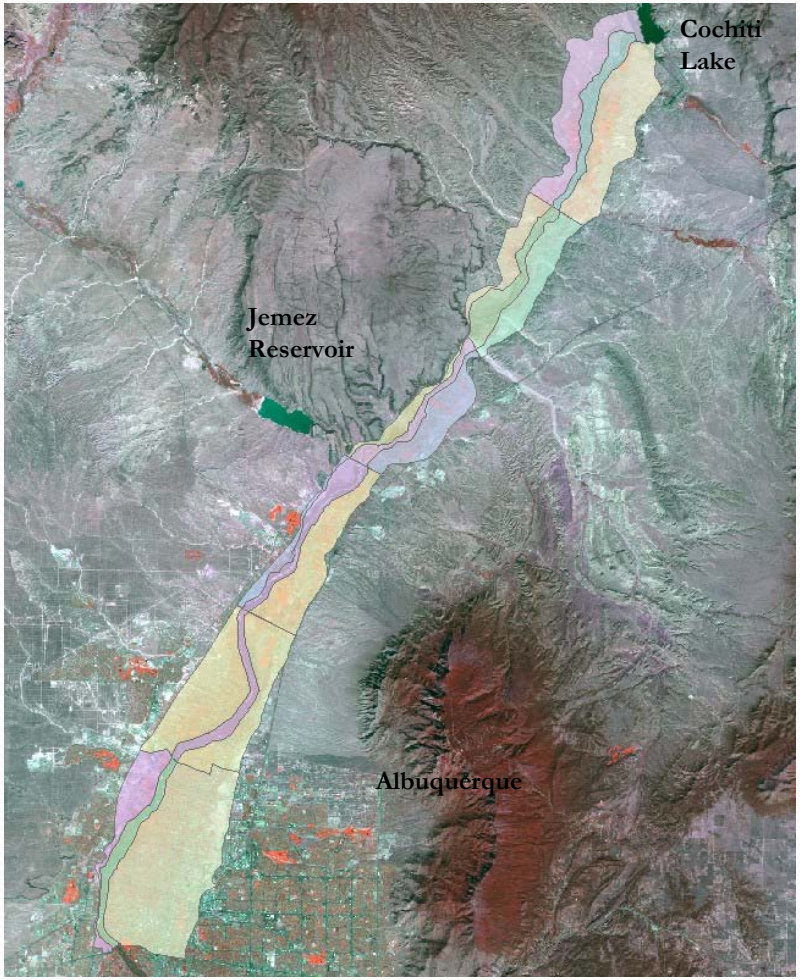
- Old Model
  - Uses regression relations for river seepage
  - Feedback loop to correct for too much or too little water in river and drains
  - Model needs flow input in each reach
- Many alternatives explored



URGWOM

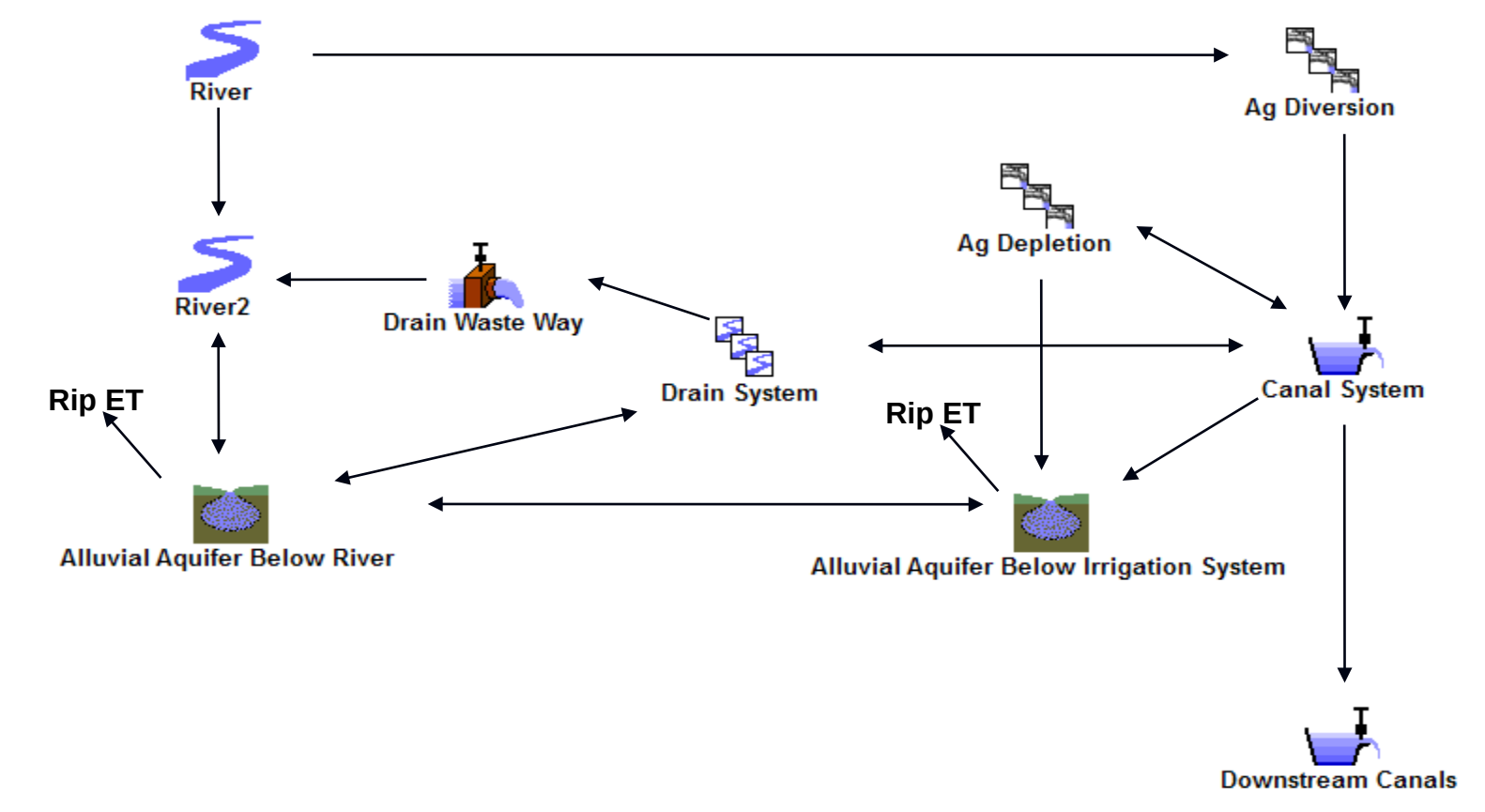
Model Reaches

- Middle Rio Grande is divided into 19 separate groundwater reaches along the following six river reaches:
  - Cochiti to San Felipe
  - San Felipe to Central
  - Central to Isleta
  - Isleta to Bernardo
  - Bernardo to San Acacia
  - San Acacia to San Marcial
- Sub-reaches ~ 5 to 7 miles long
- 3 groundwater areas for each reach.
- east of the river, below the river, and west of the river
- 57 groundwater cells



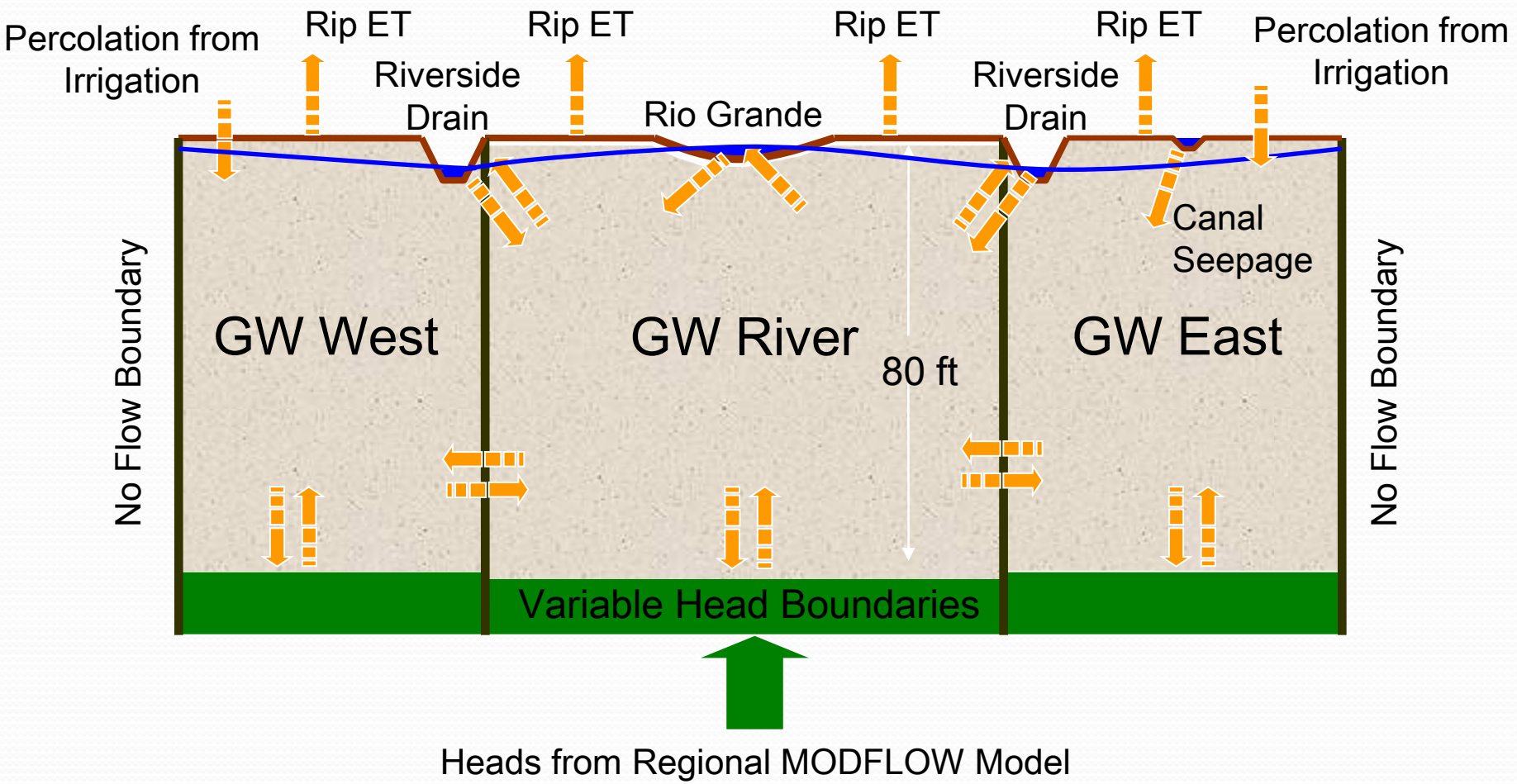
URGWOM

Conceptual Design



URGWOM

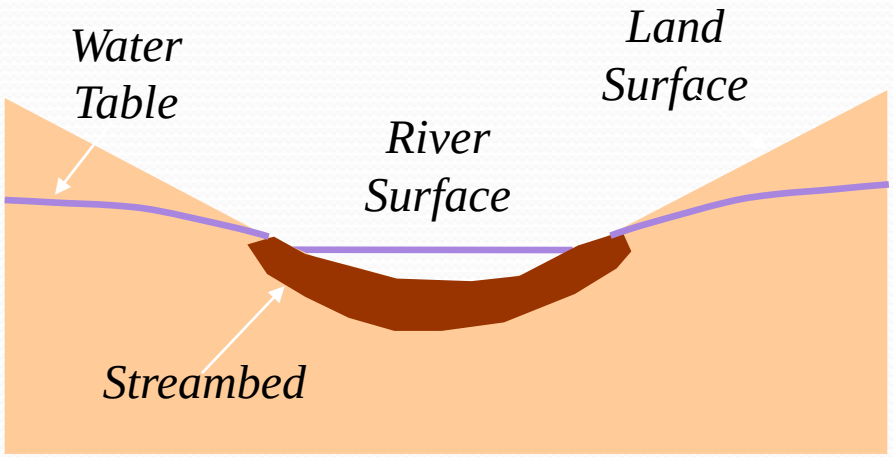
Vertical Discretization



URGWOM

Head Dependant Flow

Simulation of Stream - Aquifer System



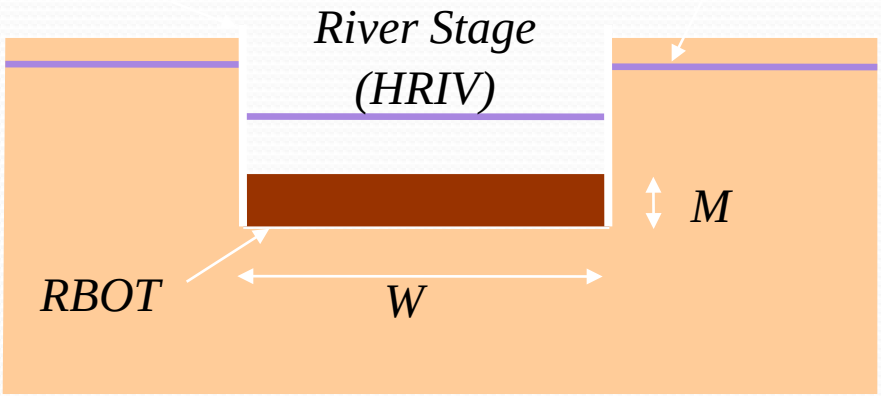
Stream –aquifer System

$If \quad h > RBOT$

$Seepage = Cond\,(HRIV - h)$

$If \quad h <= RBOT$

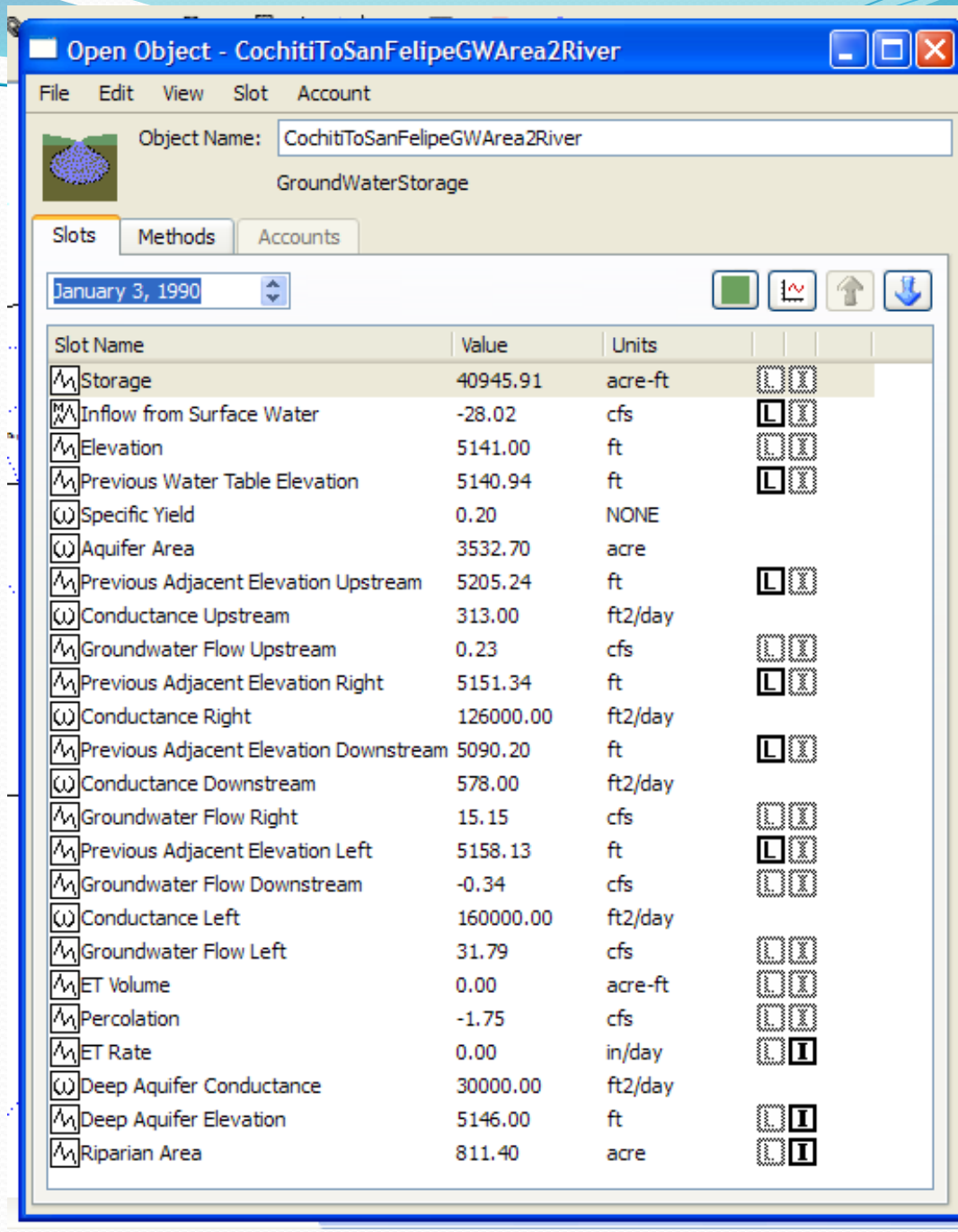
$Seepage = Cond\,(HRIV - RBOT)$



$Riverbed\ Conductance = KLW/M$

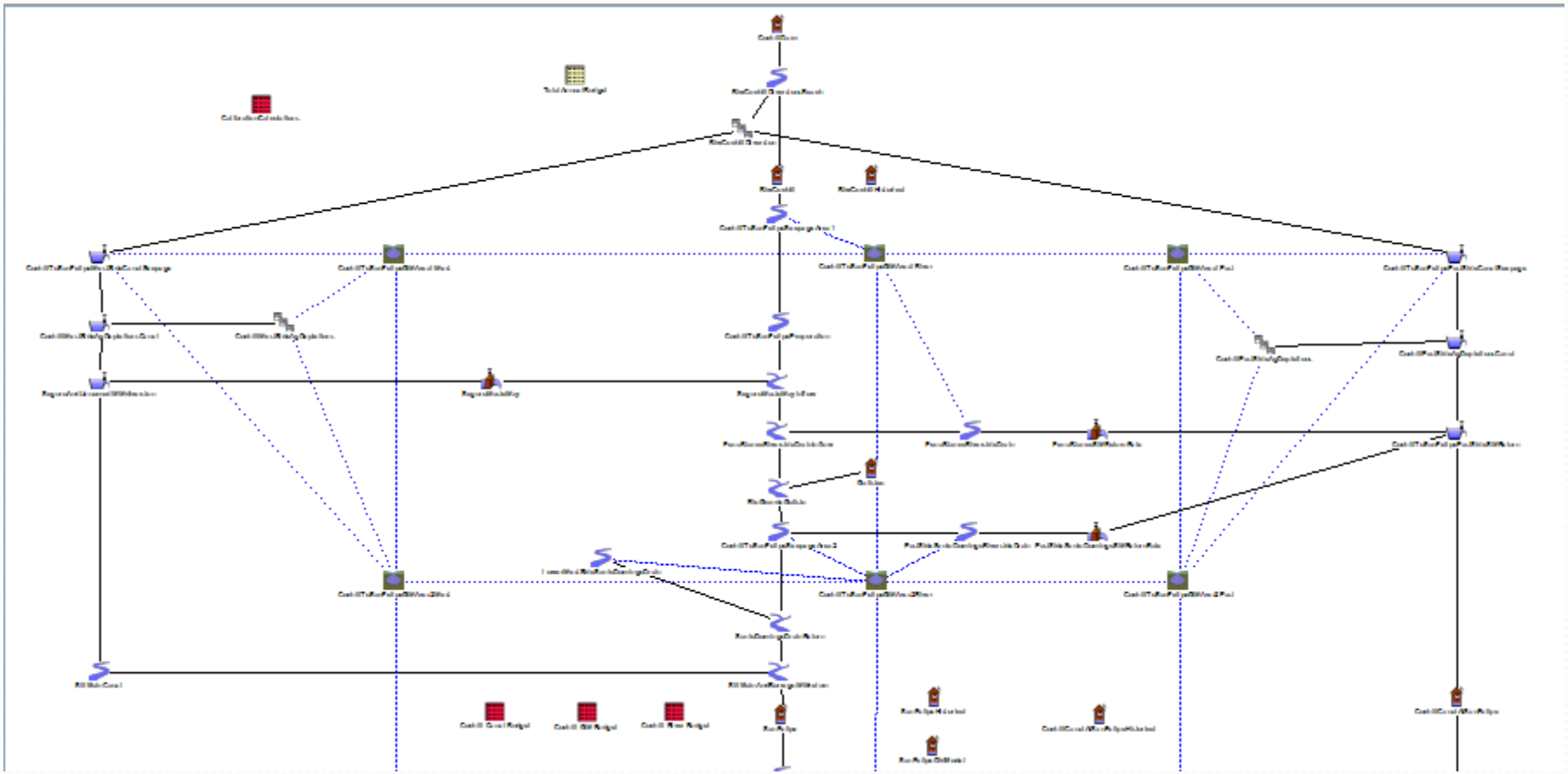
URGWOM

Example GW Object data



URGWOM

Cochiti to San Felipe Reach



URGWOM

Parameter Development – River and Drain objects

- average channel elevation
- open water and wetted sand evaporation equations
- river bed conductance
- average rating table

URGWOM

River and Drain – river bed conductance

$$C = \frac{W_s \bullet L_s \bullet K_v}{T_{sb}}$$

- C is conductance
- W_s is stream width, in feet
- L_s is stream length, in feet
- K_v is vertical hydraulic conductivity, in feet/day
- T_{sb} is stream bed thickness, in feet

URGWOM

River and Drain – average rating table

$$Q = \left(1.486/n\right) \bullet A \bullet R^{2/3} \bullet S^{1/2}$$

Rating Table

SanFelipeToCentralSeepag...

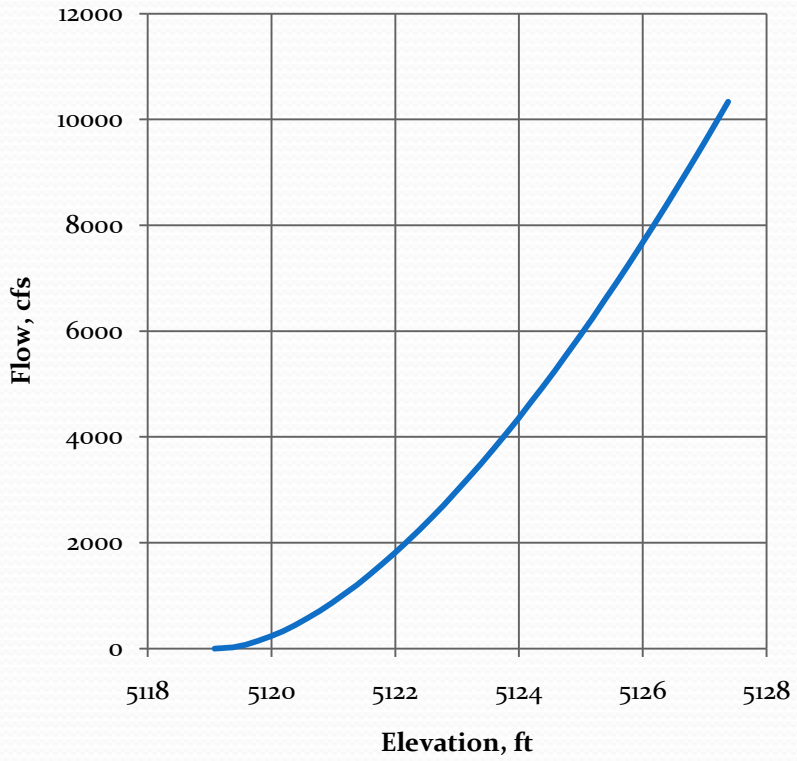
File Edit Row Column View Adjust

Inflow Stage Table

Value: 0 cfs

	Flow cfs	Stage ft
0	0.00	5119.08
1	22.46	5119.38
2	71.21	5119.58
3	139.76	5119.78
4	225.41	5119.98
5	326.46	5120.18
6	441.71	5120.38
7	570.25	5120.58
8	711.33	5120.78
9	864.32	5120.98
10	1028.70	5121.18
11	1204.01	5121.38
12	1389.85	5121.58
13	1585.85	5121.78

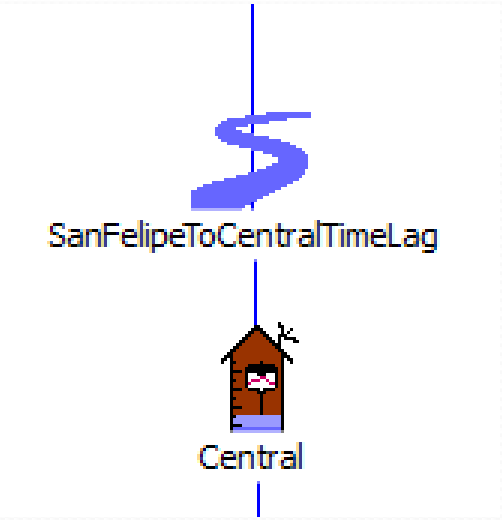
Rating Curve



URGWOM

River Routing Method

- Time Lag Method
  - Cochiti to Central one day;
  - Central to San Acacia one day;
  - San Acacia to San Marcial one day



URGWOM

Parameter Development – GW Objects

- aquifer dimensions
- storage coefficient
- deep aquifer heads and elevations
- riparian areas
- ET rate
- initial storage
- initial shallow aquifer elevation (head)
- conductances

URGWOM

GW Object – conductances

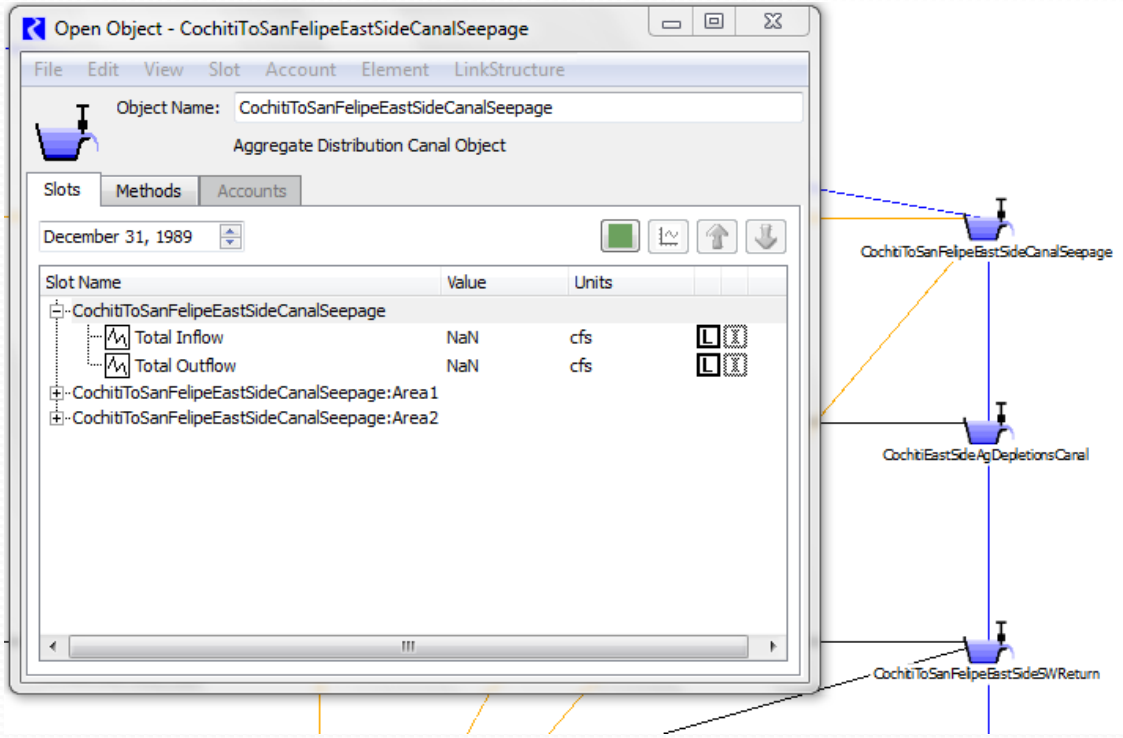
$$C_h = \frac{l_f \bullet t_s \bullet k}{l_c}$$

- C_h is horizontal conductance, in ft²/d,
- l_f is face length, in ft,
- t_s is saturated thickness, in ft,
- K is horizontal hydraulic conductivity, in ft/d,
- l_c is length between centroids of groundwater objects, in ft.

URGWOM

Canal Seepage

- Canal seepage linked to each GW object
- Seepage simulated as a percent of the flow at the top of the canal
- Range from 14% to 2%



URGWOM

Simulated Wasteways to the River

- Cochiti Division
  - East Side:
    - Pena Blanca Riverside Drain;
    - East Side Santo Domingo Riverside Drain;
  - West Side
    - Seguro Wasteway;
    - End of Sili Main Canal.
- Albuquerque Division
  - East Side
    - Central Waste way;
    - Albuquerque Riverside Drain Wasteway.
  - West Side
    - Upper Corrales Waste way;
    - Lower Corrales Wasteway;
    - Attrisco Wasteway.
- Belen Division
  - East Side
    - Combined Parelta and Lower Parelta Wasteways;
    - Lower San Juan drain outfall;
  - West Side
    - Isleta Wasteway;
    - Belen Drain outfall;
    - Drain U-7 wasteway;
- Socorro Division
  - West Side
    - 9-Mile outfall

URGWOM

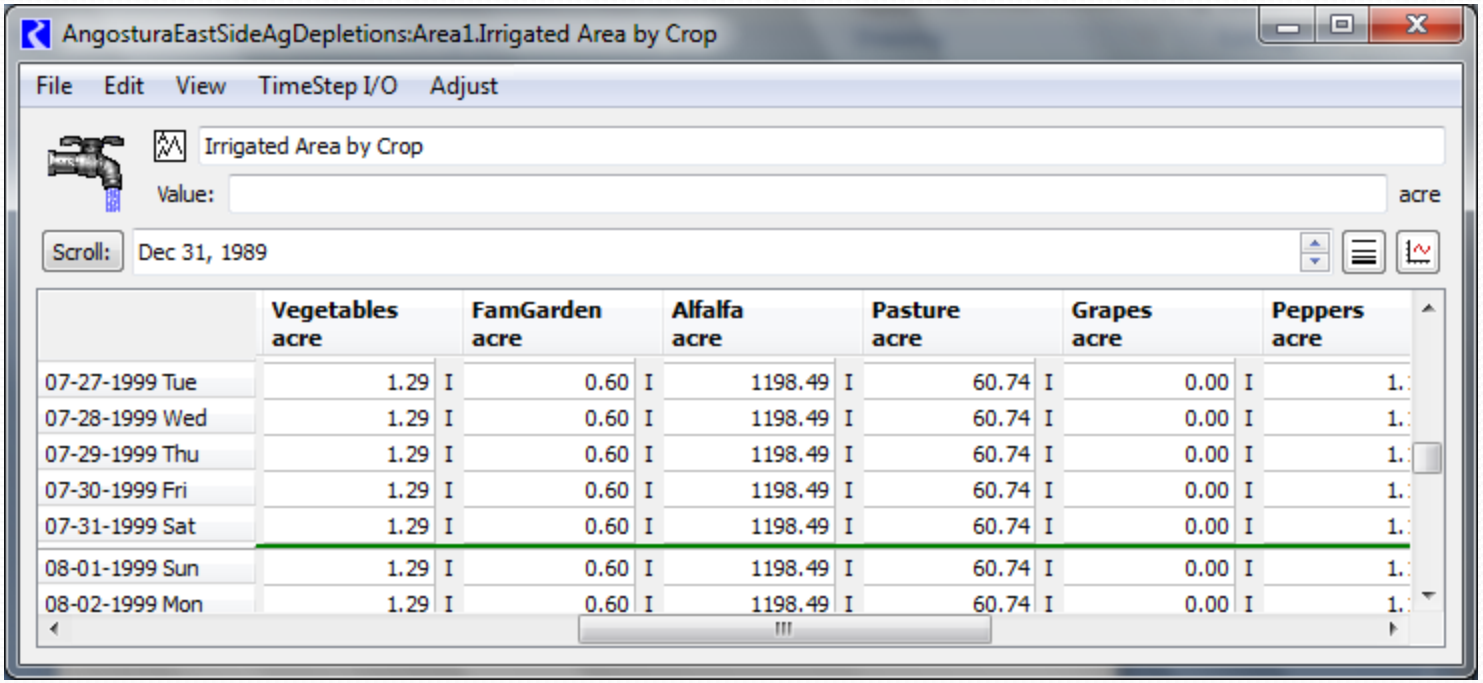
Simulation of Crop Areas

- Crop Areas
  - 1975 to 1999 Bureau of Reclamation Crop Survey Reports
  - 2000 to current – IKONOS crop area
- Crop ET Rate – ET Tool Box
- Farm efficiency – 50%
- GW return – 5% of excess irrigation water
- SW return – the remainder after consumption by crop and GW return

URGWOM

Simulation of Crop Areas

- Crop area and ET rate data entered in an array in the model



	Vegetables acre	FamGarden acre	Alfalfa acre	Pasture acre	Grapes acre	Peppers acre
07-27-1999 Tue	1.29	0.60	1198.49	60.74	0.00	1.
07-28-1999 Wed	1.29	0.60	1198.49	60.74	0.00	1.
07-29-1999 Thu	1.29	0.60	1198.49	60.74	0.00	1.
07-30-1999 Fri	1.29	0.60	1198.49	60.74	0.00	1.
07-31-1999 Sat	1.29	0.60	1198.49	60.74	0.00	1.
08-01-1999 Sun	1.29	0.60	1198.49	60.74	0.00	1.
08-02-1999 Mon	1.29	0.60	1198.49	60.74	0.00	1.

URGWOM

URGWOM

Calibration

Calibration Criteria

- Gage flow
- Total Surface Water depletion
- River seepage

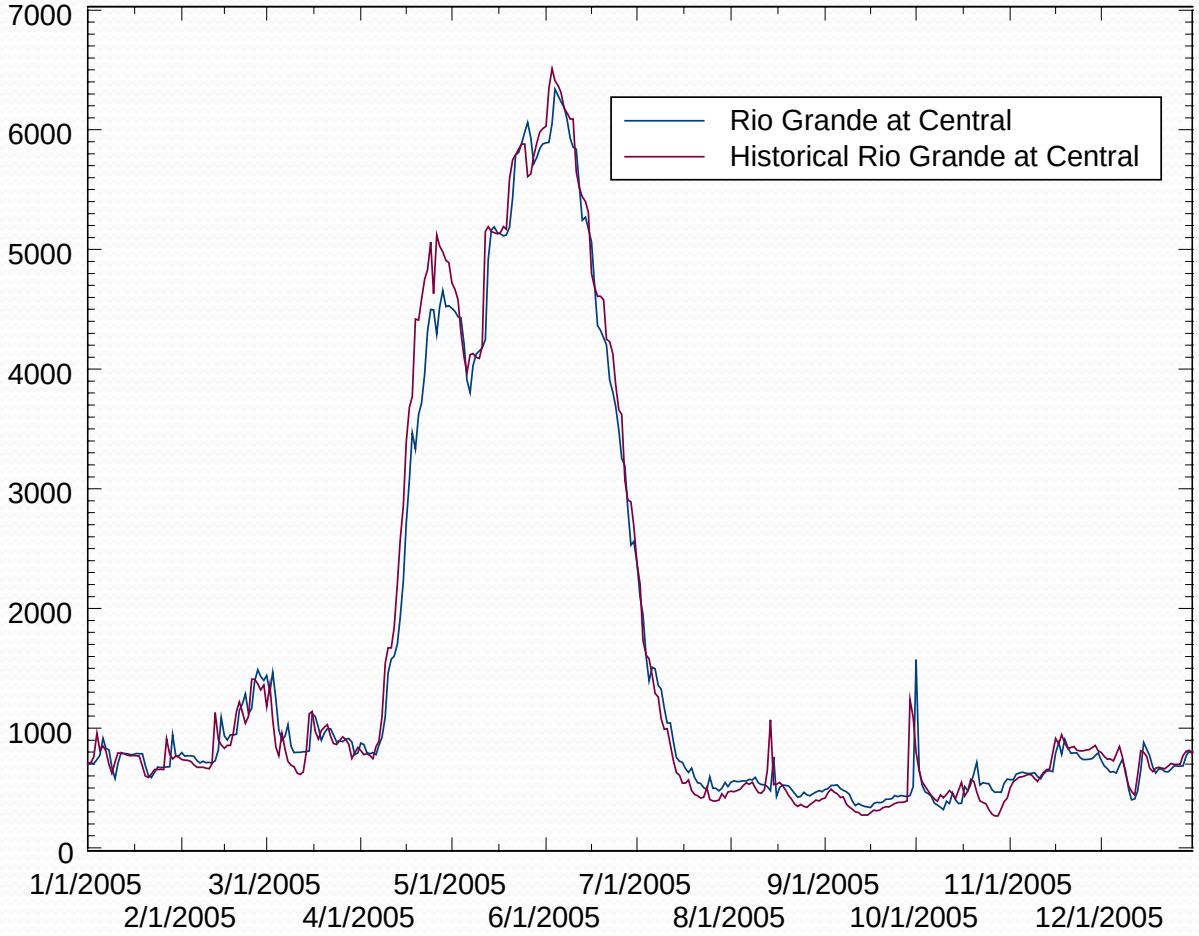
URGWOM

Calibration Parameters

- Riverbed Conductances;
- Deep Aquifer Conductances/Heads;
- Canal Seepage;
- GW Return Flow Ratio;
- Percent of Returns at Waste ways.

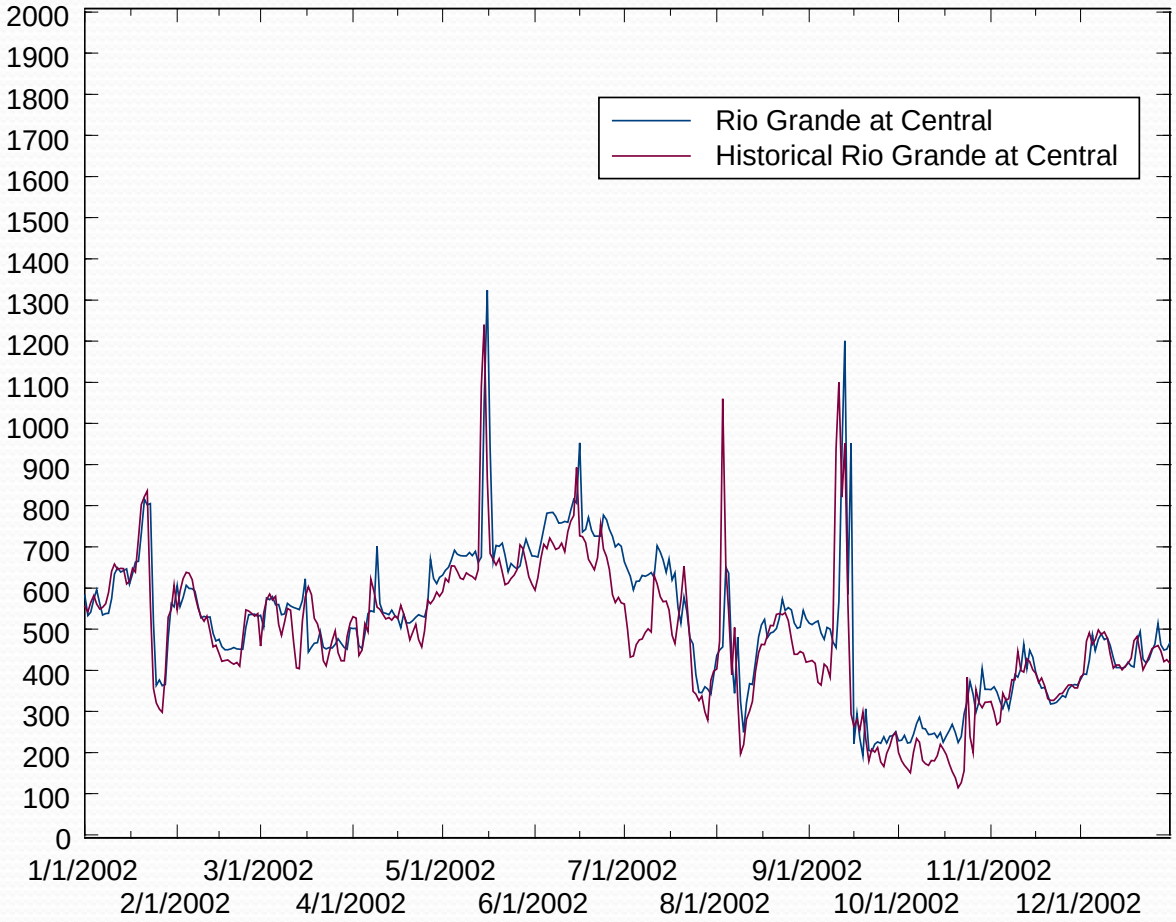
URGWOM

Rio Grande at Albuquerque- 2005



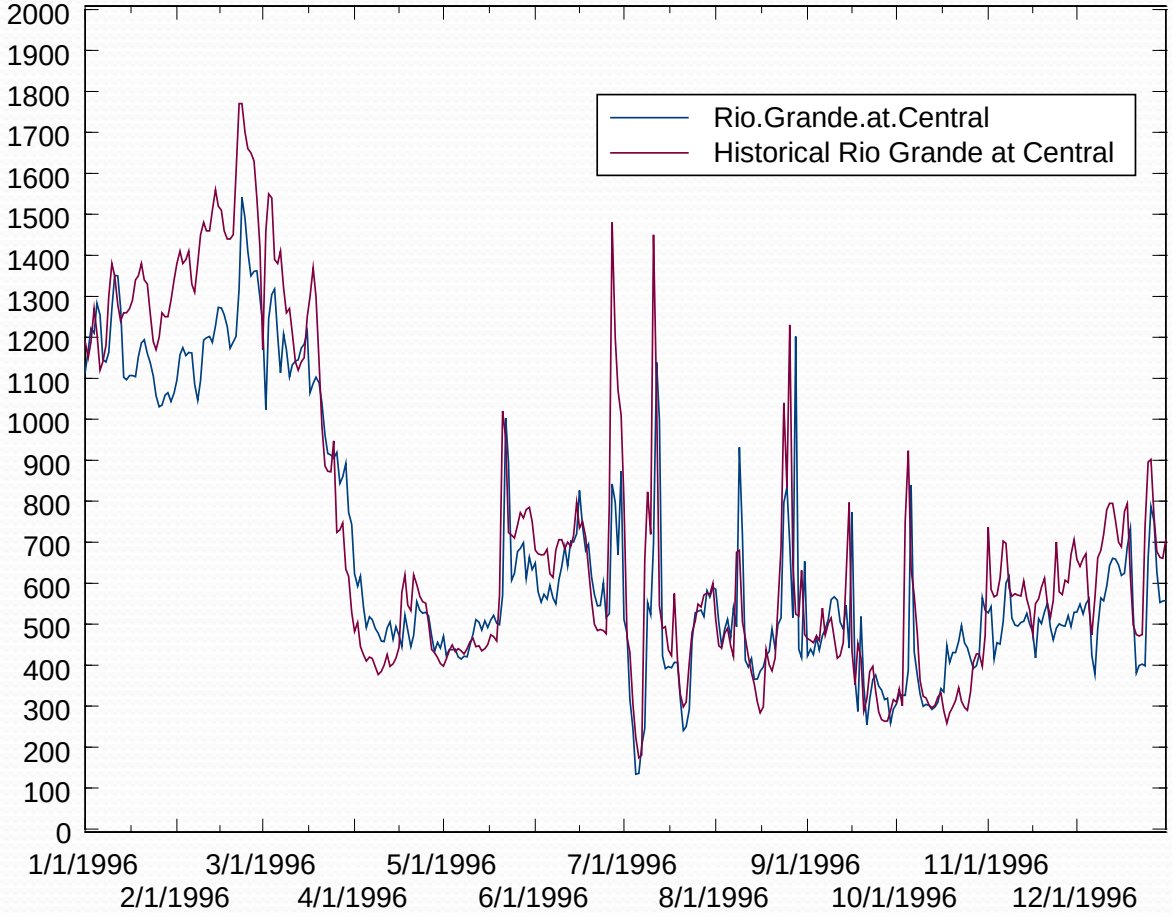
URGWOM

Rio Grande at Albuquerque- 2002



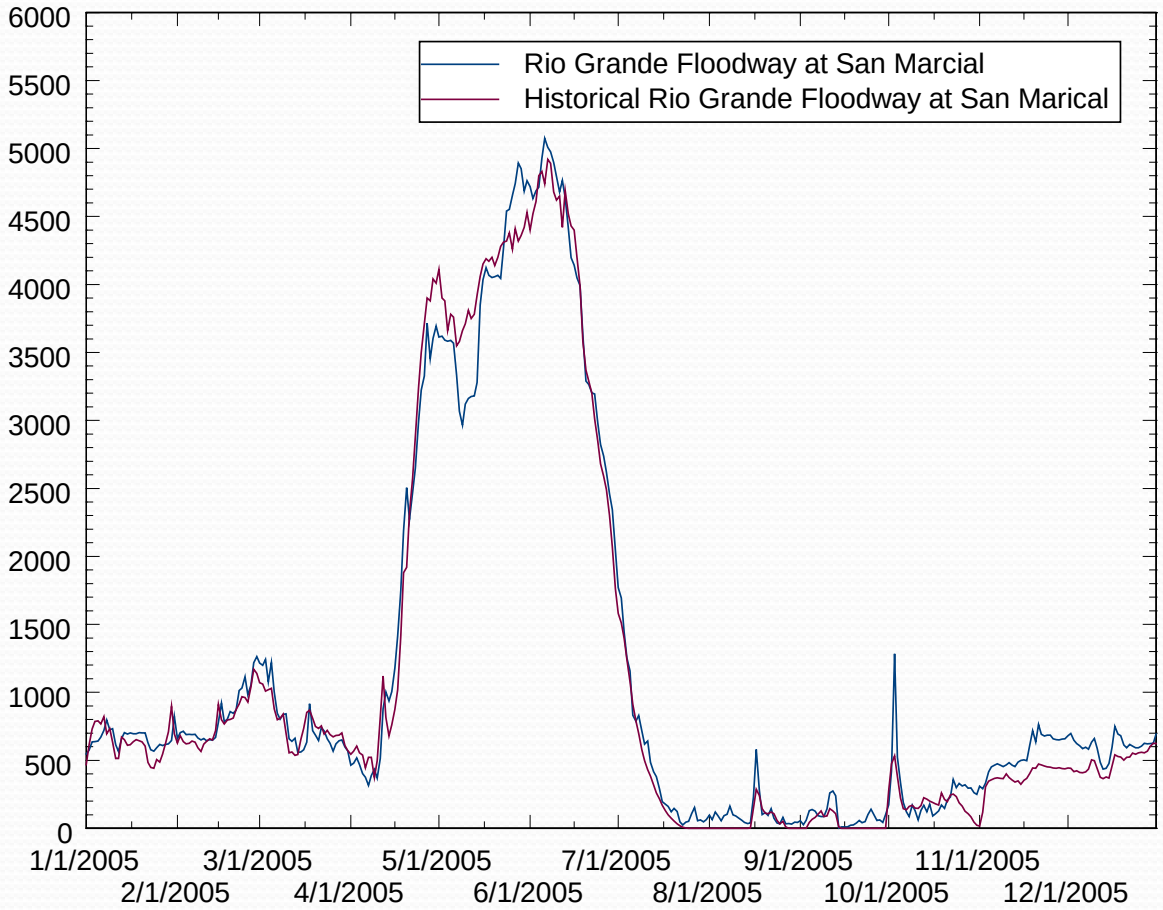
URGWOM

Rio Grande at Albuquerque- 1996



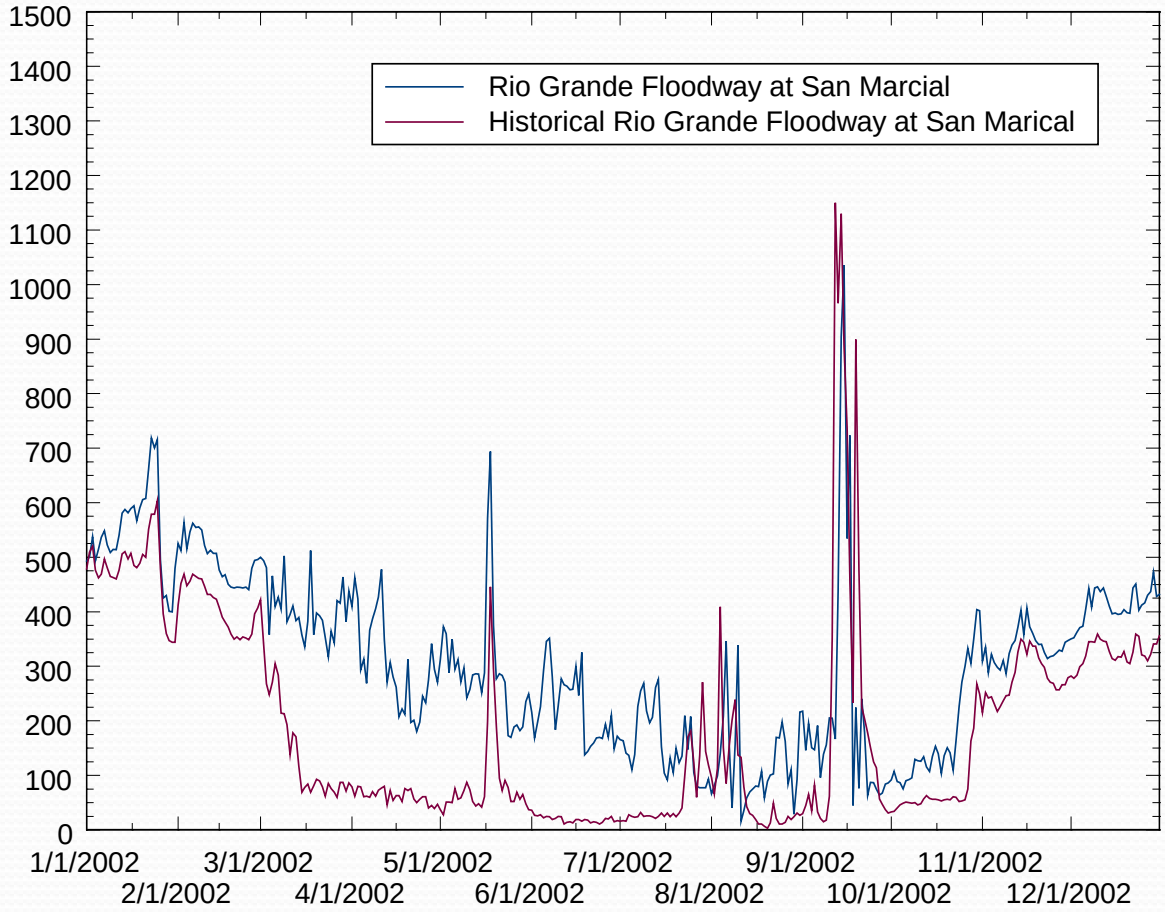
URGWOM

Rio Grande at San Marcial- 2005



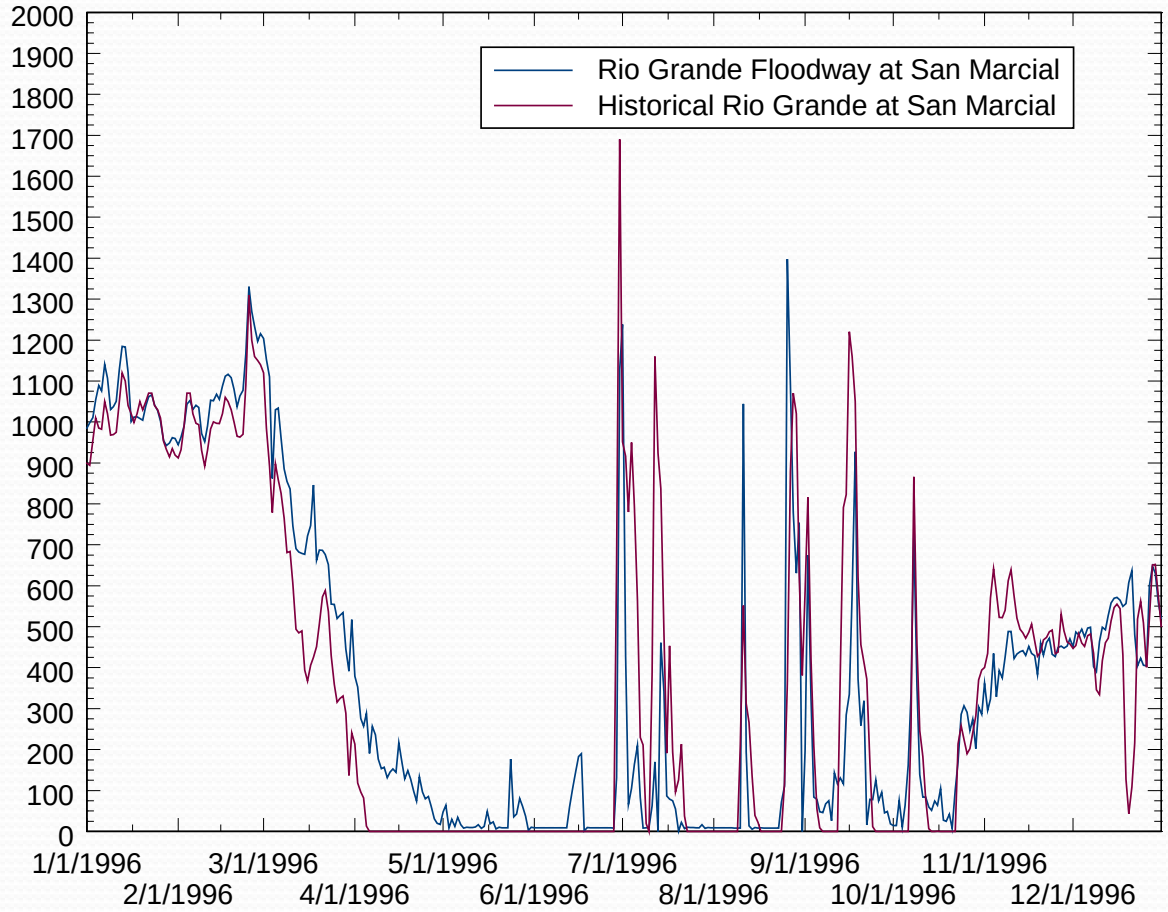
URGWOM

Rio Grande at San Marcial- 2002



URGWOM

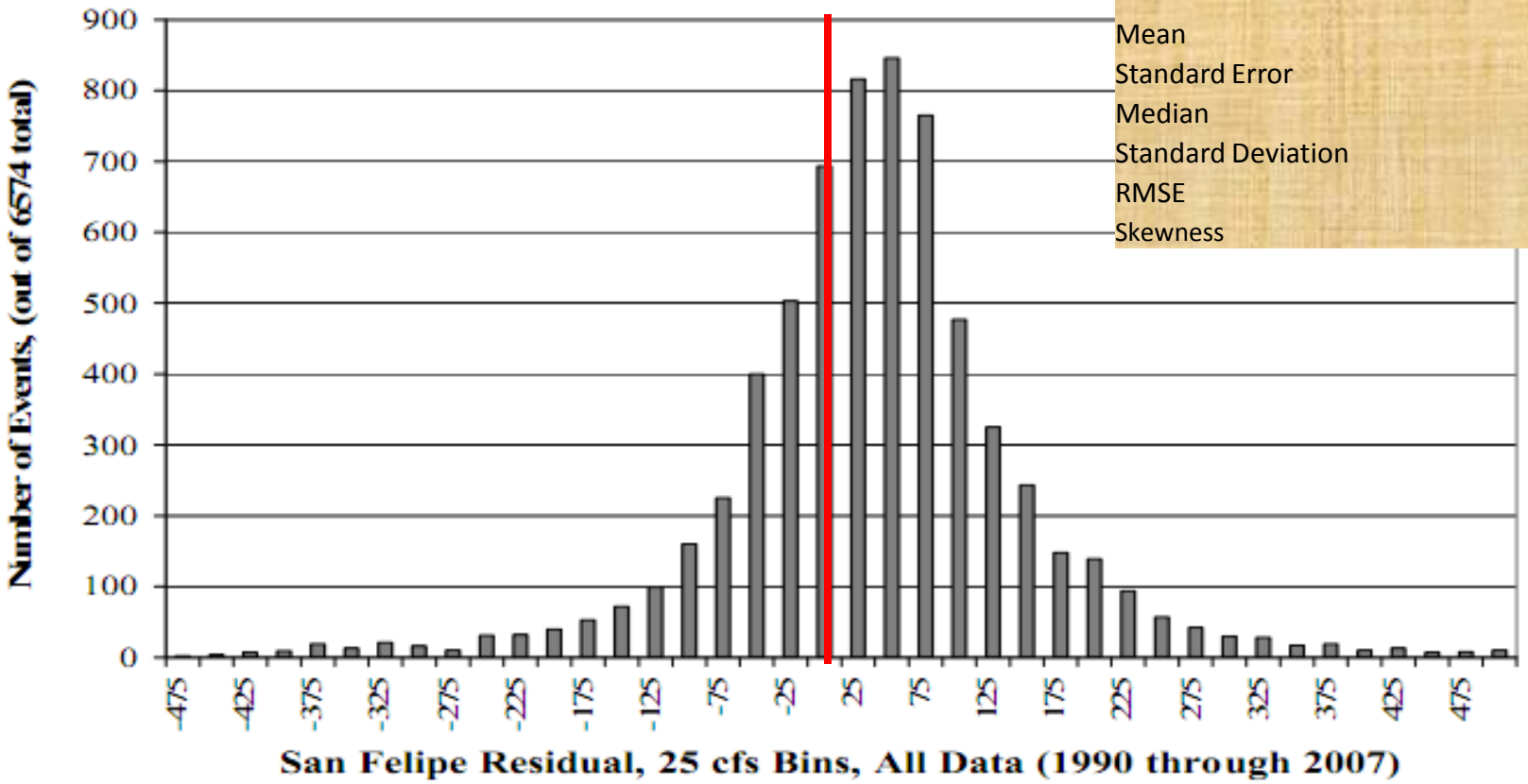
Rio Grande at San Marcial- 1996



URGWOM

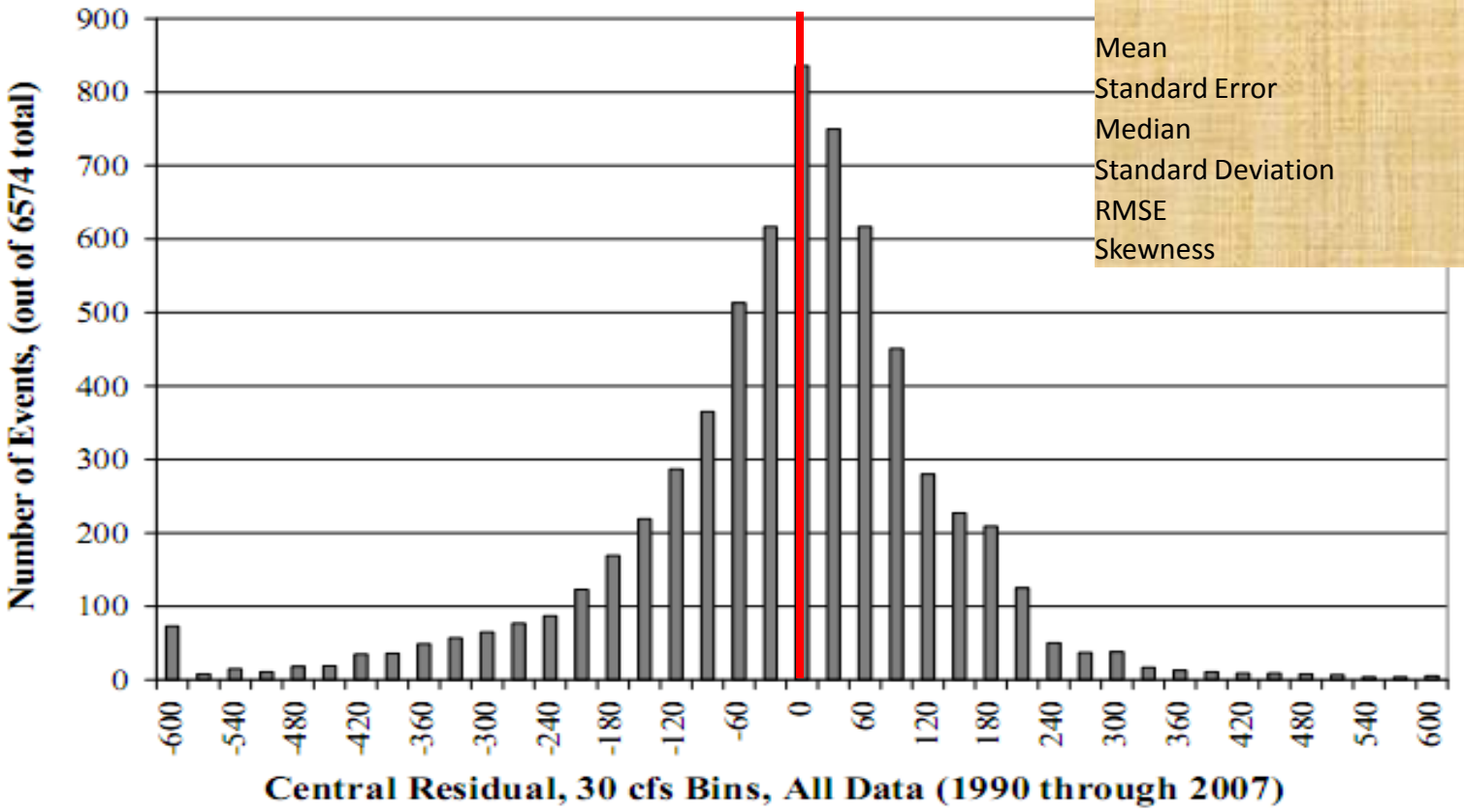
Residuals of Simulated - Actual Flow, San Felipe

San Felipe Gage	
Mean	24.32
Standard Error	1.77
Median	25.77
Standard Deviation	143.14
RMSE	145.19
Skewness	1.43



URGWOM

Residuals of Simulated - Actual Flow, Central

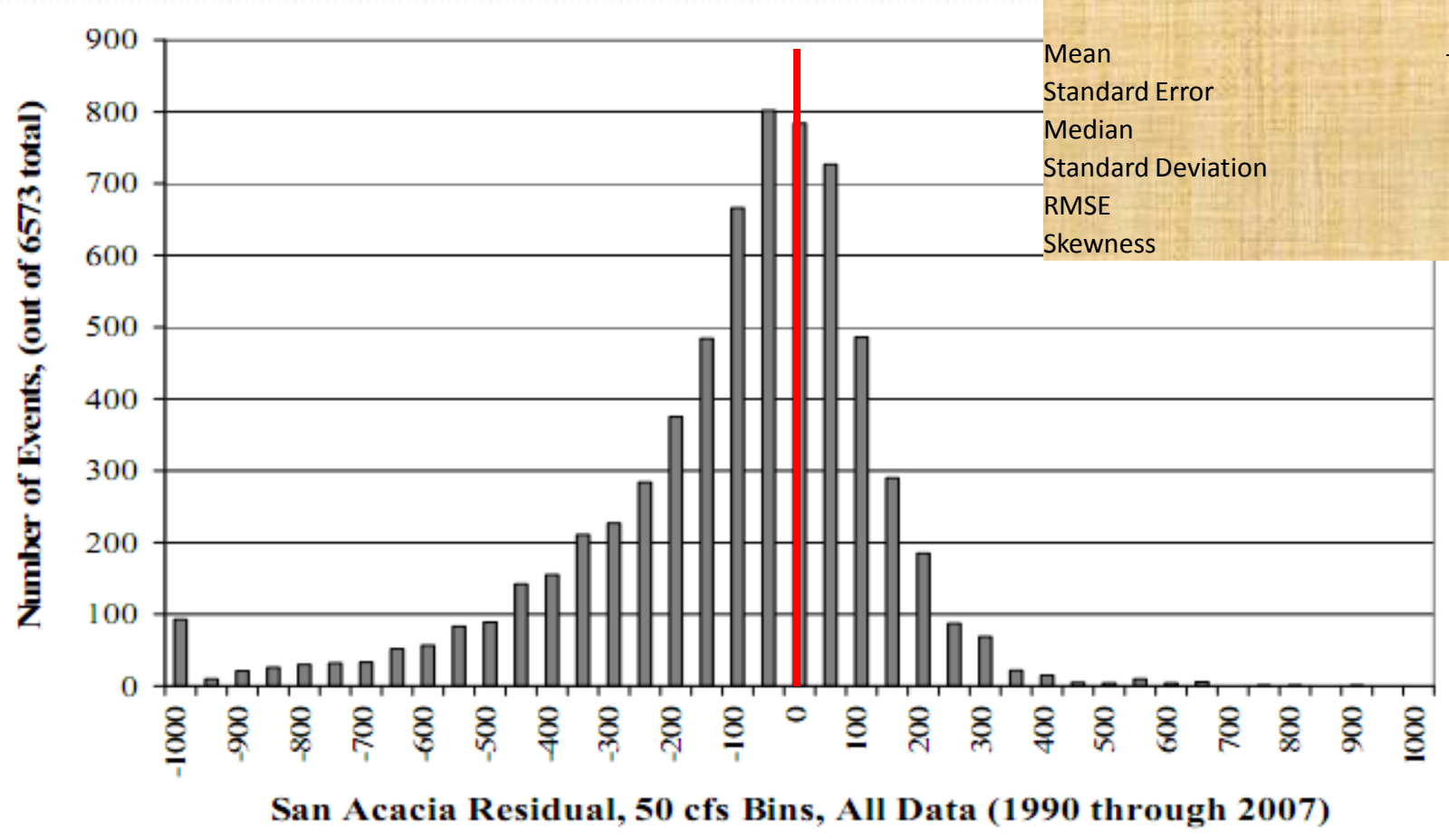


Central Gage	
Mean	-30.90
Standard Error	2.19
Median	-13.91
Standard Deviation	177.51
RMSE	180.16
Skewness	-1.09

URGWOM

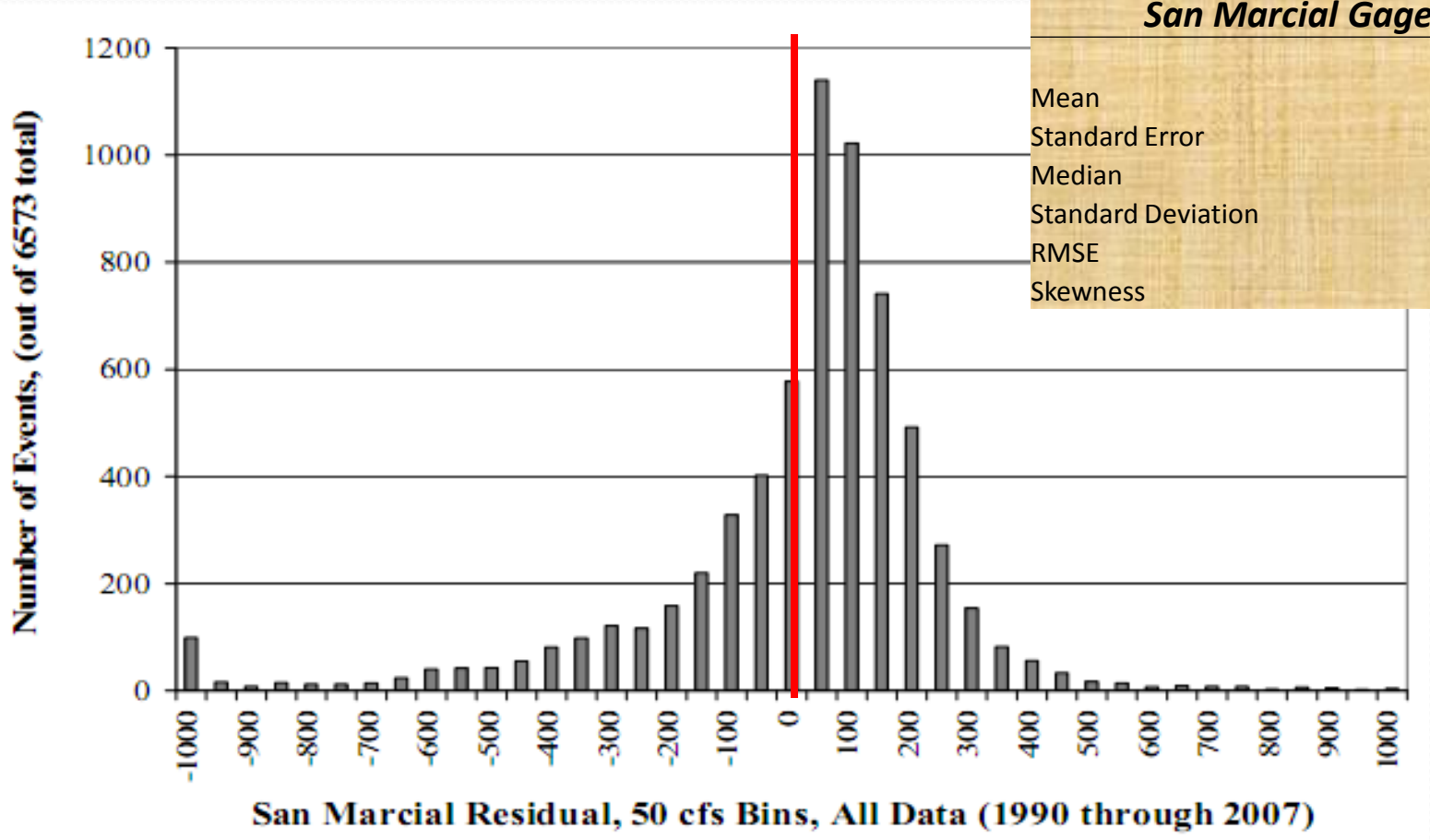
Residuals of Simulated - Actual Flow, San Acacia

San Acacia Gage	
Mean	-139.97
Standard Error	3.46
Median	-85.90
Standard Deviation	280.58
RMSE	313.53
Skewness	-2.60



URGWOM

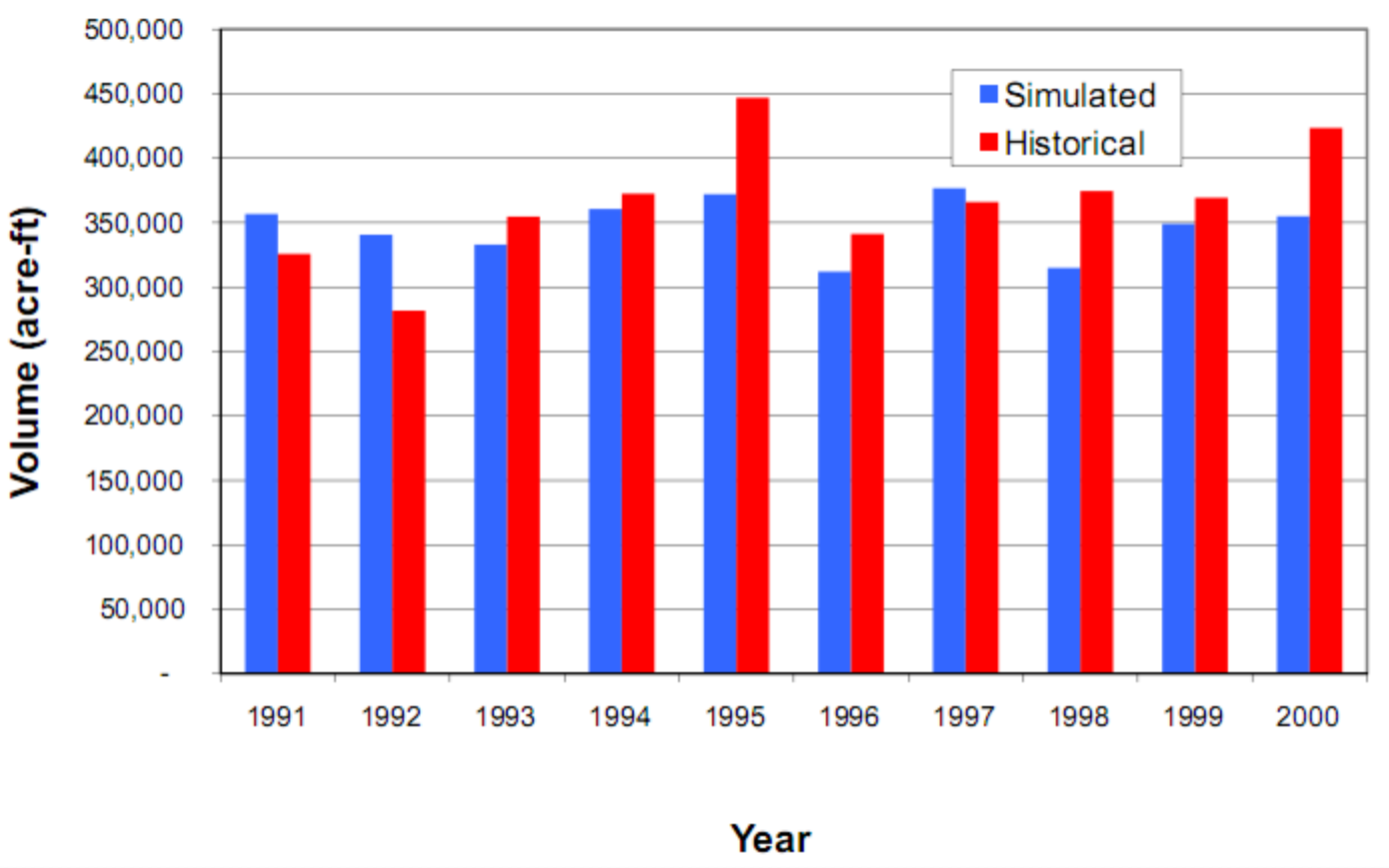
Residuals of Simulated - Actual Flow, San Marcial



San Marcial Gage	
Mean	-17.00
Standard Error	3.69
Median	31.54
Standard Deviation	298.79
RMSE	299.25
Skewness	-3.18

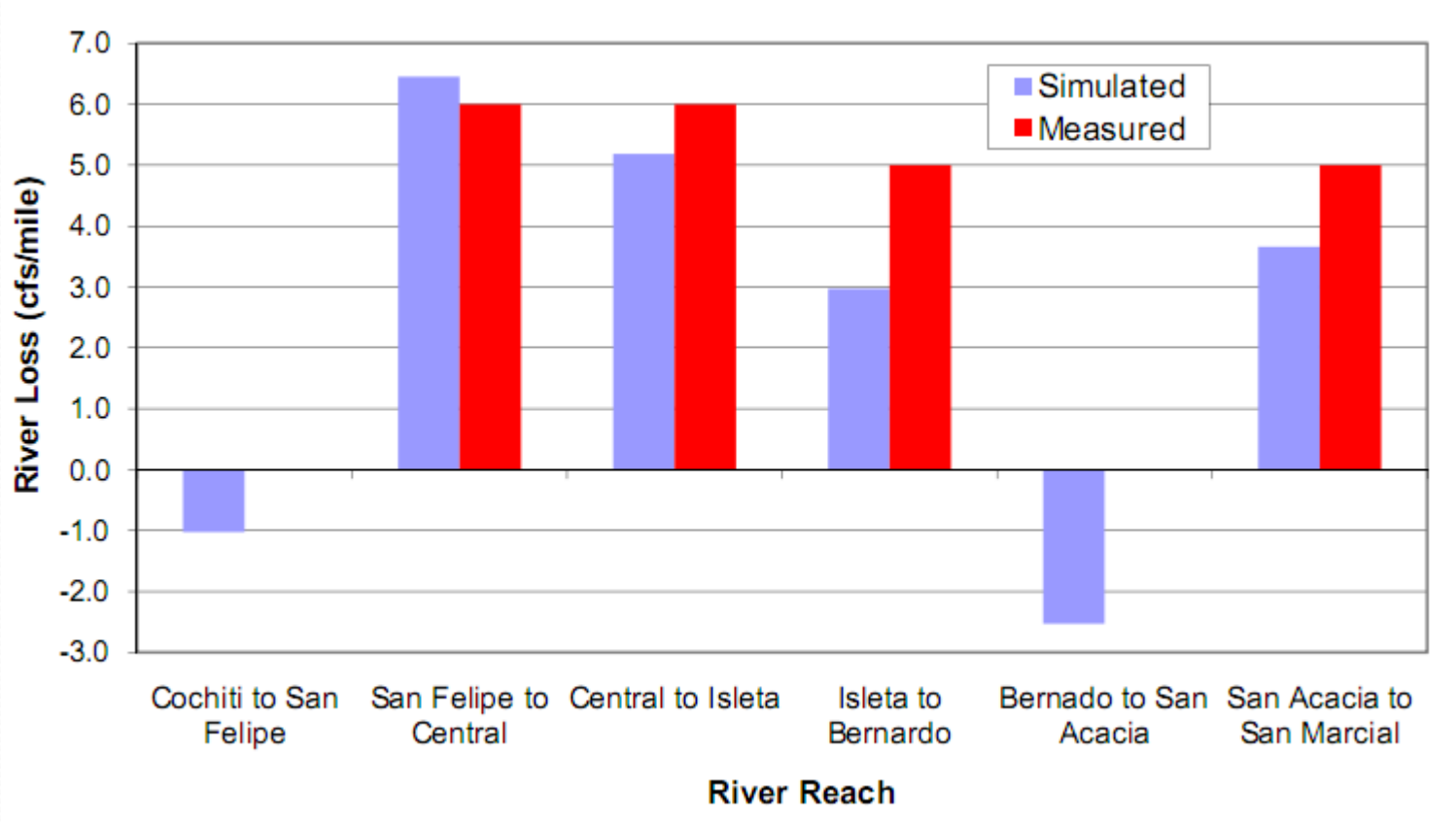
URGWOM

Total Annual Depletions



URGWOM

Actual and Simulated Seepage



URGWOM

URGWOM

Future Work

Future Work

- Recalibrate canal and drain seepage
  - New studies for canal and drain seepage
  - Drain seepage study last February
- Possibly change to one weighted crop
  - Smaller model faster run time
- Calibrate crop deep percolation %
- Calibrate with new values from ET toolbox
- New open-water – wetted sand method

URGWOM

Questions