

Collaborative Modeling to Support the 2004 Arizona Water Settlements Act

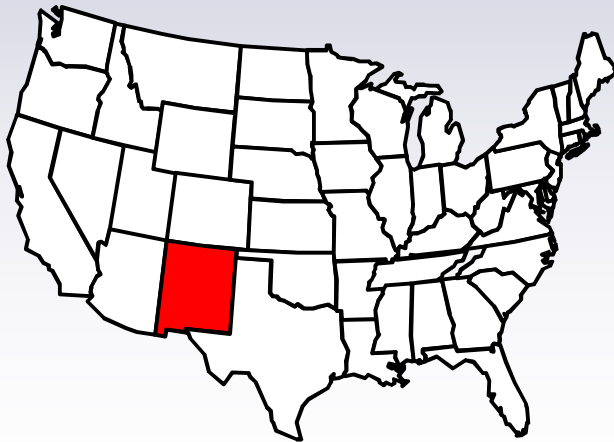
SAND2007-3235C

**Vincent C. Tidwell, Amy Sun, Geoffrey T. Klise and
Jim Brainard**

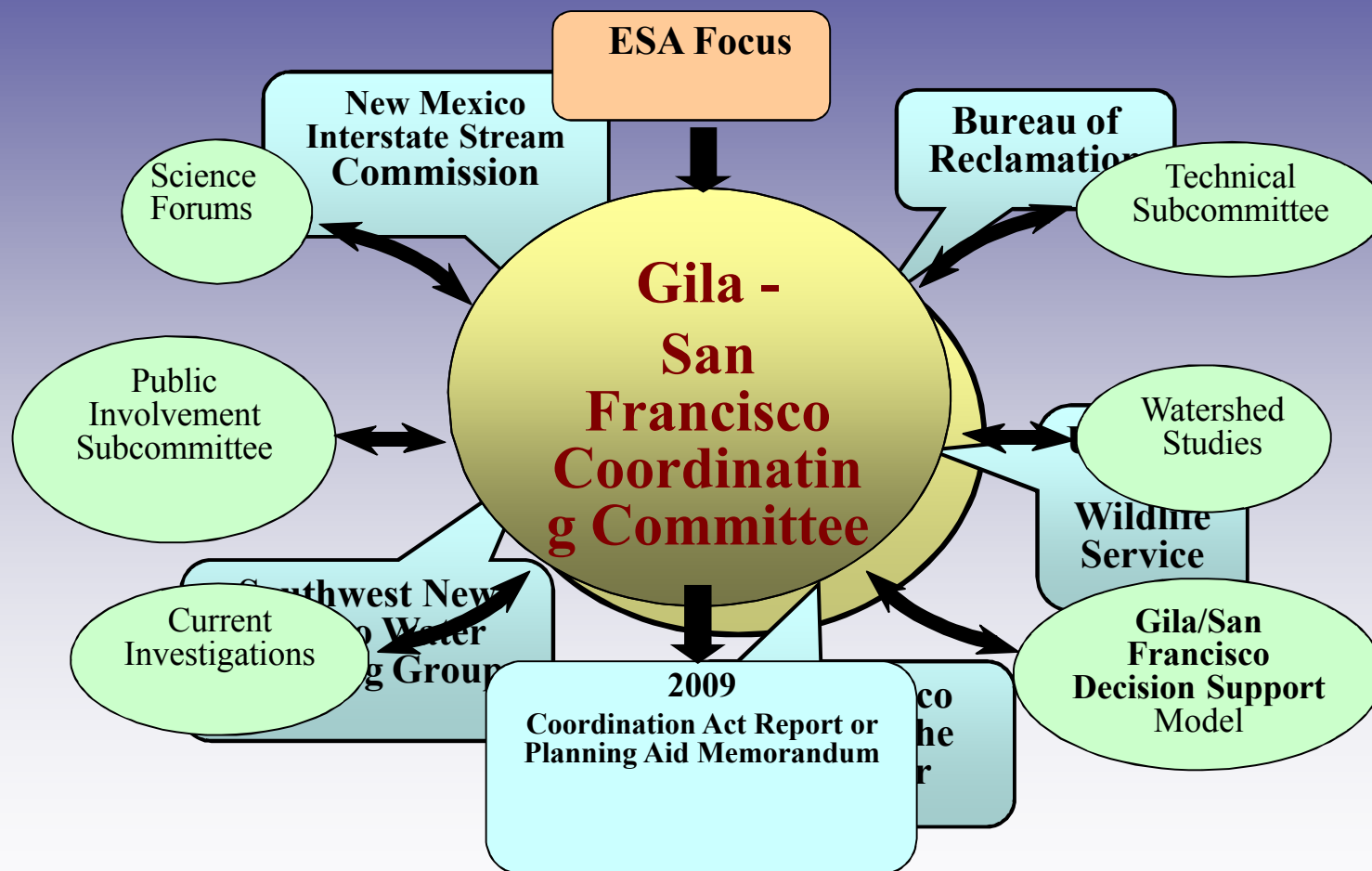
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Geohydrology Department
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Settlement Background

- 2004 Arizona Water Settlements Act
 - Allows consumption of up to 140,000 acre feet of water in a 10-year period in the New Mexico reach of the Gila/San Francisco Basin (in exchange for Central Arizona Project water)
 - Diversions subject to the Consumptive Use and Forbearance Agreement (CUFA) to ensure downstream senior rights are not harmed
 - \$66-\$128 Million is available for “water utilization alternatives to meet water supply demands”



Decision Structure



Objective

- Our goal is to create an interactive, real-time decision tool to explore:
 - Water availability relative to CUFA and ESA constraints, and
 - Alternative approaches to utilizing water and funding.
- We want to de-mystify the complexity of the settlement language so that stakeholders and decision-makers are better informed.

Create an informed basis for decision making.

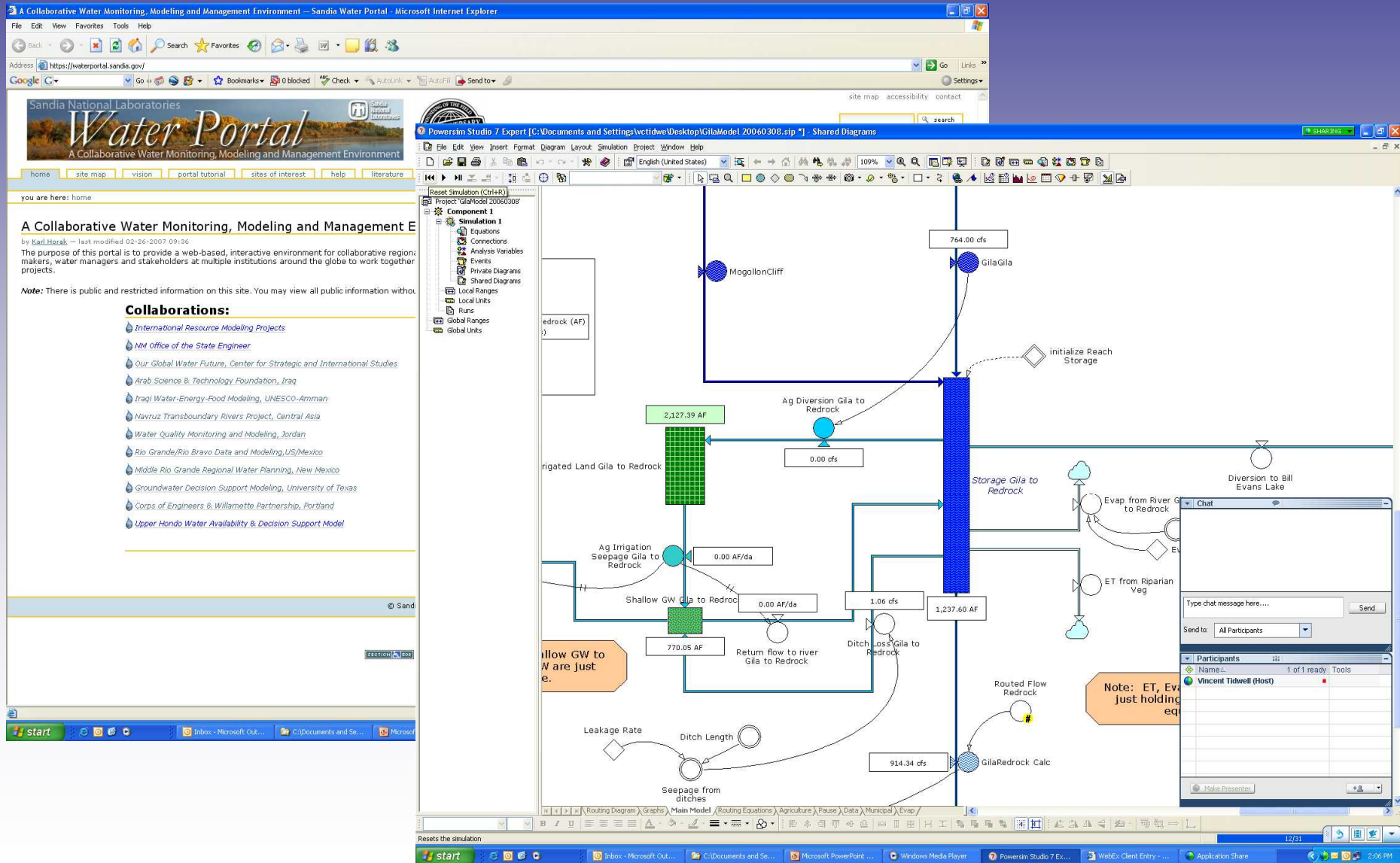
Collaborative Modeling Team

- Implemented an open and transparent model development process.
- Team began meeting in October 2005.
- Team has 2 hour meetings every other week and quarterly face to face meetings.
- Model development process:
 - Team develops causal structure of model,
 - Team identifies data,
 - Sandia develops model,
 - Team reviews model and output.

Team Composition

- Bureau of Reclamation
- New Mexico Interstate Stream Commission
- US Fish and Wildlife Service
- Municipalities of Silver City and Deming
- Soil and Water Commission representatives from Grant, Catron, and Luna Counties
- The Nature Conservancy
- Gila Conservation Coalition
- Concerned citizens
- Sandia National Laboratories

Meeting Venue



Information Sharing

gila san francisco
R I V E R B A S I N S

Sandia National Laboratories is assisting the New Mexico Interstate Stream Commission by creating an interactive water supply model tool that will engage stakeholders and decision makers in developing plans for utilizing the water and funds made available through the 2004 Arizona Water Settlements Act.

Water Model Tool

Residential/Non-Residential

Introduction

Residential

Non-Residential

3D Charts

Issues

Agriculture

Reservoirs

Desalination

Transfers

Population Growth

Drought

Settings

Non-Residential

Use the sliders below to convert percentages of existing and new non-residential properties to the various water saving measures.

A 100% change in some of these variables might not be realistic.

Leakage

	Min	Set Value	Max	Current	Delta
Consent Existing Non-Residential Property to Low-Flow Appliances	0	100	100	100	0
Consent Existing Non-Residential Property to Increasing Reduce Delayed Average of Landscaping for New Non-Residential Property	0	100	100	100	0
Reduction in Consumption by Irrigation	0	100	100	50	50

☐ Save Water on Residential Control page
☐ Use Low-Flow Appliances in New Construction
☐ Use Irrigation for New Construction

Parks and Golf Courses

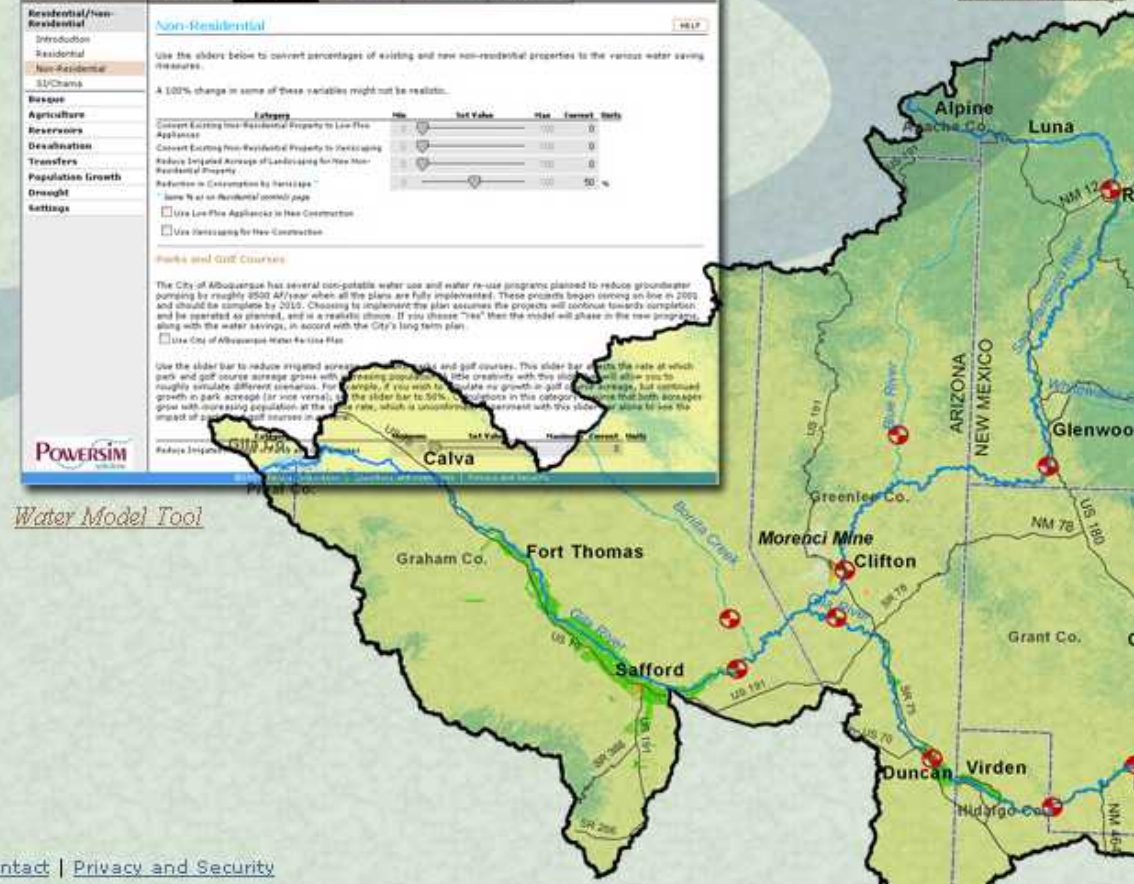
The City of Albuquerque has several non-potable water use and water re-use programs planned to reduce groundwater pumping by roughly 8500 AF/year when all the plans are fully implemented. These projects began running on line in 2005 and should be complete by 2015. Choosing to implement the plan assumes the projects will continue towards completion and be operated as planned, and is a realistic show. If you choose "Yes" then the model will phase in the new programs along with the water savings, in accord with the City's long term plan.

☐ Use City of Albuquerque Water Re-Use Plan

Use the slider bar to reduce irrigated acreage for golf courses and parks and golf courses. This slider bar affects the rate at which park and golf course acreage grows with increasing population. It does not affect the creativity with the slider bar will allow you to roughly simulate different scenarios. For example, if you wish to simulate no growth in golf or park acreage, but continued growth in park acreage (or vice versa), set the slider bar to 50%. Populations in this category will continue to build but acreage grow with increasing population at the 50% rate, which is unimportant to connect with this slider bar alone to see the impact of the water interest in.

	Min	Set Value	Max	Current	Delta
Reduce Irrigated Acreage for Parks and Golf Courses	0	100	100	100	0

[Interactive Map](#)



9,000 mi² drainage area

Land Use/Land Cover

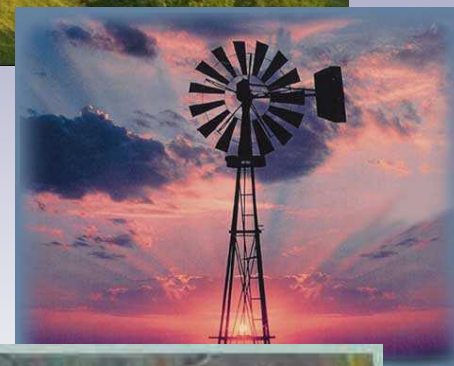
- Agricultural Land
- Barren Land
- Forest Land
- Range Land
- Urban or Built-Up Land
- Water

USGS Real-Time Gauging Station



Water Use in Basin

- Adjudicated basin.
- Water uses:
 - Irrigated agriculture,
 - Livestock,
 - Mining,
 - Domestic wells,
 - Municipal/mutual domestics.
- Potential for water use outside basin:
 - Silver City,
 - Deming,
 - Lordsburg.



Environmental Concerns

- Last major free flowing river in New Mexico



- Rich riparian habitat

Environmental Concerns

Federally listed threatened and endangered species

- Southwestern Willow Flycatcher



- Gila Trout



- Gila Chub



- Spikedace



- Loach Minnow



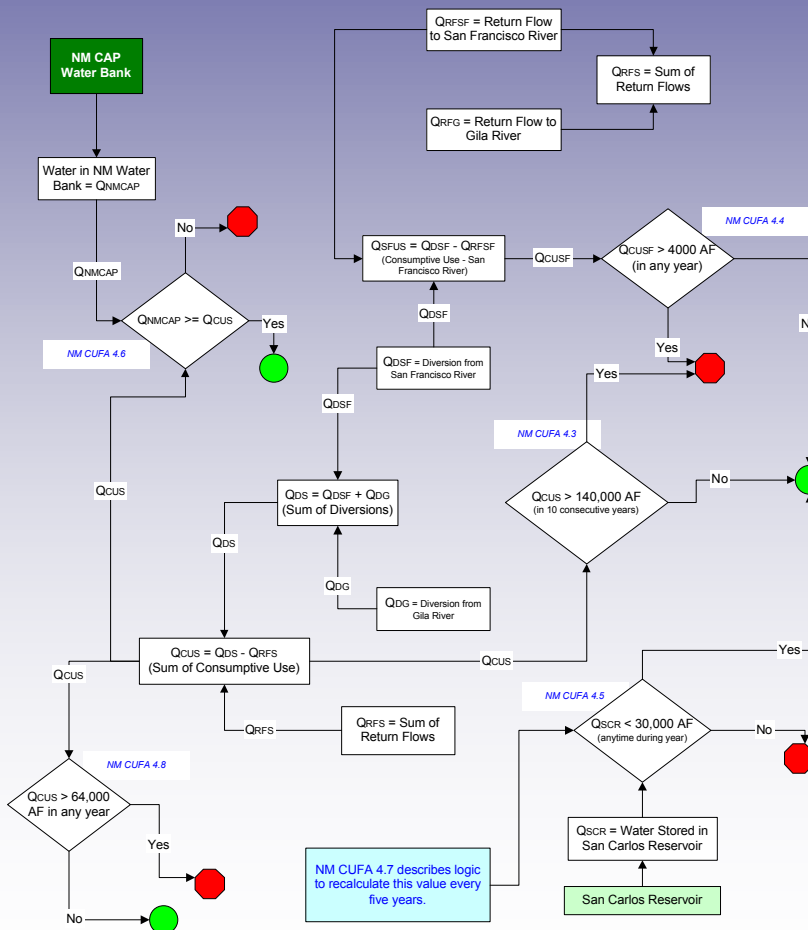
- Gila Topminnow



Institutional Controls

NM Consumptive Use

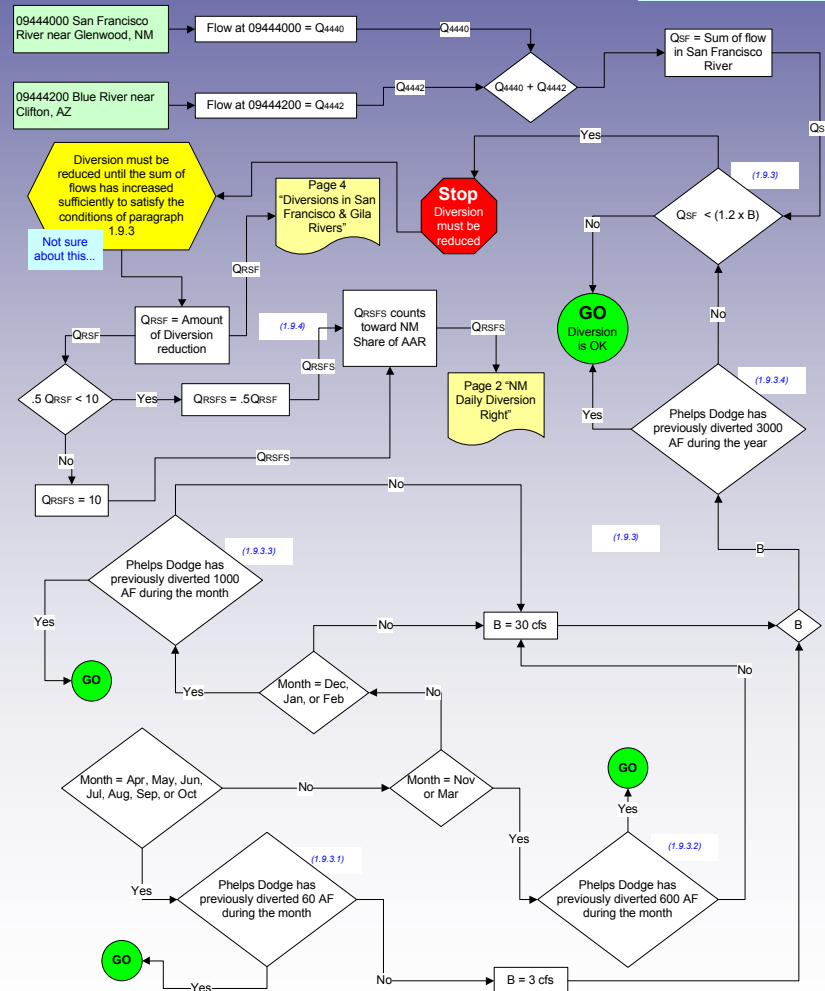
From NM CUFA



San Francisco River Diversions (From Exhibit 247 and Attech 3.1 Terms of NM Diversions)

On any day when Diversion is occurring....

1.11 describes similar logic for diversions from *additional* points on the San Francisco River.



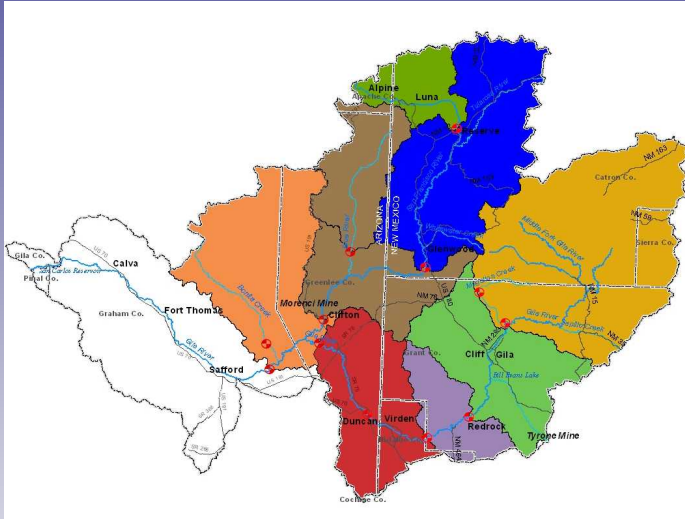
Model Components

- Surface water hydrology
- Ground water hydrology
- Watershed hydrology
- Water demand
 - Residential/commercial
 - Industrial/mining
 - Agricultural/livestock
 - Evaporative/riparian
- Institutional constraints
 - CUFA
 - ESA

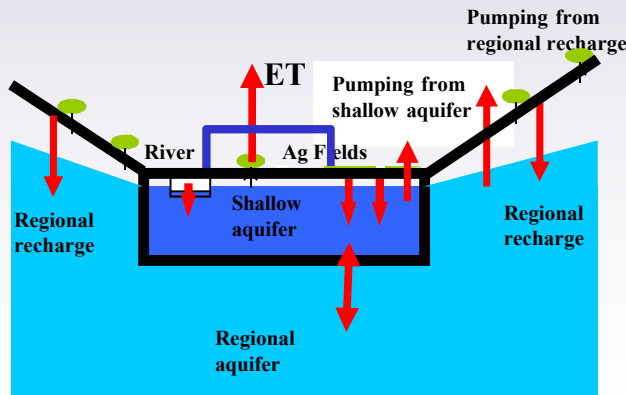


Surface and Ground Water Model

- Basin is broken up into 8 “reaches” defined by stream gauges used in the CUFA

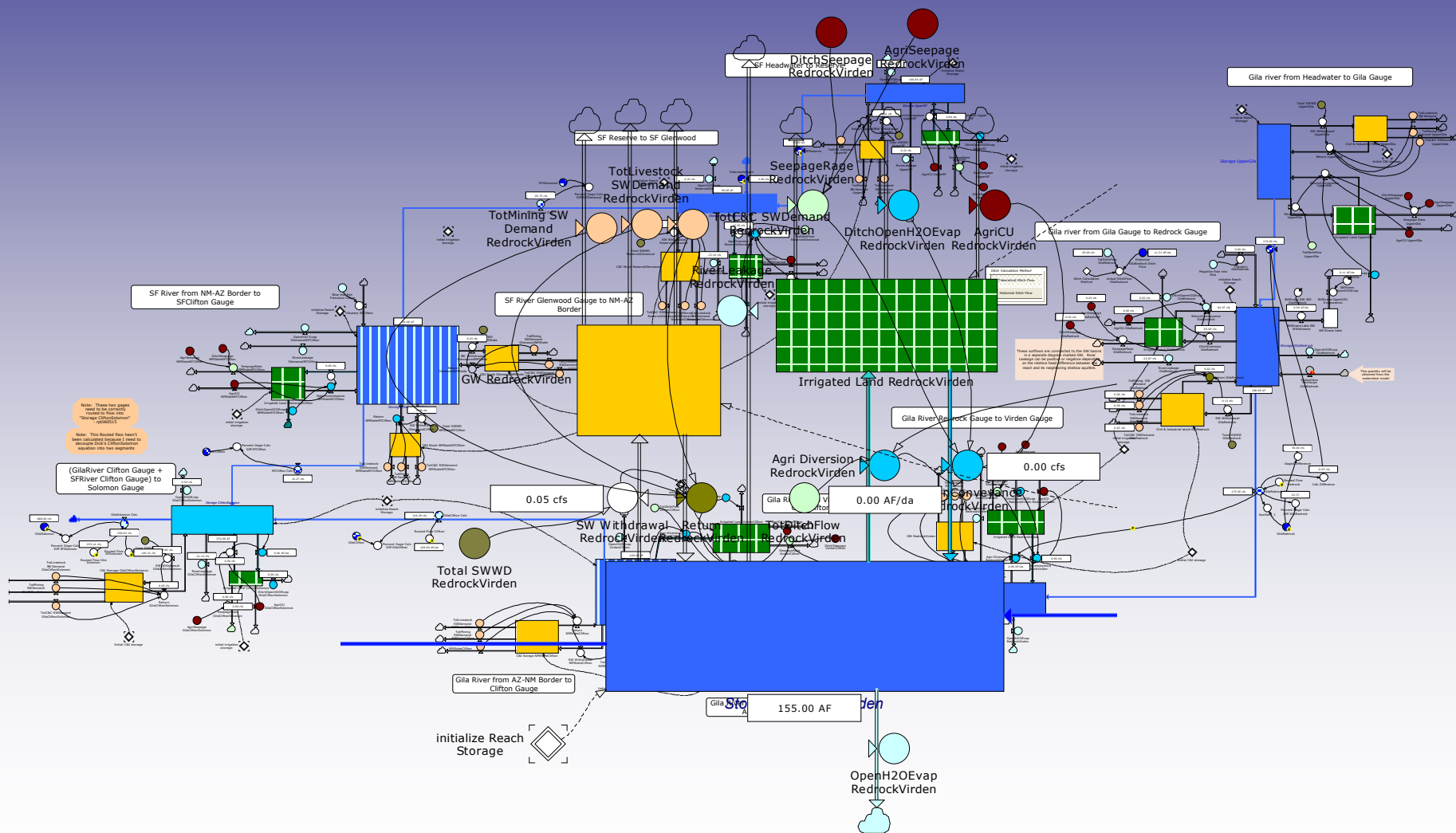


- The ground water component is broken up into a regional and fluvial aquifer per reach



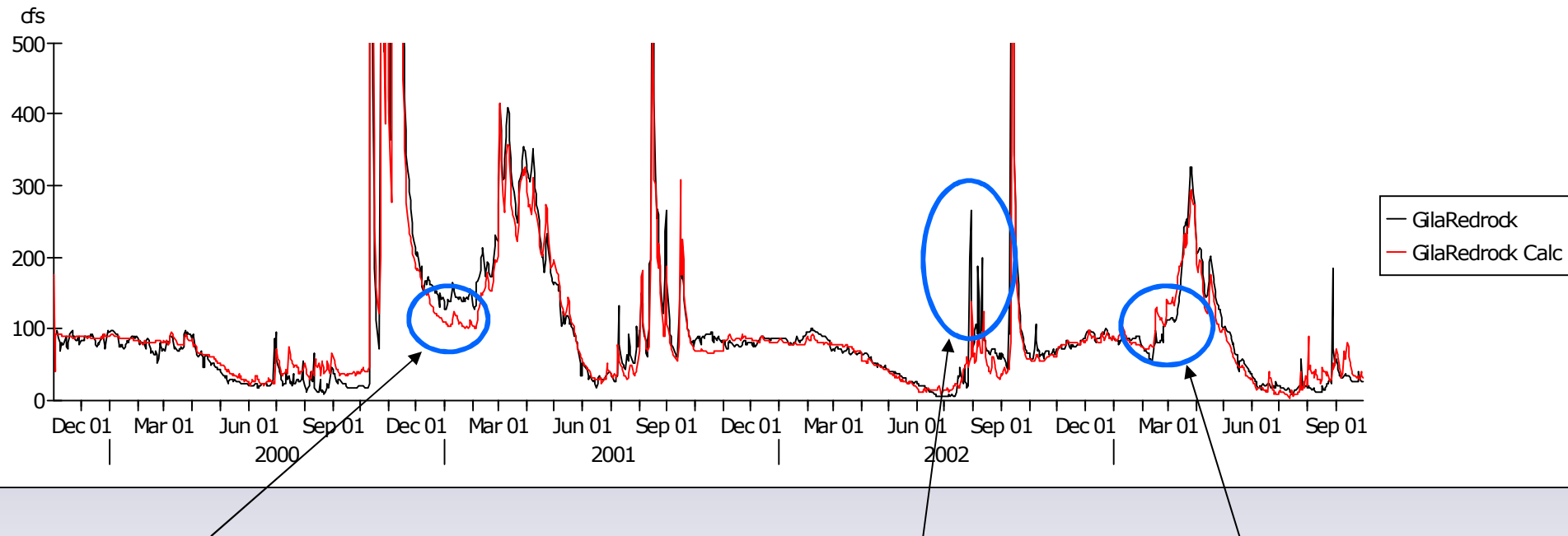
- Daily model with routed flows
- Calculated flows and river stage are “average” over that reach
- Model also can look at flows over sub-reach “critical regions”
- The model can account for:
 - Evaporative losses
 - Irrigation diversions and returns
 - Aquifer interaction
 - River leakage or gains

System Dynamics Model



Model Calibration

Calculated vs. Measured Gila Redrock Gage



- Dynamics between fluvial and regional aquifers may be causing this discrepancy

- Tributary contributions from summer monsoon events and snowmelt are missed

Model Interface



Water Usage in the San Francisco and Gila River Basins



Background

**Output
Executive
Summary**

Climate

CUFA

**Municipal
Demand**

**How To Use
this model.**

Agriculture

**Minimum
River
Flows**

Mining

**Pause
the
Model**

This is a draft version of the Gila San Francisco River Model.

Irrigation Control

Gila River Basin Modify Agricultural Acreage by Reach



Modify Upper Gila Irrigated Acres

-100 -80 -60 -40 -20 0 20 40 60 80 100 %

0% - Historical Value, 100 % is Max Adjudicated

Modify Gila-Redrock Irrigated Acres

-100 -80 -60 -40 -20 0 20 40 60 80 100 %

0% - Historical Value, 100 % is Max Adjudicated

Modify Redrock-Virden Irrigated Acres

-100 -80 -60 -40 -20 0 20 40 60 80 100 %

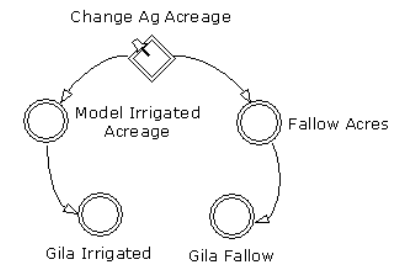
0% - Historical Value, 100 % is Max Adjudicated

Modify Virden-Clifton Irrigated Acres

-100 -80 -60 -40 -20 0 20 40 60 80 100 %

0% - Historical Value, 100 % is Max Adjudicated

Irrigated Acres	Fallow Acres
26 acre	97 acre
1,318 acre	529 acre
155 acre	318 acre
1,944 acre	1,056 acre



Note: A value of -9999 acres indicates there are no recorded rights for irrigable land.

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[Return Agriculture Page](#)

Climate Control



Climate Options and Controls

Choose a Temperature and River Option Below. These options will be used for projecting into the future, past 2005.



The historical Hydrograph and Temperature data at each gauge vary between 1979 and 2005.

The Average Hydrograph is derived from all the data between 1955 and 2005.

URGWOP stands for Upper Rio Grande Water Operations and Planning Study. In that study historical data was re-ordered by year to create a drought sequence, a short wet sequence, and a long wet sequence. Comparison of Rio Grande data with that of the Gila-San Francisco Basins suggests a correlation such that wet years along the Rio Grande tend to be wet in southwest New Mexico too. It is similar with dry years. Here we order the Gila-San Francisco hydrographs to follow the URGWOPS pattern. It may allow for some comparison between models in the future. If the starting year is 2006, then drought happens 2009-2018 and wet years are 2019-2023 and 2026-2037.

Future River Flow Data

Repeat Historical Hydrograph Data

Use Average Annual Hydrograph

Use 40 Year URGWOPS Sequence

0.00 %

0.00 cfs

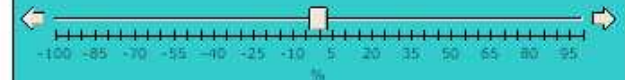
Future Temperature Data

Repeat Historical Temperature Data

Use Average Temperature

Use 40 Year URGWOPS sequence

Percent Temp Perturbation



0.00 %

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Target Flow Control

Set Season Variable River Flows



San Francisco River Basin

Choose Type of Minimum Flows
San Francisco constant = 10 cfs
Gila River constant = 150 cfs

- Use Season Variable Flows
- Use Constant Flows

Reserve-Glenwood Minimum

36 cfs	Fall
36 cfs	Winter
40 cfs	Spring
39 cfs	Summer

Modify Reserve-Glenwood

Glenwood-Clifton Minimum

30 cfs	Fall
30 cfs	Winter
32 cfs	Spring
32 cfs	Summer

Modify Glenwood-Clifton

DRAFT

Version:

20070416



Gila River Basin

Gila-Redrock Minimum

45 cfs	Fall
28 cfs	Winter
76 cfs	Spring
53 cfs	Summer

Modify Gila-Redrock

Redrock-Virden Minimum

53 cfs	Fall
30 cfs	Winter
59 cfs	Spring
53 cfs	Summer

Modify Redrock-Virden

Virden-Clifton Minimum

34 cfs	Fall
25 cfs	Winter
68 cfs	Spring
38 cfs	Summer

Modify Virden-Clifton

Clifton-Solomon Minimum

42 cfs	Fall
47 cfs	Winter
51 cfs	Spring
55 cfs	Summer

Modify Clifton-Solomon

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Return to CUFA

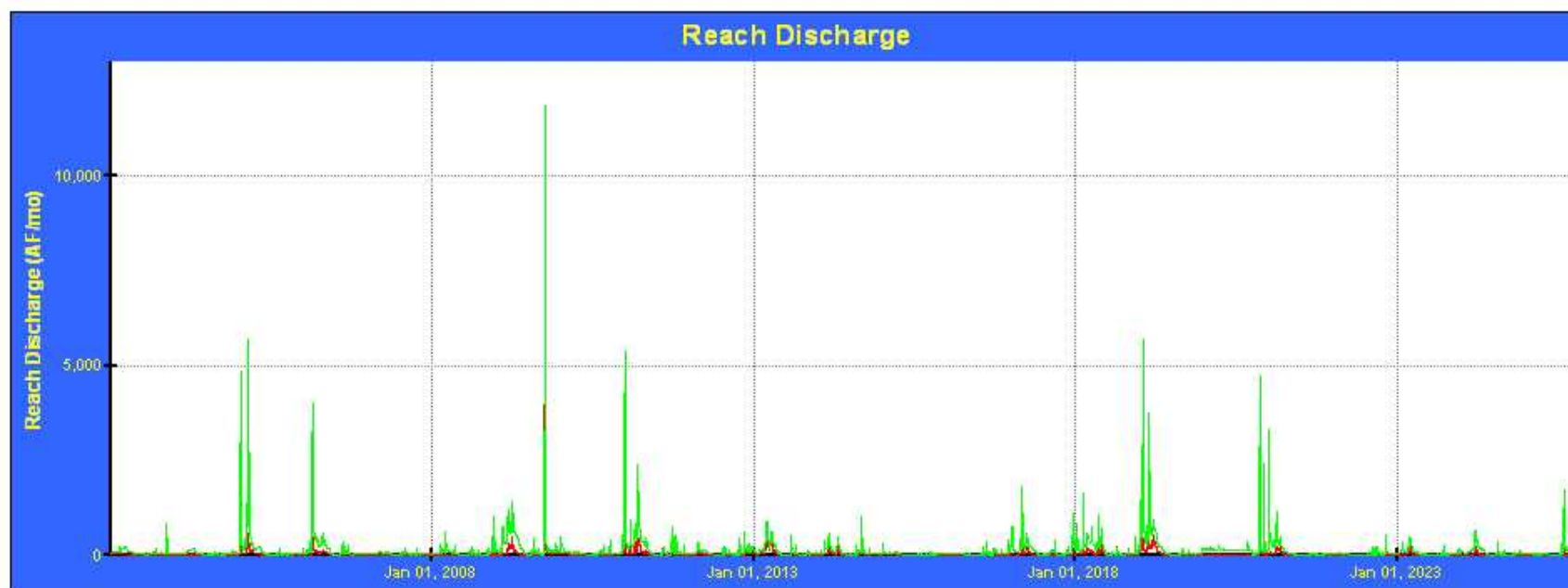
Hydrograph Output

San Francisco Basin Modeled Hydrographs

Graph Control
Reserve to Glenwood
Plotted in Red

Graph Control
Glenwood to Clifton
Plotted in Green

Graph Control
Choose A Reach
Plotted in Blue

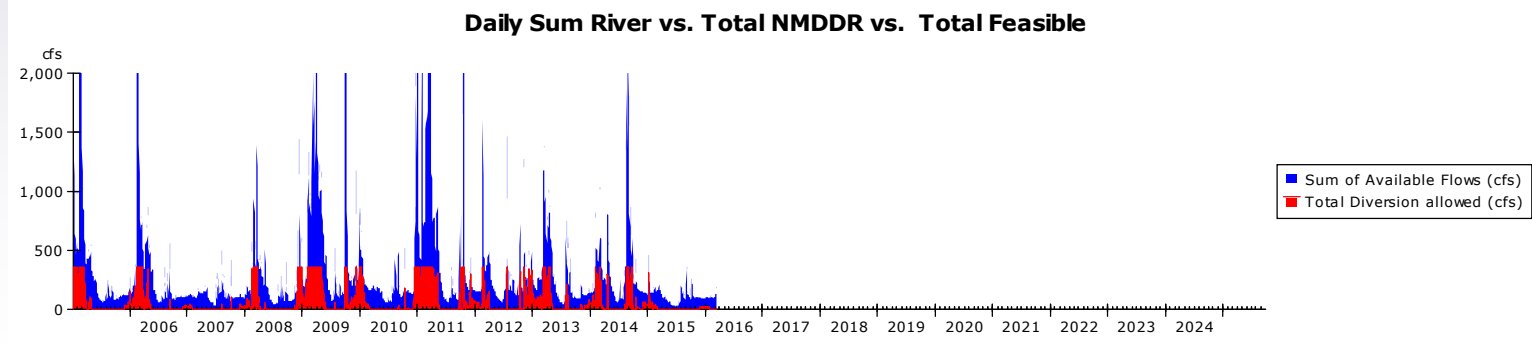
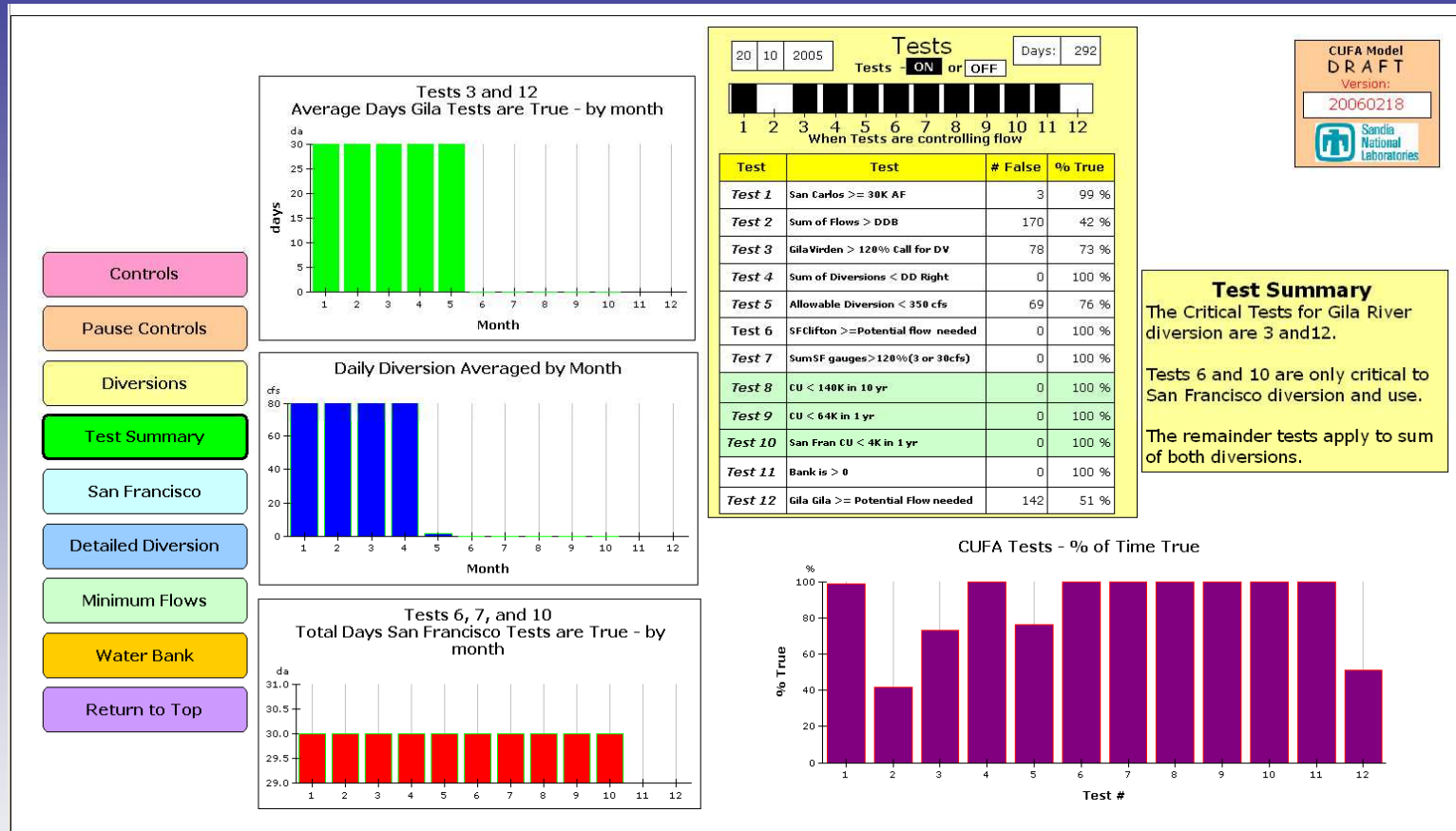


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See Locations of
River Reaches

CUFA Output



Target Flows Output

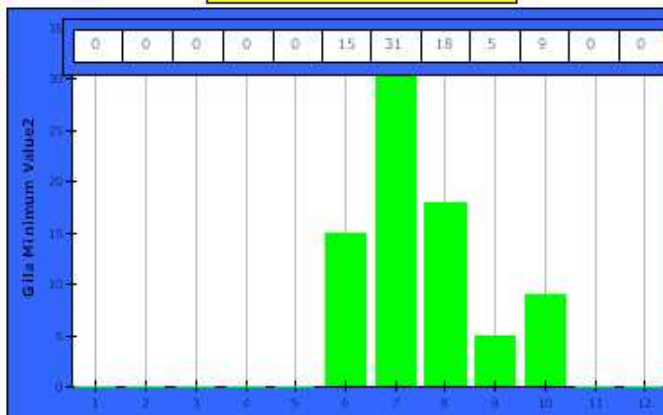
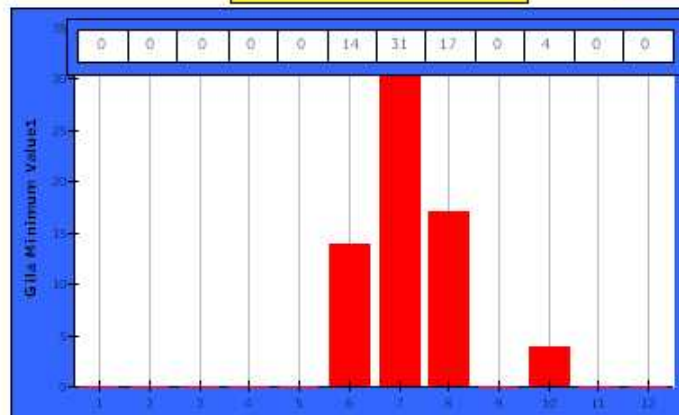
Gila River Basin Days Below Minimum Flow

Graph Control
Gila - Redrock
Plotted in Red

Year

2,006

Graph Control
Redrock-Virden
Plotted in Green



Year
Upper Gila Reach
Gila to Redrock
Redrock to Virden
Virden to Clifton
Clifton to Solomon

Year	2,003	2,004	2,005	2,006	0	0	0	0	0	0
Upper Gila Reach	344	309	215	170	0	0	0	0	0	0
Gila to Redrock	151	97	61	62	0	0	0	0	0	0
Redrock to Virden	156	101	75	69	0	0	0	0	0	0
Virden to Clifton	139	110	69	82	0	0	0	0	0	0
Clifton to Solomon	68	70	50	47	0	0	0	0	0	0

Annual
days
Below
Minimum
Flow



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See Locations of
River Reaches

Project Status

- Project is currently on hold
- Numerous entities considering how to continue collaborative modeling effort

Land Letter -- Thursday, March 22, 2007

RIVERS: N.M. governor vetoes Gila River development bill; stakeholders tackle alternatives

April Reese, *Land Letter* Western reporter

New Mexico Gov. Bill Richardson (D) vetoed legislation last week that would have funneled state funds toward controversial development projects on the Gila River.

Meanwhile, a stakeholder group of water officials and local interests is studying options for protecting the state's last free-flowing river while meeting future water demands.