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to: Southwest New Mexico Stakeholder Group

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subject: Gila-San Francisco Decision Support Tool Assumptions

The Gila-San Francisco Decision Support Tool is the product of a collaborative modeling effort which analyzed the water needs and supply for the Southwest four-county region. Catalyzed by the 2004 Arizona Water Settlement Act and prompted by a keen awareness for the unique ecology in the region, the team worked together over the last three years to create a framework to address pressing water resource issues. The assumptions are listed under different themes: water supply, water demand, and NM CUFA. Under water supply, there are two sub-modules: surface water and ground water baseline assumptions. Under water demand, there are demand parameters that are used across six broad categories: livestock, mining, population, water rights, riparian, and minimum flow. Lastly, the interpretation of the New Mexico CUFA is also noted here. This list is not exhaustive, but it captures most of what is defined as of September 2008. The constants used in the model are listed in Table 1.

Water Supply - Surface Water

- Water supply in this region is based on USGS gauge data. The model has extracted historical data from the USGS 09430500 gauge (http://waterdata.usgs.gov/nm/nwis/uv?09430500) and the USGS 09430600 gauge (http://nwis.waterdata.usgs.gov/nm/nwis/nwisman/?site_no=09430600&agency_cd=USGS) to simulate water supply for the Gila River. It uses data from the USGS 09442680 gauge (http://waterdata.usgs.gov/nm/nwis/uv?09442680) and the USGS 09444200 gauge (http://nwis.waterdata.usgs.gov/nwis/uv?09444200 to simulate water supply for the San Francisco River.
- The Gila San Francisco basin is divided into eight reaches (five in Gila and three in SF rivers). Each reach represents a spatial aggregate with its own supply and demand equations. The boundaries of these reaches coincide with downstream locations of USGS gauges such that the simulated supply and demand can be calibrated against historical flow in those locations. Physical characteristics of the reach such as reach dimensions and elevations are assigned at the reach-level.
- Since the model does not track precipitation events, water supply due to climate must contribute to the simulated hydrograph. These volumes are added to the model at each reach subsequent to the USGS gauges mentioned above. These volumes are based on historical hydrographs at the following locations: USGS 09431500, USGS 09432000, USGS 09442000, USGS 09444000, USGS 09444500, and USGS 09448500.
- The temperature data are based on twenty-six temperature monitoring stations around the GSF region and weighted relative to the centroids of each reach location.
- The water supply for agriculture diversion within each reach is based on correlations of recorded USGS ditch flow and USGS river flow. The correlations are defined as second-order polynomial fits. No ditch diversion can ever be greater than the amount

river flow. Similarly, a minimum flow in the river is required in order for non-zero diversions to occur.

Water Supply - Groundwater

- Within each reach, the GSF groundwater basin is divided into two types of aquifers: fluvial and deep aquifer. The boundary between those two is drawn based on available geologic information using GIS tools. The flow amongst aquifers are defined by the relative differences in hydraulic heads. There are two types of wells within each groundwater partition, shallow wells and deep wells.
- The Mimbres groundwater basin is divided into nine sub-basins based on its geologic and hydrologic characteristic. The delineation is based on OSE well records and past publications. Unlike the GSF groundwater model, these are no alluvial region in Mimbres; however, the sub-basins are communicative controlled by the same equations as used for the GSF groundwater model. Pumping from Franks Wells field is also included as a source of water for the basin.
- The Animas groundwater basin has no divisions and acts as a single source of water supply.
- There is water exchanged between GSF and Mimbres basins through the Mangas Trench. The amount of water moves from Mimbres to Gila at a rate of 4,800 AF/yr.

Water Supply – Interactions between Surface Water and Groundwater

- The groundwater module and surface water module are connected by flow caused by relative differences in hydraulic heads. The hydrologic parameters for the flow equations are adjustable parameters in the model such that the difference between simulated hydrographs match closely to historical hydrographs. The calibration period spans from January1982 to January 2006.

Water Demand – General

There are two types of demand data that the model uses: the Southwest New Mexico Regional Water Plan (http://www.dbstephens.com/project_plans.php?plan_id=231) and the other collectively from OSE records, GIS database, and personal communications. Because the data from SWNM Regional Water Plan are temporally coarse (5-year interval), the model uses the second category exclusively. The consumptive use simulated data are checked against the SWNM Regional Water Plan for consistency. The OSE data range from monthly Bill Evans pumping records dated back to 1968 to yearly irrigation reports dated back to 1969.

The default values stated in the following sections are adjustable in the Tool's User Interface. Hence, one can study the impact of regional consumptive use patterns by changing these default input parameters. Table 1 also summarizes the default parameters in User Interface.

The water rights statistics are based on information from OSE's WATERS database. (http://iwaters.ose.state.nm.us:7001/iWATERS/)

Water Demand – Consumptive Use

- *Livestock* –Cattle population is based on USDA's cattle statistics in the four county region dating back to 1975. Cattle consumptive use is currently set at 25 gallons/day/head. The distribution of surface water and groundwater consumptive use is defaulted at 50%.

- *Mining* – OSE's monthly records submitted by Phelps Dodge are used to simulate daily Bill Evans water diversion for mining operations. The model assumes zero mining water rights are leased out to other uses.
- *Population* – Projections of population in the four county area is estimated based on Bureau of Business & Economic Research (http://www.unm.edu/~bber/) and the US Census bureau (http://www.census.gov/).
- *Population: Silver City & Surrounding Municipalities* – Because of its presence, the Silver City water demand from population is further refined in the model. The model defaults to 7,066 households for the region increasing at a rate of 0.22 households/day. Per capita use within the distribution system is defaulted to 140 gal/day/person. The model defines 2.5 person per household for this region. It is assumed that each "hookup" is equivalent to a "household".
- *Domestic Non-Consumptive Water Rights* – The model assumes 0.6 AF/year/household consumptive use for each rural household in the four-county region. The rural households are defined by the difference of county population and city population divided by 2.5 person/household. In addition, each household is assumed to own a single DNC well.
- *Adjudicated Domestic & Stockwell Water Rights* – The model assumes a 50% utilization rate of each of the 3 AF/yr/well water right.
- *Agriculture* –Irrigated crops are defined by the breakdown from 2005 OSE's hydrographic survey. Evapotranspiration is calculated for each crop type using Hargreaves equation along with daily minimum and maximum temperatures. The ditch efficiency for each reach is estimated to be the ratio of crop irrigation requirement (OSE CIR) to the average water use within each reach based on historical hydrographic survey. The excess water beyond crop ET becomes shallow groundwater seepage.
- *Riparian* – Similar to agricultural crops, riparian consumptive use is calculated using the Hargreaves equation. The riparian area is estimated using GIS mapping tools.
- *Minimum flow* – The minimum flow structure within the model is only implemented in the context of calculating New Mexico consumptive use for CUFA. The default assumes 150 cfs for the Gila river and 10 cfs for the San Francisco river.

2004 AWSA New Mexico Consumptive Use and Forbearance Agreement (NM CUFA)

As a critical component of the 2004 Arizona Water Settlement Act, the NM CUFA is a legal document that spells out the requirements for diversion. As it is interpreted in the model, it is comprised of twelve different tests. The order the tests are applied is compliant with the order that the ISC uses in its spreadsheet calculator. The minimum flow requirement as well as the agriculture demand, both of which are not required by CUFA, are subtracted from the potential diversion right.

Table – 1 Baseline Values for User Adjustable Parameters within the Tool.

User Adjustable Parameters	Default value	Unit	Low	High
CUFA				
Initial NM CAP Bank	54,000	AF/yr	0	70,000
Bypass parameter multiplier-winter	0.8		0.5	1
Bypass parameter multiplier-summer	0.75		0.5	1
Duncan-Virden call - January	13	cfs	0	100
Duncan-Virden call - February	20	cfs	0	100
Duncan-Virden call - March	38	cfs	0	100
Duncan-Virden call - April	48	cfs	0	100
Duncan-Virden call - May	54	cfs	0	100
Duncan-Virden call - June	56	cfs	0	100
Duncan-Virden call - July	57	cfs	0	100
Duncan-Virden call - August	51	cfs	0	100
Duncan-Virden call - September	49	cfs	0	100
Duncan-Virden call - October	42	cfs	0	100
Duncan-Virden call - November	37	cfs	0	100
Duncan-Virden call - December	23	cfs	0	100
Streamflow values	calculated			
Agricultural Practice				
UG-Gila Cattle population	1835	head		
Gila-Redrock Cattle population	10201	head		
Redrock-Virden Cattle population	12301	head		
Virden-to NM Stateline	4110	head		
SW-GW split	50	%		
USF-Reserve Cattle Population	717	head	17	1417
Reserve-Glenwood Cattle Population	2530	head	530	4530
Glenwood-Clifton Cattle Population	2125	head	125	4125
Mimbres - Deming Irrigated acres	16165	acre		2005 total water rights
Mimbres - Columbus Irrigated acres	2858	acre		2005 total water rights
Animas - Animas Irrigated acres	4617	acre		2006 total water rights
Animas - Lordsburg Irrigated acres	1998	acre		2006 total water rights
USF-Reserve Irrigated land	36	acre		2005 adjudicated total
Reserve-Glenwood Irrigated land	822	acre		2006 adjudicated total
Glenwood-Clifton Irrigated land	0	acre		2007 adjudicated total
Minimum Flow				
San Francisco	10	cfs		
Gila River	150	cfs		
Mining Leased Water Rights				
Mining water rights to irrigators	0	AF	0	14,000
Mining water rights to municipalities	0	AF	0	31,000

Population Growth

Adjudicated Domestic Consumptive Use	0.6	AF/yr/household	0	1
Domestic Non-consumptive Use	50% of adjudicated water rights		0%	100%

County Growth Rate (%)				
Hidalgo Co		**Low**	**High**	
	2000			
	2010	-0.22	1.26	
	2020	-0.31	0.53	
	2030	-0.44	0.05	
	2040	-0.5	0.01	
Catron Co				
	2000			
	2010	0	1.15	
	2020	0	0.57	
	2030	0	0.13	
	2040	0	0.11	
Grant Co		**Low**	**High**	
	2000			
	2010	-0.5	-0.5	
	2020	0.61	1	
	2030	0.48	1	
	2040	0.41	1	
Luna Co				
	2000			
	2010	1.24	2.48	
	2020	1.04	2.07	
	2030	0.81	1.61	
	2040	0.64	1.27	

City Growth Rates (%)					
Low		Deming	Hurley	Bayard	Santa Clara
	2000	1.49	-0.55	-0.55	-0.55
	2010	1.25	0.67	0.67	0.67
	2020	0.97	0.53	0.53	0.53
	2030	0.77	0.45	0.45	0.45
High		Deming	Hurley	Bayard	Santa Clara
	2000	2.98	-0.55	-0.55	-0.55
	2010	2.48	1.1	1.1	1.1
	2020	1.93	1.1	1.1	1.1
	2030	1.52	1.1	1.1	1.1
Low		Virden	Luna	Reserve2	Glenwood2
	2000	-0.05	0 %	0 %	0 %
	2010	-0.04	0 %	0 %	0 %
	2020	-0.03	0 %	0 %	0 %
	2030	-0.02	0 %	0 %	0 %
High		Virden	Luna	Reserve2	Glenwood2
	2000	0.00	1.7 %	1.7 %	1.7 %
	2010	0.00	1.15 %	1.15 %	1.15 %
	2020	0.00	0.57 %	0.57 %	0.57 %

2030	0.00	0.13 %	0.13 %	0.13 %

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Daniel B. Stephens & Associates, Inc. (2005), Southwest New Mexico Regional Water Plan.

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Franklin and Duncan Valley TBI Data. Gila Water Commission. 2004 to 2006.

USGS NWIS Web Water Data - http://water.usgs.gov/ - Stream gauge and water well information.

New Mexico Office of the State Engineer WATERS database http://iwaters.ose.state.nm.us:7001/iWATERS/.

New Mexico Office of the State Engineer website http://www.ose.state.nm.us/PDF/Maps/underground_water.pdf.

New Mexico Consumptive Use and Forbearance Agreement, October, 2005.

References for Mimbres Groundwater Model – Courtesy of Alison Williams

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GIS Information – Courtesy of Geoff Klise

New Mexico Resource Geographic Information System Program – http://rgis.unm.edu - General New Mexico GIS data.

USGS Seamless Data Distribution System – http://seamless.usgs.gov - elevation data.

USGS National Hydrography Dataset – http://nhd.usgs.gov - Watershed information including rivers, streams, basin, sub-basin, watershed boundaries.

New Mexico Office of the State engineer – Statewide Geodatabase was obtained from their GIS specialist, George Clarke. Other data from them is on the RGIS website listed above.

Southern Arizona Data Services Program - clearinghouse for southern Arizona GIS data http://sdrsnet.srnr.arizona.edu/index.php?page=datamenu&lib=1&sublib=14

Arizona State Land Department - http://www.land.state.az.us/alris/ - site for Arizona GIS data.

Southwest Regional Gap Analysis Project - http://fws-nmcfwru.nmsu.edu/swregap/default.htm Riparian vegetation information

National Climatic Data Center - http://www.ncdc.noaa.gov/oa/ncdc.html - temperature information for evapotranspiration analysis.