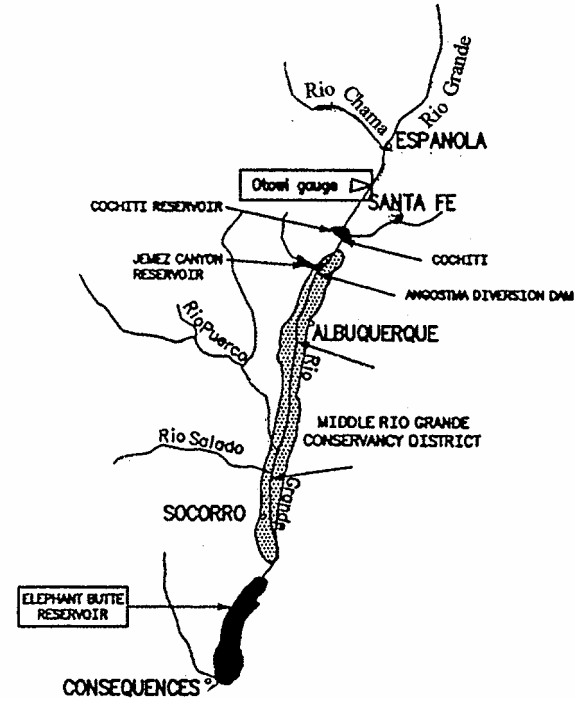
Middle Rio Grande

WATER BUDGET

(Where water comes from, & goes, & how much)

Averages for 1972-1997



Action Committee

of the

Middle Rio Grande Water Assembly

October 1999

This water budget deals with WET WATER, not with water rights nor water claims.

CONTENTS -- AND WHY

This water budget is in no way related to any regional water-planning boundaries or other planning efforts. It covers the reach between Otowi Gage and Elephant Butte Dam, the two "index" (accounting) points for the Rio Grande Compact, a reach called by convention New Mexico's "Middle Rio Grande."

MIDDLE RIO GRANDE WATER BUDGET
SUMMARY TEXT
(Note: A glossary is provided on page 9)

This simple water budget and the material accompanying it are designed for a broad audience of people who have an interest in the region's water resources. This summary provides context for understanding the information in the tables and graphs on the following pages. An audience with good understanding will, we hope, improve public input and also multiply the public's influence over water stewardship.

The water budget addresses wet water in both the surface water and the groundwater parts of the regional hydrologic system. Many water budgets have been created over the past three decades by knowledgeable professionals. The numbers we use here differ little from those earlier presentations. Most of those water budgets however were embedded in lengthy technical documents not at all designed for non-hydrologist audiences.

Both tabular and graphic formats are used in this pamphlet to present the hydrologic picture, and the numbers in the two formats are the same. Some people like numbers, some like pictures. In addition to the annual averages, an *actual* one-year water budget, for 1993, a near-typical year, is also provided.

1. The **Middle Rio Grande Valley** addressed in this water budget extends from the Otowi gage on the north (where the Los Alamos highway crosses the Rio Grande) to Elephant Butte Dam on the south, a distance of about 200 miles. These are the two "index" points, or water-accounting points, in New Mexico that are specified by the Rio Grande Compact.

2. **Groundwater and surface water** are but parts of a single hydrologic system. Throughout the river's floodplain (the "inner valley" of the Rio (Jrande) the water table in most places (though not at Albuquerque) is only 10 feet or so below land surface. The uppermost groundwater in the shallow aquifer, which underlies the floodplain, is in direct contact in most places with the surface water in the river and with water in the many drainage ditches throughout the valley. It is here that all exchanges between groundwater and surface water occur.

3. **All municipal water systems pump groundwater** to supply their customers, and the larger systems--principally Albuquerque and Rio Rancho--pump at rates we now know significantly exceed the ability of the Rio Grande to replenish *(ie.,* recharge) the aquifer. This is called "**mining" groundwater**.

- Groundwater currently is being mined at a rate of about 70,000 acre-feet per year (af/y). An effect of the overdraft is that the water table beneath Albuquerque has been seriously lowered--locally beneath the northeast heights by amounts approaching 200 feet.
- Both specialists and non-specialists are aware that this rate of exploitation is unsustainable, and alternative plans are under serious discussion by many parties and concerned specialists.

4. This is an **annual water budget**. It gives annual averages for nearly all inflows, outflows and changes in storage in the system, and it identifies the pathways on which these occur. Information presented herein conforms generally with definitions and parameters used in the Rio Grande Compact.

- **Natural variability** is high for nearly all the numbers in the budget. The variability range is shown for some, but not all, parameters. (The high variability in flow of the Rio Grande is shown graphically in the histogram on page 3.)

- The data for river flows at Otowi gage and Elephant Butte Dam, the data for major-tributary inflows, and the data for most of the aquifer pumping and municipal wastewater are direct measurements of surface-water flows or pumping. Most other numbers are from complex analyses, and/or from analytical or computer modeling.
- Rio Grande flow gaging data have officially reported uncertainties of the order of 10%. Groundwater and other calculated data have uncertainties at least this large. Hence, the accuracy of data in this water budget is affected by this reality.

5. The water budget is for the **26-year period of 1972-1997**, inclusive.
- Flow records at the Otowi gage go back more than 100 years, but in 1971 the San Juan-Chama diversion project began importing water from the Colorado River system into the Rio (irande.

6. The **Otowi** gage, located as it is downstream from the confluence of the Rio Chama and the Rio Grande at Espafiola, measures the combined flow of native water in the Rio Grande system and the imported water from the San Juan-Chama diversion system.
- The 1972-1997 average flow *of native* water at Otowi is approximately 1,100,000 acre-feet/year.
- The 1910-1993 average of all flows past the gage is also about 1,100,000 acre-feet (at).

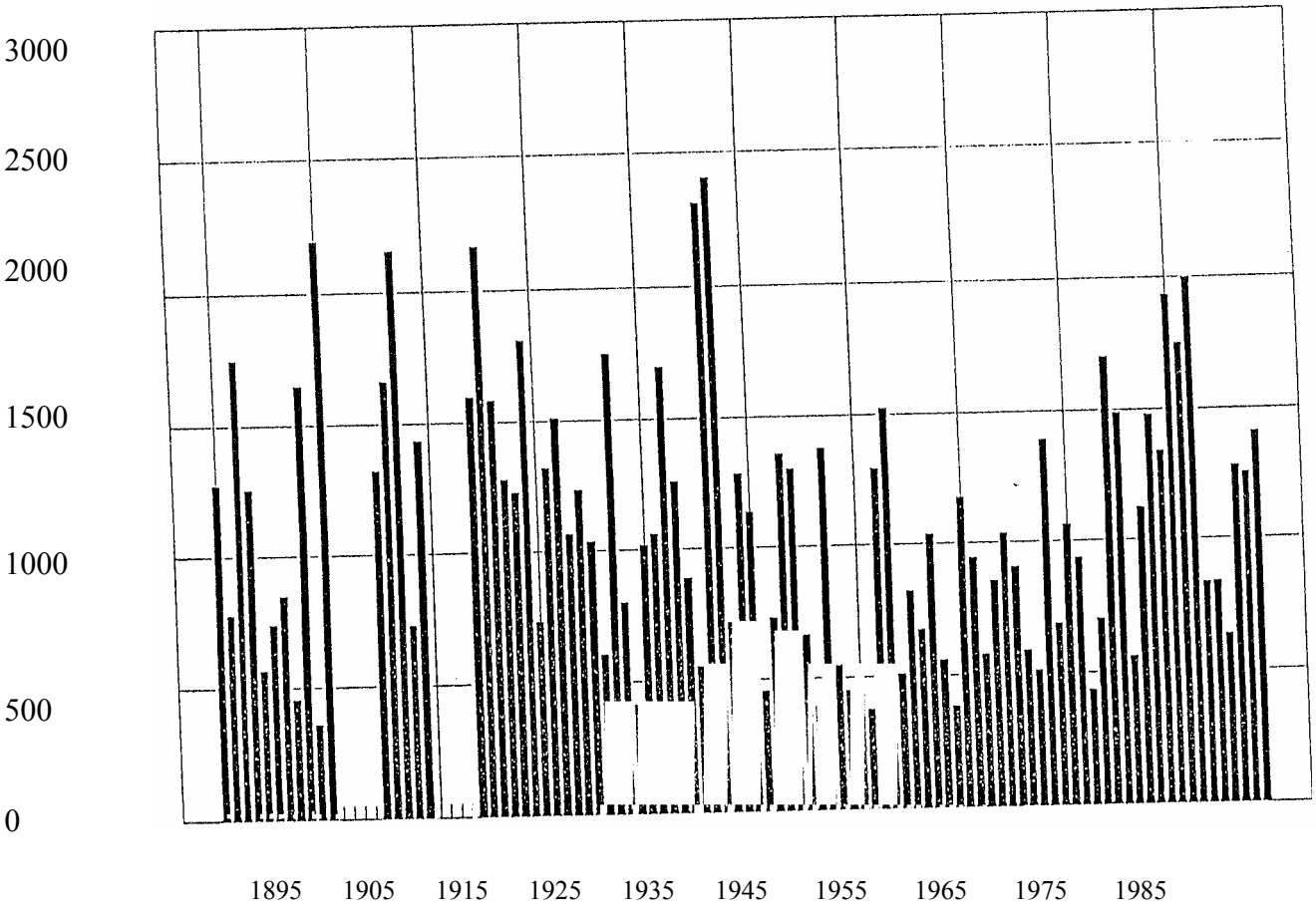
7. The **San Juan-Chama diversion projec**t delivers an average of 96,000 af/y to Heron Reservoir. Evaporation and water used to increase reservoir storage reduces the amount reaching the Rio Grande. That reaching the Rio Grande has augmented the flow at Otowi gage by about 55,000 ally since 1971.
- This is part of New Mexico's Colorado River share; it is picked up from tributaries of the San Juan River, conveyed through a tunnel under the continental divide to Heron Lake, then to the Rio Chama.
- The San Juan-Chama water is not subject to Rio Grande Compact control.

8. The **Rio Grande Compact** specifies the annual amount of surface water to be provided to downstream users from Elephant Butte Reservoir based on "native" Rio Grande inflow at Otowi. Four values that relate to Elephant Butte outflow are given in the accompanying table and flow diagram. These are, (a) the delivery that would be required if the averages in the table were the actual flow for a single year; (b) The average of **actual wet-water flows** past the dam; (c) the average of annual **Scheduled Deliveries** mandated by the Rio Grande Compact; and (d) the average of the **Elephant Butte Effective Supply** (which combines actual deliveries and change in lake storage). Note: given 10% or larger error for data, the Elephant Butte Effective Supply and the deliveries mandated by compact are statistically the same.

9. "**Depletion**" is calculated by subtracting the outflow at Elephant Butte Dam from the native-water inflow at Otowi. (Note that this calculation ignores all other inflows and outflows that originate *within* the Middle Rio Grande.)
- Under the compact, the *maximum* that the Middle Rio Grande is allowed to deplete from any and all Otowi *native inflows exceeding 1,500,000 af/y* is a fixed 405,000 af/y. At lesser inflows, the depletable amount decreases progressively (down to 47,000 at inflows of 100,000 ally).
- *Evaporation from Elephant Butte Reservoir* must be included as part of the Middle Rio Grande's permissible depletion.

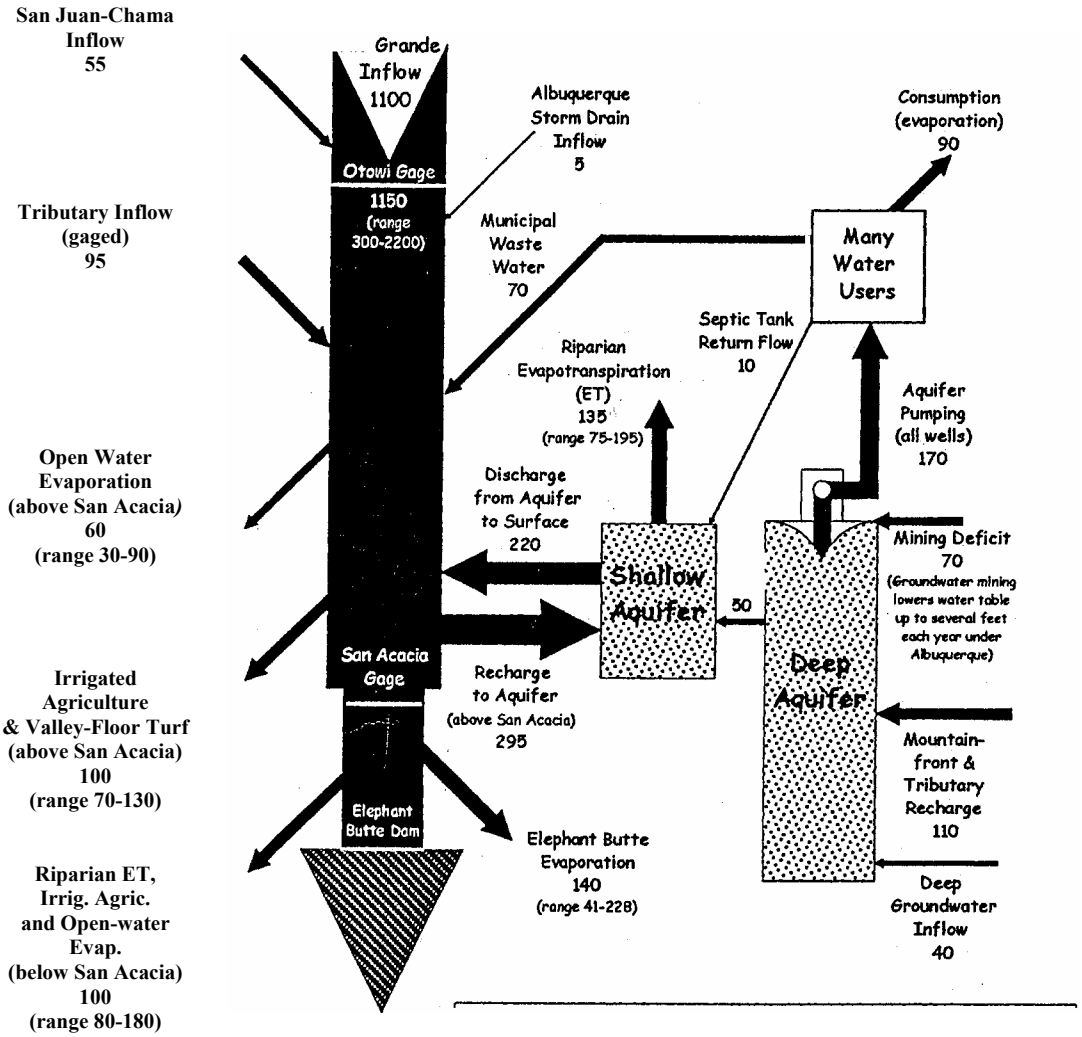
10. Direct **evaporation from Elephant Butte Reservoir** is commonly the largest single depletion loss from the system. The amount varies widely from year to year, being controlled by both weather and size of the lake surface through the year.
- Note: The ouffiow called "Recharge to shallow aquifer" above San Acacia, while a larger number, is mostly offset by nearby shallow-aquifer returns to the surface-water part of the system.

Rio Grande at Otowi Bridge (water year)



⇑
thousands of acre-feet

MIDDLE RIO GRANDE WATER BUDGET
(Annual Values Typical for 1972-1997)



To Downstream Users (range 300-1435)

850 Water delivery calculated from this water-budget analysis
729 *Average* of wet water deliveries 1972-1997 from Rio Grande Compact records
786 Average deliveries mandated by the compact 1972-1997
799 Average Elephant Butte effective supply (delivery plus change in storage)

Values are annual average (rounded). Natural variability is large for most. Some but not all variabilities are shown.

Line widths are drawn in relative scale of magnitude

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10/7/99 Version

MIDDLE RIO GRANDE WATER BUDGET

Annual Surface-Water & Groundwater Averages (rounded) for 1972-1 997

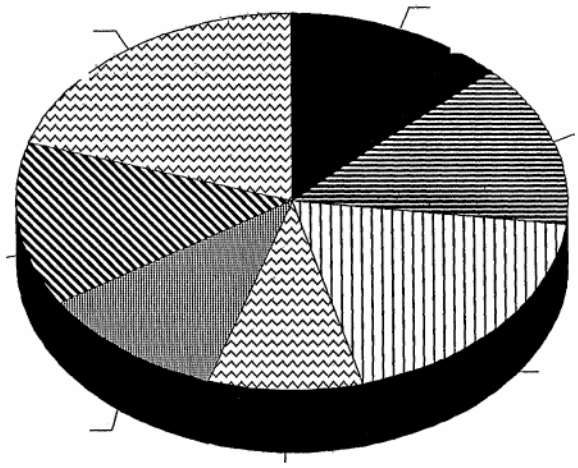
Annual Surface-Water Inflow		Amount (Native Water) (1000 ac-ft)	Annual Variability (1000 ac-ft)
Rio Grande native water at Otowi Gage ("Otowi Index")		1,100	297-2,170
San Juan-Chama Project imported water reaching Otowi Gage		55	2-150
Tributary inflow (the rios Santa Fe, Galisteo, Jemez, Tijeras, Puerco, Salado)		95	
Ungaged tributaries		unknown	
Storm-drain inflow from Albuquerque		5	
Municipal Wastewater inflow (pumped from groundwater)		70	
Discharge from shallow aquifer to surface system	*Otowi to San Acacia*	220	
		1545	
Annual Surface-Water Outflow			
Recharge to shallow aquifer	*Otowi to San Acacia*	295	
Open-water evaporation (incl.from farm fields)	*Otowi to San Acacia*	60	±30
Irrigated agriculture and valley-floor turf	*Otowi to San Acacia*	100	±30
Riparian ET, irrig. agric. & open-water evap.	*Combined below San Acacia*	100	80-180
Elephant Butte evaporation		140	41-228
Surface-water outflow from Elephant Butte Dam to downstream users		**850	300-1,435
		1545	
Groundwater Recharge(+) & Discharge(-)			
SHALLOW AQUIFER (underlying Rio Grande flood plain)			
Recharge {from surface wtr & percolation from irrig)	*Otowi to San Acacia*	+295	
Septic-tank return flow (from pumping)	*Otowi to San Acacia*	+ 10	
Inflow from deep aquifer	*Otowi to San Acacia*	+ 50	
Riparian evapotranspiration (all non-crop ET)	*Otowi to San Acacia*	- 135	
Discharge to surface-system drainage ditches	*Otowi to San Acacia*	- 220	
		0	
DEEP AQUIFER			
Deep groundwater inflow (from north & west)		+ 40	
Mountain-front & tributary recharge	*Otowi to San Acacia*	+110	
Groundwater pumped (all wells)	*Otowi to San Acacia*	- 170	
Consumed (that is, evaporated)	90		
Municipal wastewater to river	70		
Septic-tank return flow to shallow aquifer	10		
Outflow to shallow aquifer		- 50	
Groundwater mined from aquifer	*Otowi to San Acacia*	- 70	

Table footnote:

** Calculated outflow (rounded) based on the data in this table. The average of wet-water actual flow past the dam is 729,000 ac-ft. The average of "scheduled deliveries" mandated by the Rio Grande Compact for the 1972-97 Otowi Index supply is 786,000 ac-ft. The average of the Elephant Butte Effective Supply (actual deliveries plus changes in Elephant Butte lake storage) is 799,000 ac-ft. (See Summary, Note 8.)

Middle Rio Grande Water Depletions

Urban consumption is of mined, deep groundwater;
other depletions are either or both surface water or shallow groundwater



Elephant Butte Lake Evaporation 20%

Urban Consumption above San Acacia 13%

Irrigation, Riparian Transpiration & Open-Water Evap. below San Acacia 14%

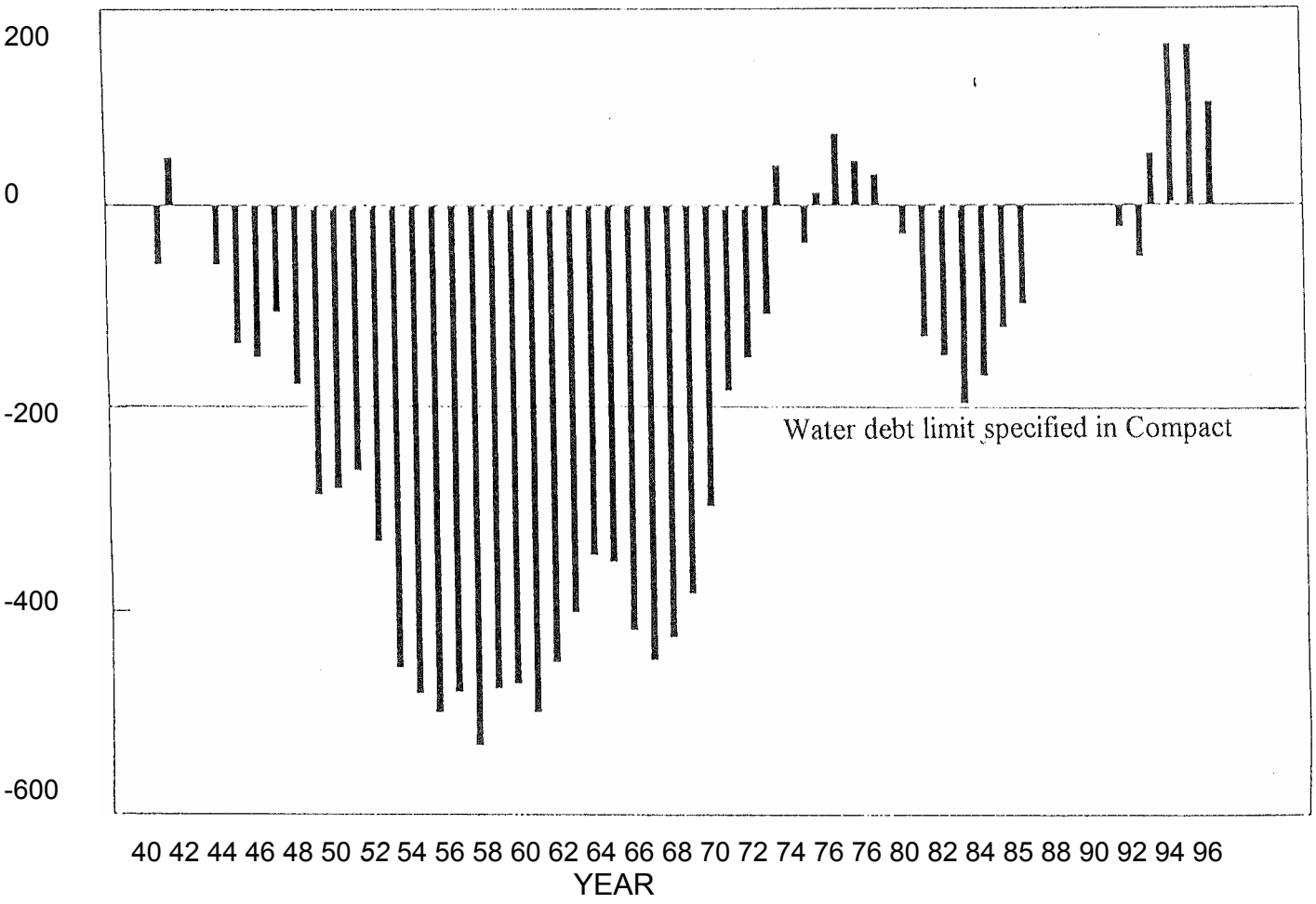
Irrigated Agriculture above San Acacia 14%

Net Aquifer Recharge above San Acacia 11%

Riparian Transpiration above San Acacia 19%

Open-Water Evaporation above San Acacia 9%

Rio Grande Compact - Deliveries by NM at EButte
Annual Summary of Credits and Debits Accrual 1940-1996



1993 ACTUAL SURFACE-WATER BUDGET--- MIDDLE RIO GRANDE

(Calendar-Year Gage & Other Records of USGS & Rio Grande Compact Commission)
(Compiled by Steve Hansen, US Bureau of Reclamation)

Gaged Inflows, Otowi to San Marcial:

	(acre-feet)	(acre-feet)
Otowi Gage (includes 36,300 ac-ft of San Juan-Chama water)	1,481,000	
Los Alamos Canyon	3.1	
Pueblo Canyon	720	
Rito de los Frijoles	989	
Santa Fe River	11,810	
Galisteo Creek	4,250	
Jemez River, near Jemez Springs.	86,440	
North AMAFCA Channel	9,900	
Tijeras Arroyo	450	
South AMAFCA Channel, above Tijeras Arroyo	400	
Rio Puerco	25,900	
Rio Salado	(Not gaged)	
Albuquerque Water Treatment Plant (augmentation from groundwater)	60,000	
Total Gaged Middle Basin Inflow (Cochiti to San Marcial)	1,681,862	
Gaged Outflows at San Marcial:		
Rio Grande Floodway	1,077,000	
Low-Flow Conveyance Channel	241,800	
Total Gaged Middle Basin Outflow (at San Marcial)	1,318,800	
MIDDLE BASIN DEPLETION (Inflow - Outflow) (1)		**363,062**
Elephant Butte Evaporation (Outflow):	194,312	
COMPACT DEPLETION (Middle Basin depl.+ Eleph.Butte evap.) (2)		**557,374**
Delivery Requirements to Downstream Users from Elephant Butte Dam:		
Amount Actually Available for Delivery, at Elephant Butte Dam (3)	1,108,000	
Rio Grande Compact Required Delivery (based on Otowi Gage Index)	1,084,500	
BALANCE		**23,500**
Compact Mass-Balance Closure Error:		
Reduction necessitated by '93 changes in reservoir storage & other (ie., This analysis compared to official Rio Grande Compact computation)	24,300	
1993 YEAR-END DEFICIT (from 1993 Annual Compact Report)		**<800>**

(1) Compare with 1980-87 average of 366,000 ac-fl calculated by Pat Turney of the ISC staff.
(2) Compare with 1980-87 average of 520,000 ac-ft calculated by Pat Turney of the ISC staff
(3) Middle Basin Outflow, less Eleph.Butte evaporation, & less 16,500 "Compact Adjustment"

Glossary

Aquifer A geological zone (e.g., a group of strata) in the subsurface that is saturated (i.e., is below the "water table") and is sufficiently permeable to yield useful quantities of groundwater to wells. See also "Deep Aquifer" and "Shallow Aquifer."

Consumption In water-resource jargon, water is used consumptively when it is evaporated or transpired, and thereby lost completely from the system.

Deep Aquifer The saturated, potentially water-yielding part of the older basin-fill sediments that geologists-call the Santa Fe Group. The deep aquifer is the primary water source for most municipal, industrial, and many private-domestic users. It is in direct hydraulic connection with the Shallow Aquifer, which rests on it along the river floodplain. The water table in the deep aquifer is locally as much as **1,000** feet below land surface.

Depletion The net reduction in surface-water flow between two specified points in the flow system. Middle Rio Grande depletion is calculated as follows; native-water inflow at Otowi, minus outflow at Elephant Butte Dam. (Note that all inflows and outflows occurring *within* the boundaries of the Middle Rio Grande are ignored in the equation.)

Evapotranspiration (ET) The combined processes of simple evaporation and plant transpiration through which liquid water is converted to water vapor and lost from the water system.

Native Water Water originating in the Rio Grande drainage

Paper Water A term that whimsically identifies water *rights* owned or claimed within a system. Compare with "Wet Water", which identifies the *actual* water within the system.

Recharge The general process of water being added to a groundwater reservoir. The process includes infiltration from surface water, downward percolation from soil water, and subsurface percolation from adjacent aquifers.

Riparian The environment adjacent to streams and rivers wherein water is more abundant, and especially the flora occupying this environment.

San Juan-Chama Project The trans-basin diversion project that began operating in 1972 to transport water from three tributaries of the San Juan River (in the Colorado River system) into the Chama River basin, thence into the Rio Grande at Española. Heron Reservoir, perched dramatically above the Chama River, receives an average of 96,000 acre-feet of water annually through the Azotea Tunnel, which passes under the continental divide.

Shallow Aquifer This is the saturated part of the geologically "Recent" alluvium--those river-borne deposits 60-100 feet thick that underlie the Rio Grande floodplain. It is hydraulically interconnected with the surface-water system (river and drainage ditches), and also it is interconnected with the deep aquifer. Because of its shallow water table, it supplies water to vegetative evapotranspiration in the valley.

Water Budget A summary that shows the balance in a hydrologic system between water supplies (inflow) to the system and water losses (outflow) from the system. It is a common reporting tool for water-resource systems.

Water Table The surface designating the top of the zone of saturated strata in the subsurface. Below the water table all pore spaces among sediment grains, and all fractures in the geological materials are water filled.

Wet Water The actual water in a water-resource system; as opposed to "paper water", which is a term used for water *rights* owned or claimed within the system.

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Our overriding aim in creating this pamphlet has been to be informative and to be accurate. This water budget was compiled by a varied group of specialists who are familiar with the Rio Grande and with the many past water budgets published by other agencies. While revised editions may be issued as better numbers become available, we are confident that none of the important conclusions likely to come from its study will change.

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