6

Water Resources Assessment for the Planning Region

This chapter presents information about water resources in the water planning process. The following topics are included:

- The Water Budget
- Water Supply
- Water Quality Issues
- Summary of Water Supply Considering Legal Limitations

"Demand exceeds supply" is the three-word summary of the statewide water situation (Gould 2002). The same is true for the Middle Rio Grande Region (MRG Region), where the average demand has exceeded supply by approximately 55,000 acre-feet per year (afpy), and that during the unusually wet last quarter of the 20th century.

Participants in the Action Committee (AC) of the Middle Rio Grande Water Assembly (Water Assembly) prepared a water budget for the plan (see Appendix B). Below is a discussion of the water budget. It is followed by a discussion of the supply portion of the budget in Section 6.2 and the demand portion in Chapter 7.

6.1 The Water Budget

One of the main objectives of this plan is to understand and to address the *relationship* between the wet water resources and demands upon those resources, now and in the future. This chapter and the next chapter present information about the resources and demands upon those resources.

6.1.1 Definition and Characteristics of a Water Budget

A *water budget* shows the relationship between inflows and losses, expressed as the sum of the water coming into the region less the sum of consumption and outflows. Inflows to the MRG Region include both surface water and ground water. Precipitation within the region is included in tributary and storm-drain inflows. Losses to the region consist of consumption by evaporation, evapotranspiration and downstream outflows. Throughflow to Elephant Butte Reservoir is accounted neither as an inflow nor a loss.

Before getting into the specifics of the MRG Region's water budget, it is important to identify some characteristics of water budgets in general. A water budget and its data are based upon several characteristics that bear heavily on the water budget's interpretation:

- The data in a water budget are based upon a *time period*. The time period could be in the past in which case the water budget reflects what the situation actually was. The time period could be in the future, in which case the water budget reflects what could happen or what will be made to happen. In dealing with a water budget, it is important to understand the time period and the associated intent.
- Data in a water budget address a *physical space*. The space could be a hydrological basin or a political subdivision or some kind of hybrid. The space could include groundwater, surface water, or both. In dealing with a water budget, it is important to understand the referenced geographical space, and any adjustments that may have to be made to account for the physical space of interest.

- Data in a water budget are based upon *assumptions*. Assumptions include decisions on topics such as the exact boundaries of riparian and agricultural areas, flow rates from unmeasured flow streams, and behaviors of underground geological structures. In creating or interpreting a water budget, it is important to understand the underlying assumptions. Assumptions tend to vary among studies, but tend to be self-consistent within a study. For example, different studies use different models, define uses differently, and establish distinct reporting parameters. One needs to be very cautious about understanding the family of underlying assumptions when blending or comparing data from more than one study.
- Data in a water budget are based upon real-world measurement numbers whose *precision* is not as good as one might desire; a 20% to 50% degree of imprecision is not uncommon. As an example, the net regional deficits reported by very reputable studies are 41,000, 55,000, 60,000, and 70,000 afpy.

6.1.2 The Three-County Regional Water Budget

The MRG Region's water budget presents average flows between 1972 and 1997. The region's current physical space is the three-county region from the Sandoval/Santa Fe County line in the north to the Valencia/Socorro County line in the south. Vertically, the region encompasses the surface water, the shallow aquifer, and the deep aquifer.

The Middle Rio Grande Water Budget (Action Committee 1999) , hereafter called the five-county water budget, addresses a river reach from Otowi Gage on the north to Elephant Butte Dam on the south. Socorro and Sierra counties are in a separate region. As explained in 6.1.3 below, the Water Assembly adjusted the five-county water budget numbers to fit the three-county region, a river reach from the Sandoval / Santa Fe County line on the north to the Valencia / Socorro County Line on the south. Here is the three-county water budget. This information is reflected in Figure 6-1.

- Incomes– 430,000 afpy:
  - 110,000 Native Rio Grande Inflow
  - 70,000 San Juan-Chama Inflow (incl. approx. 15,000 afpy used but not required to fill Heron Reservoir)
  - 95,000 Tributary Inflow (gauged)
  - 5,000 Albuquerque Storm Drain Inflow
  - 110,000 Mountain Front and Tributary Recharge
  - 40,000 Deep Groundwater Inflow
- Consumptions–316,000 afpy:
  - 90,000 Consumption (evaporation) - residential industrial, municipal
  - 52,000 Open Water Evaporation (above Valencia/Socorro County Line)
  - 69,000 Riparian Evapotranspiration (ET, above Valencia/Socorro County Line)
  - 105,000 Irrigated Agriculture & Valley Floor Turf (above Valencia/Socorro County Line)
- Outflows–169, 000 afpy (for consumption in Socorro-Sierra Region
- Incomes less Consumptions and Outflows = Net Draw from Assets – 55, 000 afpy

These data represent a range of values. It is very important to understand that these data contain uncertainties and averages. For example, "Net Draw from Assets" has been reported at 41,000, 55,000, 60,000, and 70,000 afpy, all from credible sources (see the first three citations in Section 6.1.5 below). As indicated in Section 6.1.1, uncertainties stem from unequal time periods for measurements, differences in spatial boundaries, varied assumptions such as categorization of uses, and limited precision and accuracy of measurements.

It is clear that continued mining of the aquifers at the current rate is untenable. While the exact limitations of the regional aquifers are unknown (and to some extent are dependent on willingness to endure side effects and high costs of extraction) it has been demonstrated that the aquifers are quite limited; the reserve is not infinite as was thought some decades ago. The City of Albuquerque strategy to reduce current pumping by treating and using all of its San Juan-Chama Project water will ease the stress on the aquifers for a period of time.

6.1.3 Derivation of Regional Water Budget

The five-county water budget reports water data from Otowi to Elephant Butte Dam. The Water Assembly derived the data for the three-county MRG Region from the five-county water budget by making the following adjustments and assumptions:

- As an approximation, it is assumed that the north edge of the region's measurements are equivalent to actual measurements at the Otowi Gage about 10 miles north of the county line intersection with the river.
- While the five-county water budget analyzes flows among three subsystems (surface, shallow, and deep), the three-county water budget addresses only the overall whole-system inflows and outflows. The three-county water budget treats the Rio Puerco and the Rio Jemez as tributary sources. Detailed planning for water within those subregions is addressed in Chapter 12.
- We added approximately 15,000 afpy to the San Juan-Chama Project inflow because the 1972-1997 measurement period included the time that Heron Reservoir (capacity 400,000 acre-feet) was being filled, This 15,000 afpy would have been available to contractors, had they called for it..
- It identified the "below San Acacia" consumption as an outflow from the MRG Region to the Socorro-Sierra Region.
- Following direction from the Interstate Stream Commission (ISC), it excluded deliveries across Elephant Butte Dam from both inflows and losses.
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- To account for the consumption between the Valencia/Socorro County line and San Acacia, it decreased the consumptions and increased the outflow from the 100,000 acre-feet in the five-county water budget (see Historical Archive G-3).
    - 16,000 afpy (decrease) Irrigated Agriculture
    - 45,000 afpy (decrease) Riparian
    - 8,000 afpy (decrease) Open Water Evaporation
    - 69,000 afpy (increase) Outflow
- Following guidance from a team of experts and direction from ISC, it excluded water that evaporates from Elephant Butte Reservoir from both the inflows and losses, although the evaporative loss from the Reservoir comes out of the amount of wet water available to the five counties to use.
- In early 2003, a team of Water Assembly and other experts was gathered to resolve the diversity of reported riparian/bosque acreage. That team recommended that a best estimate for the Rio Grande main stem would be 23,000 acres. At 3.0 afpy per acre, this comes to and estimated 69,000 afpy riparian consumption.
- In mid-2003, a team of Water Assembly experts was gathered to resolve the diversity of reported irrigated agriculture acreage. That team recommended a best estimate for the Rio Grande main stem would be 50 thousand acres of irrigated agriculture. At 2.1 afpy per acre, this comes to an estimated 105,000 afpy consumption by irrigated agriculture.

Figures ES-1 and ES-2 depict the inflows and outflows for the three-county water budget in a pie chart format.

6.1.4 The Five-County Water Budget

In 1999 the Water Assembly published the Middle Rio Grande Water Budget (Appendix B). Participants in the Water Assembly who called themselves El Grupo Técnico prepared this water budget, which was debated and accepted by the AC. The water budget was developed for the reach from Otowi gage to Elephant Butte Dam, a five-county region including Sandoval, Bernalillo, Valencia, Socorro, and Sierra counties.

Following are the five-county water budget numbers. This information is reflected in Figure 6-2.

- Incomes – 1,420,000 afpy
  - 1100 Native Rio Grande Inflow
  - 55 San Juan-Chama Inflow
  - 95 Tributary Inflow (Gaged)
  - 5 Albuquerque Storm Drain Inflow
  - 110 Mountain Front and Tributary Recharge
  - 40 Deep Groundwater Inflow
- Internal Flows
  - 170 Deep Aquifer Pumping (all wells) to Many Water Users
  - 70 Municipal Waste Water from Many Water Users to Surface Flows
  - 10 Septic Tank Return Flow from Many Water Users to Shallow Aquifer
  - 50 Deep Aquifer to Shallow Aquifer
  - 220 Discharge from Shallow Aquifer to Surface Flows
  - 295 Recharge to Shallow Aquifer from Surface Flows above San Acacia
- Consumptions – 625,000 afpy
  - 90 Consumption (evaporation) [residential industrial, municipal]
  - 60 Open Water Evaporation (above San Acacia)
  - 135 Riparian Evapotranspiration (ET, above San Acacia)
  - 100 Irrigated Agriculture & Valley Floor Turf (above San Acacia)
  - 100 Riparian Evapotranspiration, Irrigated Agriculture, and Open-water Evaporation (below San Acacia)
  - 140 Elephant Butte Evaporation
- Outflows – 850,000 afpy (at Elephant Butte Dam) Note: This is a calculated value that does not consider changes in storage in Elephant Butte Reservoir from 1972 to 1997. However, given the uncertainties in water measurements, the calculated value is within acceptable margin of error.

- Incomes less Consumptions and Outflows = Net Draw from Assets – 70,000 afpy

6.1.5 Sources for the Water Budget

Numerous contributors in El Grupo Técnico along with the AC concurred on the water budget's content. Data to create the water budget were drawn from many existing studies. Following are the contributors and their affiliation at the time the water budget was produced:

Kevin Bean, Consultant (public relations)
Lee Brown, Consultant (economics)
Cliff Crawford, University of New Mexico
Cliff Dahm, University of New Mexico
Gary Daves, City of Albuquerque
Doug Earp, City of Albuquerque
Norm Gaume, City of Albuquerque
Susan Gorman, Pioneer West
Jaci Gould, U.S. Bureau of Reclamation
Sterling Grogan, Middle Rio Grande Conservancy District
Bob Grant, Interstate Stream Commission Commissioner
Steve Hansen, U.S Bureau of Reclamation
Steve Harris, Rio Grande Restoration
Deb Hibbard, Rio Grande Restoration
Frank Jones, (then Bureau of Indian Affairs)
Andrew Kelton, Consultant (public relations)
Mike Kernodle, Consultant (hydrology)
Ed Korzdorfer, U.S. Natural Resources Conservation Service
Dick Kreiner, U.S. Army Corps of Engineers
Rob Leutheuser, U.S. Bureau of Reclamation
Andy Lieuwen, N.M. Office of the State Engineer
Karl Martin, U.S. Bureau of Reclamation
Jim McCord, Hydrosphere Consulting
Marty Mitchell, Weston Engineering Solutions, Inc.
Joe Quintana, Mid Region Council of Governments
Subhas Shah, Middle Rio Grande Conservancy District
John Shomaker, John Shomaker and Associates, Inc.
Gail Stockton, U.S. Army Corps of Engineers
John Stomp, City of Albuquerque
Frank Titus, NM Bureau of Geology and Mineral Resources
Jeff Whitney, U.S. Fish and Wildlife Service

In addition to the five-county water budget, the following studies constitute the best sources for information used in this plan. Executive Summaries from several of these studies are available in Appendix Series C.

Bartolino, James R. and James C. Cole. Ground-Water Resources of the Middle Rio Grande Basin, New Mexico. U.S. Geological Survey Circular 1222, 2002. (See Appendix C-3.)

S.S. Papadopulos & Associates, Inc. Middle Rio Grande Basin Water Supply Study. Prepared for the New Mexico Interstate Stream Commission and the U.S. Army Corps of Engineers, Albuquerque District, under contract no. DACW47-99-C-0012. Boulder, CO, August 2000. (See Appendix C-6.)

McAda, D.P. and Peggy Barroll. Simulation of Ground-water Flow in the Middle Rio Grande Basin Between Cochiti and San Acacia, New Mexico. U.S. Geological Survey Water-Resources Investigations Report 02-4200, 2002. (See Appendix C-2.)

Grissino-Mayer, H. "A 2129-year Reconstruction of Precipitation for Northwestern New Mexico, USA." Tree Rings, Environment and Humanity. Eds. J.S. Dean, D.M. Meko and T.W. Swetnam Radiocarbon: Tucson, AZ. 1996. 191-204.

Daniel B. Stephens and Associates. Assessment of Regional Water Quality Issues and Impacts to the Water Supply. Prepared for Mid-Region Council of Governments, Albuquerque, NM, 2003. (See Appendix C-11.)

6.2 Water Supply

This section presents the quantitative aspects of the wet water supply for the MRG Region. Detailed data and information concerning the region's water supply has been documented in several key studies which are listed above.

6.2.1 Surface Water

Surface water quantification appears in the five-county water budget (Action Committee 1999). The region has four sources of surface water. In addition, there is an ongoing return to surface flow of pumped ground water through sewage treatment, along with an ongoing exchange of water between the shallow aquifer and the surface water flow. A more detailed exposition of surface-water attributes appears in S.S. Papadopulos & Associates (2000) and in Bartolino and Cole (2002).

6.2.2 Ground Water

For ground-water details see the five-county water budget (Appendix B), Bartolino and Cole (2002), and S. S. Papadopulos & Associates (2000).

Another USGS study (McAda and Barroll 2002) details the ground-water situation for the region. In the past 40 years, ground-water pumping has increased throughout the region. As reflected in Figure 2-1, this pumping has lowered the water table in the Albuquerque region substantially, more than 120 feet in some locations.

6.2.3 Inflow and Outflow Water

The four major sources of surface water inflows to the region are native Rio Grande water, San Juan-Chama Project water, tributary inflow from Rio Puerco and Rio Jemez, and storm-drain inflow.

Figure 6-1 Water Budget External Inflows, Consumptions, and Outflows (Source: The Middle Rio Grande Water Assembly)

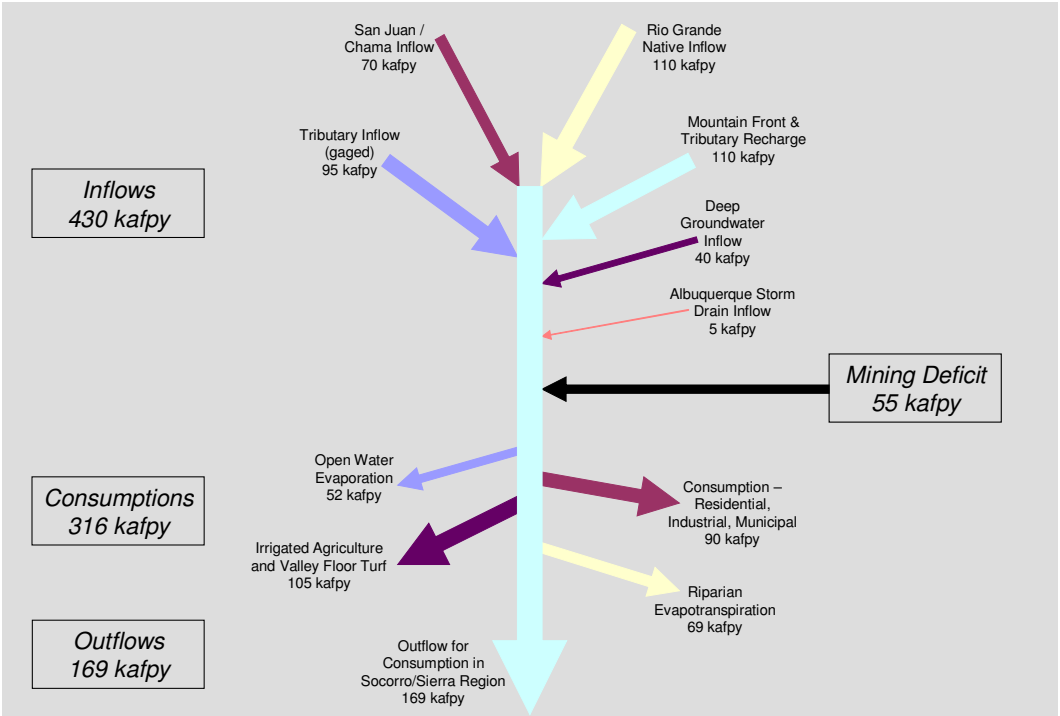


Figure 6-1. Water Budget External Inflows, Consumptions, and Outflows
Data Relative to the Three County Region; Averages for Last Quarter of the Twentieth Century
Water Delivered to Elephant Butte Reservoir Has Been Excluded from Both Inflows and Outflows

The five-county water budget reports 1,100,000 acre-feet average annual inflow of native Rio Grande water at Otowi Gage for the last quarter of the 20th century. According to a 2,200-year tree-ring study by Grissino-Mayer (1999), the rainfall at El Malpais during that quarter century was about a fifth higher than the average for the 22-century period (see Figure 6-3). This implies that extrapolation for the future from water budget data may yield an overly optimistic picture.

- During the same time, the region had an adjusted inflow of San Juan-Chama Project water of 70,000 afpy. That is the water that is delivered from the San Juan River in the Colorado Basin across the Continental Divide through a tunnel. That tunnel was constructed in the 1960s, and as a result of their investment in the construction project, the water from the project is contracted to various users along the Rio Grande. There is some concern that the full obligated deliveries might not continue to be available during coming periods.
- The five-county water budget estimates an inflow to the main stem of the Rio Grande from the Rio Puerco and the Rio Jemez of 95,000 afpy.

There are three destinations for surface water that flows out of the MRG Region, all sent downstream in the riverbed across the Socorro/Valencia county line. These destinations are: water for far downstream delivery at Elephant Butte Dam to New Mexico, Texas, and Mexico; water that evaporates from Elephant Butte Reservoir; and water that is consumed within the Socorro-Sierra Region above Elephant Butte.

- The five-county water budget cites 850,000 afpy as the analyzed delivery across the Elephant Butte Dam for the averaging period. The guidance from the ISC is that this 850,000 afpy amount of water from the MRG Region inflows and from its outflows should be excluded.
- The five-county water budget cites 140,000 afpy as the average evaporation from Elephant Butte Reservoir during the period. The guidance from the ISC is that this 140,00 afpy amount of water from the MRG Region inflows and from its outflows should be excluded.
- The five-county water budget cites 100,000 afpy as the average consumption in the Socorro-Sierra Region between San Acacia and the Elephant Butte Dam for irrigated agriculture, for riparian evapotranspiration, and for open water evaporation (other than at Elephant Butte). In comparison to the amounts in the MRG Region, the mining of groundwater in the Socorro-Sierra Region is negligible. The guidance from ISC is that this amount of water should be treated as an outflow from the MRG Region to the Socorro-Sierra Region.

6.2.4 Pump and Storage Water

According to the five-county water budget**,** an average of 170,000 afpy was pumped annually from the aquifers over the 1972-1997 time-period. This pumping includes water for urban domestic, commercial/industrial, and institutional uses, as well as rural pumping for domestic, agricultural, and mining purposes.

While the rate of increase has probably been reduced for the region, one must consider the 170,000 afpy average to be made up of lower values near the beginning of the time period and higher values near the end. This datum is for the five-county region. However, Water Assembly experts believe that the pumping in the Socorro-Sierra Region is negligible in comparison to the pumping in the MRG Region, and thus, the pumped water accrues to the MRG Region.

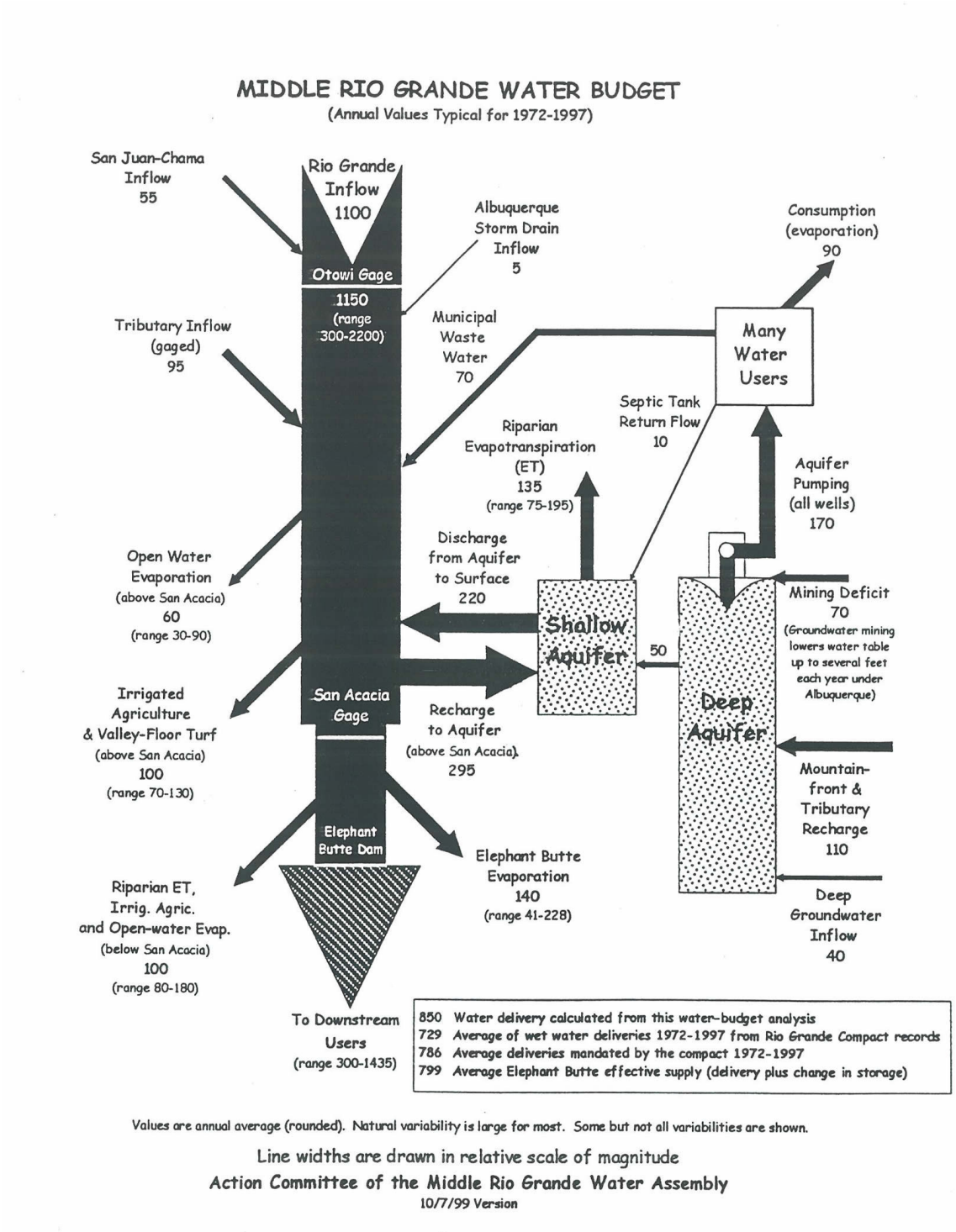
There is no current program in the region for aquifer storage and retrieval (ASR). However, Section 8.1.1, Aquifer Storage, discusses considerations of possible ASR programs in the future as a drought management tool.

6.3 Water Quality Issues

This section presents the qualitative aspects of the wet water supply for the region.

With ISC funds, under contract to MRCOG, and with technical oversight from the Water Assembly, Daniel B. Stephens and Associates (DBS&A) performed an Assessment of Regional Water Quality Issues and Impacts to the Water Supply (Appendix C-11).

Figure 6-2 The Five-County Water Budget for the Historical Period 1972-1997. This figure shows, after adjustment, a mining deficit of 55,000 afpy. The system budget deals with three water subsystems—surface, shallow aquifer, and deep aquifer (Source: The Middle Rio Grande Water Assembly)



- **Water Sources Quality Assessment**—Section 1 of the DBS&A report addresses contaminant impacts on water quality–those contaminants that are not naturally occurring in the water supply.
- **Identification of Sources of Contamination**—Section 2 of the DBS&A report addresses water quality issues relating to naturally occurring contaminants.
- **Assessment of Feasibility of Water Quality Management Plans**—Section 3 of the DBS&A report addresses a summary of water quality impacts on available water supplies.

6.4 Summary of Water Supply Considering Legal Limitations

The renewable water supply for the MRG Region fluctuates by a factor of two to three from the mean, and is on average 55,000 afpy less than demand for the last quarter of the twentieth century.

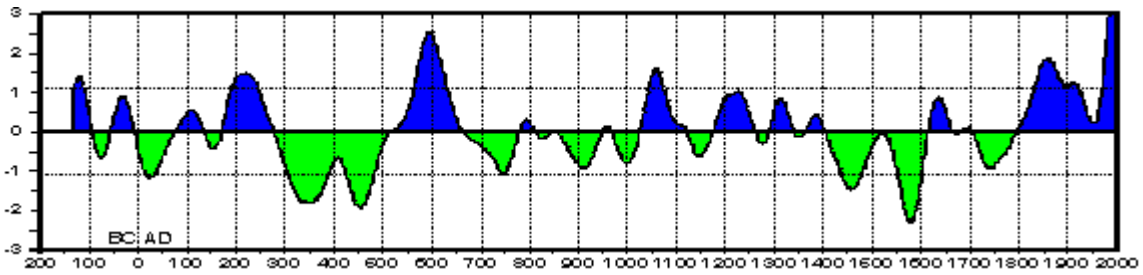
The approximate 17% deficit from renewable supply (deficit divided by consumption) is currently being made up by mining the aquifer. While there are clear limitations and consequences to continued aquifer pumping, that pumping does provide a significant contribution to the state's ability to meet its Rio Grande Compact obligations. It is the mission of this plan to balance use with renewable supply.

The City of Albuquerque's Water Resource Management Strategy is intended to move Albuquerque away from reliance on the aquifer towards a sustainable supply (CH2M Hill 1997). In order to consume its approximately 48,200 afpy of San Juan-Chama Project water, the City of Albuquerque has requested a permit to divert about 94,000 afpy from the river. Starting in 2006, the Albuquerque Drinking Water

Project is predicted to draw that 94,000 afpy of wet water from the Rio Grande for the city water systems. This will enable an initial 94,000afpy reduction (from an approximate 108,000 afpy) in the city's ground-water pumping from the aquifers into the surface-water subsystem. Over time, assuming no growth in overall urban consumptive demand, this reduced pumping will result in greatly reduced river effects from ground-water pumping.

For planning purposes, the Water Assembly foresees that urgent shortfall remedies will be necessary so that the Rio Grande Compact obligations continue to be met (see Section 9.3.2).

Figure 6-3 Rainfall and Culture over 2000 Years in the Four Corners area of New Mexico. Developed from wood found in El Malpais National Monument. (Source: Courtesy of Henri D. Grissino-Mayer)



Chapter 6 References

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