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Middle Rio Grande Water Budget: Present and Projected

S.S. Papadopulos & Associates, October 2006

This summary describes the water budget for the Middle Rio Grande region based on projections developed and reported in the Middle Rio Grande Water Supply Study, Phase 3 (S.S. Papadopulos & Associates, Inc., 2004). In this summary, the term *Middle Rio Grande region* refers to the portion of the Rio Grande and adjacent basin aquifers lying between the Otowi gage and Elephant Butte Dam. Located largely within this region are substantial portions of three regional planning entities: The Sangre y Jemez Planning Region (JySPR), the Middle Rio Grande Planning Region (MRGPR) and the Socorro and Sierra County Planning Region (SSPR). To avoid confusion with terminology, the planning regions identified above will be referred to using the acronyms noted. This summary describes the water budget as follows:

- A base case, representing present development conditions, but based on a wide range of potential climate/supply conditions patterned after the variability seen 1950-2002.

- Three future cases, targeted on representing 2040 conditions[1], assuming that various alternatives proposed by regional planning groups are implemented:

    - The MRGPR Alternatives
    - The SSPR Alternatives
    - Combined MRGPR, SSPR and JySPR Alternatives

This summary also discusses the budget summary and deficit information provided by the regional plan representatives at the Upstream-Downstream Workshops, conducted in 2006, as represented in their final regional plans, and compares these to the basinwide evaluation developed by SSPA in the 2004 Phase 3 study, in an effort to reconcile apparent differences. Finally, an implementation template is proposed.

Present Condition

The present condition water budget reflects the following:

- Water supply, or inflow, is based on the range of conditions that occurred between 1950 and 2002. This period is representative of long-term averages as seen in the paleo-climate record, and includes both wet and dry periods.
- Demand, or outflow, is based on water uses as of the year 2000. Stream depletions from groundwater pumping are as projected using the USGS model. Additionally, groundwater depletion not yet impacting the stream as of 2000 is calculated using the USGS model.

[1] The future projections provided by planning regions are not consistently referenced to 2040, although attempts have been made by SSPA to target this date to the extent possible using the materials provided by regions.

- Compact obligations are calculated according to the Compact schedule for a large number of potential supply conditions. Because of the non-linearity of the Compact schedule, a single value based on average supply conditions should not be, and was not, used.
- Downstream deficits are calculated as the residual, considering all reach inflows and outflows.

The water budget is solved probabilistically. Water inflows and demands are drawn from the range of likely values, given what we know about these terms. From analysis of a large number of water budget outcomes, with the various water budget terms selected according to their statistical distributions, the surface water deficit is calculated as a probability distribution, and from this, a mean value can be identified. The mean of each water budget term that is input or that represents the outcome of this process is shown schematically on Figure 1. This evaluation shows that the average surface water deficit at the bottom end of the reach (at Elephant Butte) is approximately 40,000 acre-feet per year. Additionally, there is a groundwater deficit of 71,000 acre-feet per year that will be transferred to the stream system in future years. The probability distributions from which these mean values were extracted are included in the SSPA 2004 report and can be inspected to better understand expected variability under a range of climate conditions. Table 5.3 of the report describes various flow terms from the probabilistic model for the Base Case in terms of average, 10^{th} and 90^{th} percentiles.

The surface water deficit as calculated from this process can be best described as an average, assuming the present conditions of development and water use, and under a wide range of potential variation in inflow, this latter term being based on historical conditions. This deficit has been somewhat loosely characterized as "Compact deficit" in the MRG Water Supply Study. However, as the Study notes, the Compact allows the accumulation of credits and debits – therefore, the occurrence of a deficit does not in itself constitute a Compact violation. However, if circumstances are such that a preponderance of deficits occur, year after year, Compact violation may occur.

Other points to consider in evaluating the results of this analysis:

- The analysis did not consider "minnow water" and associated impacts. In recent years, stored water has been purchased or otherwise acquired to assist in maintaining flow for the silvery minnow. This water, invoking minimal consumptive use, has served to bolster Compact deliveries.
- Other operation and management actions, beyond the scope of this discussion, have the potential to manage water for Compact deliveries.
- The demand terms in the water budget analysis are subject to a high degree of uncertainty; as are the responses in drought by water users, human and natural. These uncertainties lead to a question as to whether the deficit as modeled would actually occur, or whether adjustments, by necessity, are made that are not captured by in the analysis.

Regardless of the above qualifications, the water budget analysis demonstrates that the supplies to the basin are fully utilized. Furthermore, a deficit to groundwater is being accumulated that will enlarge the stream depletion term as time passes. Though some

refinement of the numbers may be expected in future years, the conclusion -- that there is an excess of demand over the supply-- is not expected to change.

The present water budget is related to sub-reaches that coincide, in part, with planning regions (Figure 1). On this figure, the inflow at sub reach points is indicated. These flow values reflect a calculation of water in the reach, minus the Compact obligation. Thus, they reflect amounts available for consumption by New Mexico upstream of Elephant Butte. The consumption in New Mexico includes evaporation from Elephant Butte Reservoir; hence, a significant amount of water in excess of beneficial use within Socorro/Sierra County must flow to this reach. The choice of whether to subtract Compact obligation and Elephant Butte evaporation at the top or bottom of the water budget reach has no bearing on the bottom line. The method utilized was selected simply to provide focus on the water that is consumptively used within the reach.

There is an inherent difficulty in identifying reach-specific or region-specific supply, because the Elephant Butte evaporation and the Compact obligation are a function of basin-wide operatives. There is presently no means of allocating a share of each of these to the intervening regions. Thus, any discussion of regional supply is necessarily open to interpretation, and, alternate planning assumptions. The identification of "inflow" at sub reach locations, as for example, is shown on Figure 1, is a representation of what remains to be consumptively used within the basin downstream. However, if sufficient inflow is not available, then a deficit at the downstream end of the system occurs. The water budget presently does not identify regional "goals" for delivery at sub-reach boundaries. However, using reasonable assumptions for beneficial water use as presently established within each region, and the unavoidable "other non-beneficial uses", such an exercise may be worth undertaking, though it would be surprising if regions could agree on sub-reach flow targets without great difficulty and controversy.

Projected Conditions under Regional Plan Alternatives

Regional plans have been developed in an attempt to reconcile, at the regional level, the supply and demand, based on projected future conditions. All three regions project population increases and increases in water uses, as noted below (planning periods and methods of reporting growth are not identically presented by the regions, the following is largely excerpted from the regional plans):

- Jemez y Sangre Planning Region: Population increase from 160,000 to 360,000 in the period 2000 to 2060.
- Middle Rio Grande Planning Region: Population increase of 1.5% per year, resulting in additional demands in 2050 of 95,000 acre-feet per year.
- Socorro-Sierra Planning Region: 70% growth in 40 years, reaching 60,000 persons in 2040.

SSPA has modeled the MRGPR and SSPR plans individually, and also, has modeled all three together. Report tables 5.2 and 5.5 describe the modifications made to Base Case assumptions to model these two plans separately. Report tables 5.4 and 5.6 show,

respectively, the various flow terms from the probabilistic model for the MRGPR and the SSPR plans, in terms of average, 10th and 90th percentiles. In both cases, the surface water deficit is reduced substantially, from about 40,000 to about 3,000 acre-feet per year. However, in some respects the plans overlap. Therefore a third projected case was evaluated, and also incorporating the impacts of the JySPR plan, with results summarized on Table 5.7 of the report. In this combined case, the projected mean deficit is about 7,000 acre-feet per year. This result, especially when considering model uncertainty, suggests that if the planning regions can implement the alternatives selected, that the MRG water budget can be balanced. However, apart from this finding which is referenced to the stream system and stream depletions manifested at the end of the 40-year planning period, one must not forget the groundwater deficit that has not been eliminated. At such point in time (in 2040) groundwater storage depletion is occurring at a level of 39,900 acre-feet per year, and growing. Thus, the overall water budget has not been balanced, with a total deficit of about 47,000 acre-feet per year, and, future trends continue to move away from a condition of sustainability. In summary, if all of the alternatives noted can be implemented, the basin "buys time", but the underlying problem of water use exceeding demand remains to be solved by planners in 2040.

An additional set of "drought" scenarios were developed to examine what the outcome might be if a preponderance of dry years occur in the future. These results are portrayed in table 6.2 for the Base Case and table 6.3 for the combined planning region alternatives. Assuming that the planning alternatives can be implemented, the 2040 stream system deficit is projected at 41,000 acre-feet per year, as opposed to the "normal" scenario described above with the deficit projected at 7,000 acre-feet per year. In the drought case, it is also worth note that not all agricultural lands can be served with adequate supply, and that the groundwater deficit continues as projected for the "normal" scenario. In reality, additional groundwater pumping may be a response to agricultural water shortage, further exacerbating the total debit.

The cases described above can be summarized in tabular form, as shown on p.106 of the Water Supply Study report, and reproduced below.

Compact Credit/Debit and Lagged Groundwater Pumping Impacts

Scenario	Year of Modeled Development Condition	Average Compact Credit/Debit (acre-feet per year)	Depletion of aquifer storage (acre-feet per year)
Base Case	2000	-39,600	71,000
MRGPR Preferred Scenario	2040	-2,700	39,900
SSPR All Alternatives C	2000	-3,000	71,000
Joint Alternatives	2040	-7,100	39,900
Drought Scenario	2000	-48,300	71,000
Joint Alternatives under drought	2040	-41,000	39,900

Although the regional plans provide future direction towards balancing the water budget, significant concerns regarding the feasibility of the alternatives have been raised. Most notably:

- the joint plans rely on water reclamation from native bosque restoration on over 50,000 acres of land;
- retirement of 25% of the irrigated acreage between Cochiti Dam and the Valencia-Socorro county line, with no demands incurred on those lands once they have been retired;
- draining of 40% of the exposed portion of the northern part of Elephant Butte reservoir, and elimination of any riparian growth on this area; and,
- importation of 22,500 acre-feet per year of desalinated water from other basins.

Feasibility studies, resolution of legal and environmental issues, and implementation of the alternatives may take many years; thus, without immediate movement towards implementation, it is unlikely that these goals will be met within the assumed timeframes.

Differences between the SSPA Projections and Regional Projections

There are several reasons why some of the numbers presented in the regional plans do not match the SSPA numbers. Reconciliation of all differences would require that the planners and SSPA coordinate regarding assumptions, definitions, and accounting methodology. Although significant efforts at coordination occurred during the development of the regional plans and the MRG Water Supply Study, all parties were operating with "draft" numbers, hence, moving targets, during that period. As collective knowledge evolves, continuing coordination is recommended to address the various differences. Nevertheless, some specific remarks are provided herein as may be helpful in understanding why there are differences:

- The MRGPR utilized a base hydrologic period from 1972 – 1997; these years were wetter than average, hence, inflows larger than presumed in the SSPA study;

- The SSPR attempted to utilize the same data as SSPA, however, due to deadline pressures, SSPA draft budget terms were utilized by SSPR – these numbers were subsequently updated with new information obtained by SSPA.

- The SSPR water budget reflects the basin-wide deficit to the stream system (but not with respect to the groundwater system). For this reason (along with other non-similar assumptions between the two regions) one can not add the MRGPR calculated deficit to the SSPR calculated deficit to obtain a basin-wide deficit.

Building a Joint Planning and Implementation Template

Balancing the water budget at the regional and basin levels will require the continuation of planning and monitoring of implementation, with coordination among regions. Drawing from the joint analysis in the MRG Water Supply Study, a simple accounting template can be prepared, expanding on the table below, breaking the identified goals into regional columns for "targets" and "% achieved". An additional column for projected groundwater deficits, and total basin deficits would be advisable, so as to not ignore the groundwater component. With such an accounting scheme, it would be a relatively simple exercise to track progress on the basin scale, conducting "runs" to see how well the plan was tracking with respect to balancing the budget.

Term	Modification from Base Case model
Utilization of additional SJC and water-righted native water in JySPR	New demand term of 19,730 af/year
Section 1 Inflow from desalination	New inflow term of 22,500 af/year
Section 1 Wastewater returns	107,119 af/year
Section 1 Groundwater pumping depletions	79,285 af/year
Section 1 Municipal Surface Water Withdrawals	89,000 af/year
Section 1 2000 to 2040 additional M&I demands outside Albuquerque	31,556 af/year
Section 1 Agricultural CU	Reduced by 37,511 af/year from Drought Scenario
Section 1 Riparian ET	Reduced by 17,000 af/year from Drought Scenario
Section 3 Agricultural CU	Reduced by 2,768 af/year from Drought Scenario
Section 3 Riparian ET	Reduced by 37,800 af/year from Drought Scenario
Section 3 Open Water Evaporation	Reduced by 1,649 af/year from Drought Scenario
Elephant Butte Evaporation	No change to Drought model distribution

In concept, the implementation template is simple. However, due to the fact that some changes are additive, whereas others are dependent on certain other conditions, and, that there are numerous ways to handle terms and assumptions, the exercise will require evaluation and coordination among technical representatives. The development and maintenance of such a template with specific regional input would require continuing collaboration among the regional planner's technical team and a "basin" technical representative, to consolidate input, reconcile assumptions and terminology, and, to prepare an initial basin-wide implementation template. Ideally, the initial implementation plan would be subject to periodic review and modification, as feasibility studies are developed and implementation begins.

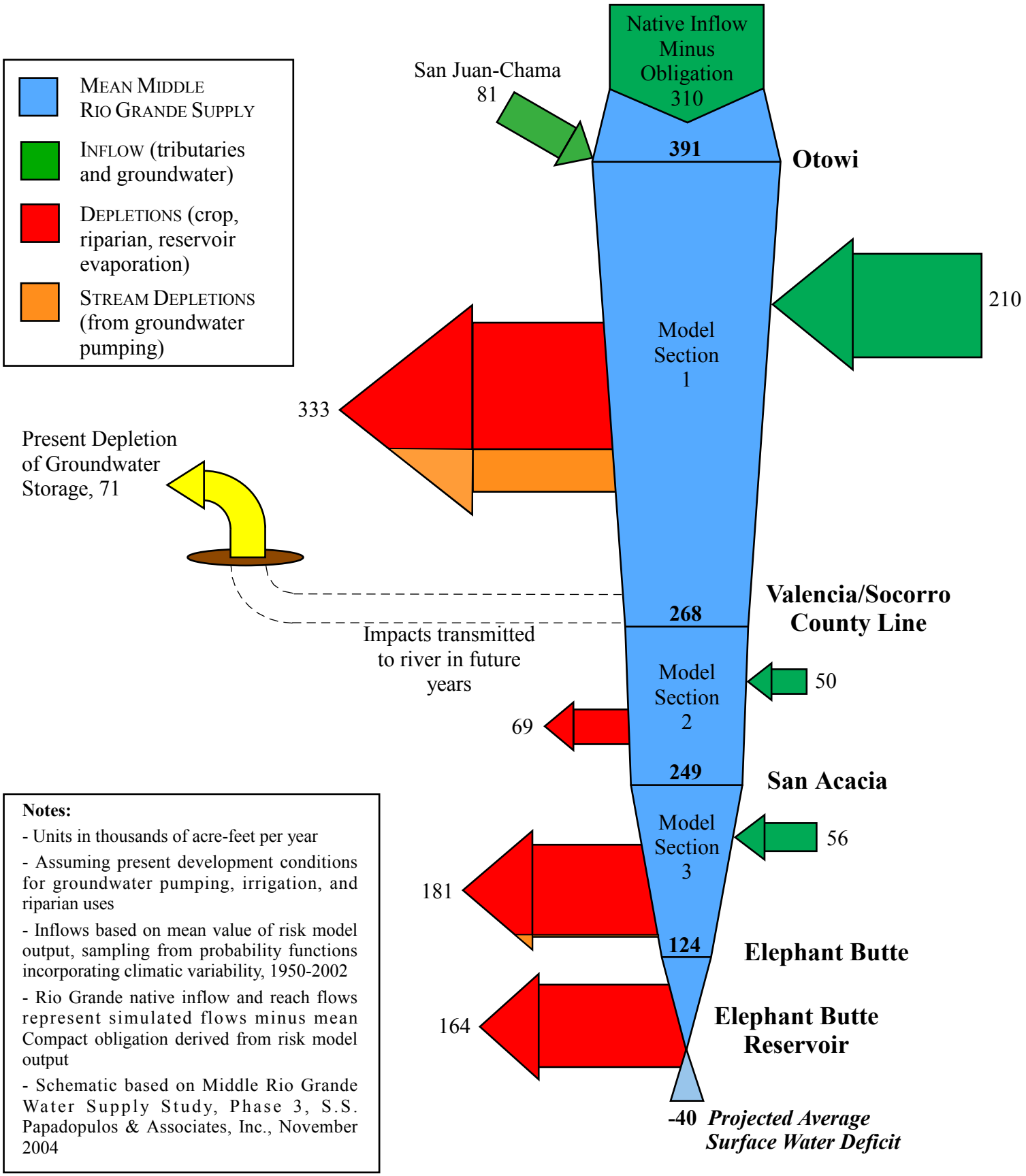
The following steps are proposed:

- Convene an initial set of meetings for technical representatives of each region and the state, to prepare an initial, or, strawman, implementation template; and to identify additional needs, for example,
    - Update of specific water budget inputs based on new data, i.e., climate change projections, or improved consumptive use or acreage estimates;
    - Identify additional needs, for example, sub-basin allocation goals (clearly, a difficult topic, and not one to be *solved* by a group such as this, regardless, an initial attempt would be instructive and helpful to this process)
- Develop a plan with schedule for periodic review of implementation, to allow for identification of actions in progress, or completed, and consequent adjustment of the basin-wide water balance,
- Determine, through consultation with NMISC and NMOSE, perhaps others, how to best integrate the regional planning efforts with state efforts and resources.

References

S.S. Papadopulos & Associates, Inc., 2004. **Middle Rio Grande Water Supply Study, Phase 3**. Prepared for the U.S. Army Corps of Engineers and the New Mexico Interstate Stream Commission. Available at:
http://www.ose.state.nm.us/isc_planning_mrgwss.html

Figure 1
Mean Annual Middle Rio Grande Water Budget, Year 2000
(referenced to stream system)



Notes:

- Units in thousands of acre-feet per year
- Assuming present development conditions for groundwater pumping, irrigation, and riparian uses
- Inflows based on mean value of risk model output, sampling from probability functions incorporating climatic variability, 1950-2002
- Rio Grande native inflow and reach flows represent simulated flows minus mean Compact obligation derived from risk model output
- Schematic based on Middle Rio Grande Water Supply Study, Phase 3, S.S. Papadopulos & Associates, Inc., November 2004