Regional Water Budget Model: The Middle Rio Grande

Bruce Thomson, The University of New Mexico

Bruce Thomson will be retiring from the University of New Mexico where he is a Regent's Professor in the Department of Civil Engineering at the University of New Mexico and is Director of the UNM Water Resources Program. He has a BS degree in civil engineering from the University of California at Davis, and MS and PhD degrees in environmental science and engineering from Rice University, Houston, TX. Bruce teaches in the areas of water chemistry and treatment, ground water hydrology and remediation, and water resources management. Recent research has included projects on water resources of New Mexico, the impact of energy and mineral development on water resources, and water reuse and treatment. He has served on many federal, state and local committees involved with management and protection of water resources. Bruce was recently elected to the Board of Directors of the Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA). He is a licensed Professional Engineer in the State of New Mexico and received the 2013 New Mexico Public Sector Engineer of the Year award.

Editor's Note: Audio was not available for transcription of this presentation. We have provided instead Bruce Thomson's presentation slides.

- Bruce Thomson (Chair) – UNM
- Jesse Roach – SNL/TetraTech
- Dagmar Llewellyn – USBOR
- Dave Jordan – Intera
- Nabil Shafike – NM ISC
- Elaine Hebard – MRGWA

- With input from John Fleck (Abq. Journal), Howard Passell (SNL), John Stomp (ABCWUA)

Figure 1. MRGWA water budget task force members.

- A quantitative analysis that shows:
  - All sources of water to a basin (i.e. control volume)
  - All sinks of water from the basin
  - How water moves through the basin
- A basin is in balance when the sources and sinks of water are equal
  - What time period should be used for determining balance (see following comments about averaging)?

Figure 3. What is a water budget (water balance)?

- The Middle Rio Grande Water Assembly (MRGWA) prepared a water budget for the Middle Rio Grande (MRG) to support Regional Water Plan (www.waterassembly.org)
  - Published in 1999
  - El Grupo Technico let by Frank Titus Ph.D.
- Renewed interest in water planning gave the Assembly incentive to update the plan.
- Frank Titus was again asked to lead the effort. Leadership subsequently assumed by Bruce Thomson

- Objective of this presentation is to describe process & preliminary conclusions.
  - Note: This report is still in DRAFT FINAL form. Comments & suggestions are welcome

Figure 2. Introduction and objectives.

- MRGWA (1999)
  - Volunteer effort
  - Based on 25 year period of record, 1972-1997
- S.S. Papodopolus & Associates (SSPA, 2004)
  - Culmination of multi-year study for NM Interstate Stream Commission
  - Included consideration of statistical variability
  - Based on 50 year period of record, 1950-1999

Figure 4. Two notable previous water budgets.

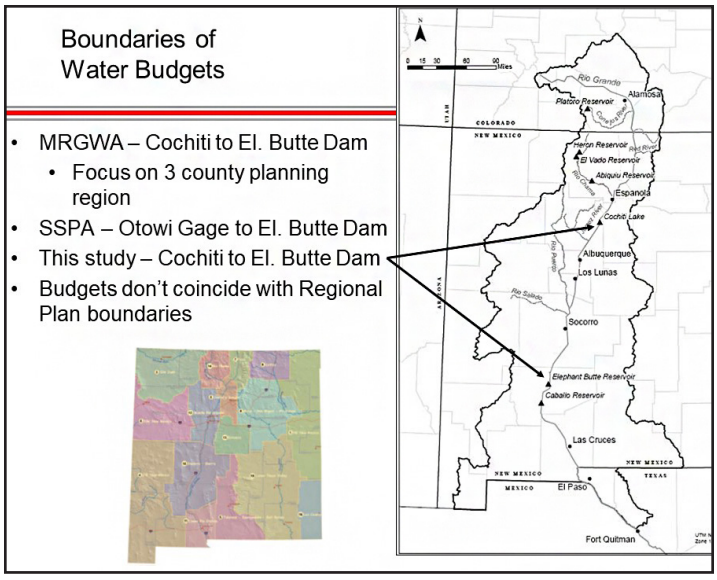

Figure 5. Boundaries of water budgets.

- There is no such thing as an "average year" hence obvious strategy is to average over period of years
- Previous budgets were based on averaging over long period of record. MRGWA – 25 yrs, SSPA – 50 yrs
- Problem with this approach:
  - How many years represent an appropriate average?
  - Difficult to identify long term trends from long term average
  - Difficult to capture changes in use or management such as SJC diversion, new reservoir (i.e. Cochiti) new management strategies (i.e. conservation)
  - Different response times for surface water & ground water
    - Ground water pumping may not affect surface water for decades

Figure 6. The problem with averaging.

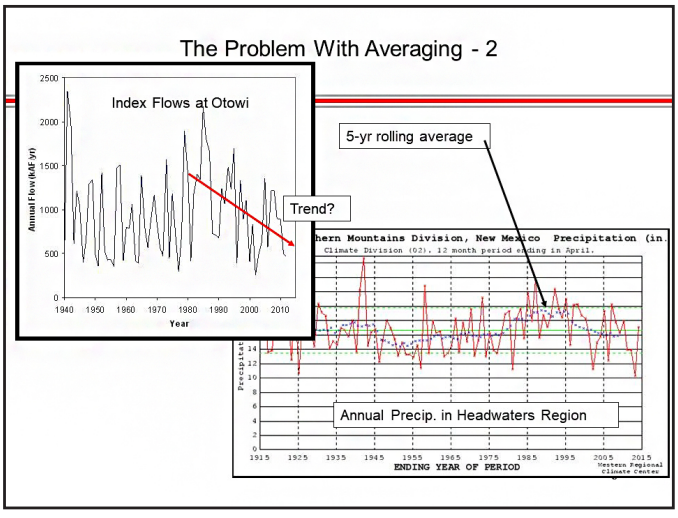

Figure 7. The problem with averaging (cont.).

Location	Period of Record[1]	Average Annual Flow (kAF/yr)	Q_{10}[2] (kAF/yr)	Q_{10}/Q_{avg}
Rio Grande near Cerro, NM	1949-2011	325.4	106	0.33
Rio Chama near Chamita, NM	1971-2011	413.2	214	0.52
Rio Grande at Otowi Bridge, NM[3]	1940-2012	951.0	410.8	0.43
Rio Grande at Albuquerque, NM	1974-2011	944.9	436.5	0.46
Rio Grande below Elephant Butte Dam, NM	1917-2011	718.5	422	0.59

[1]Period of record used in this analysis.
[2]Q_{10} is annual low flow that has a 10% chance of occurrence.
[3]Flows at Otowi Bridge are the Rio Grande Compact Index Flows (i.e. doesn't include SJC water)

Tributary	Drainage Area (mi^2)	$Q_{average}$ (kAF/yr)	Q_{10} (kAF/yr)[1]	Period of Record
Conejos River, CO	821	66.7	48	1953-2011[2]
Costillo Creek, CO	200	11.2	0.4	1966-2011
Red River, NM	185	56.7	33.7	1979-2011
Embudo Cr, NM	305	59.5	19.6	1924-2011
Rio Chama, NM	3,159	413.2	214	1971-2011
Galisteo Creek, NM	670	7.4	2	1942-1970
Jemez River, NM	1,038	43.1	13.9	1944-2011
SWRP - Albuq., NM[3]		59.6		2002-2011
Rio Puerco, NM	6,057	28.9	8.5	1941-2011
Rio Salado, NM[1]	1,394	10	0.9	1948-1984

[1]Q_{10} is annual low flow that has a 10% chance of occurrence.
[2]Data from CO Dept. of Water Resources CONPLACO gage
[3]Southside Water Reclamation Plant, Albuquerque, NM

Figure 8. The problem with averaging (highly stochastic system).

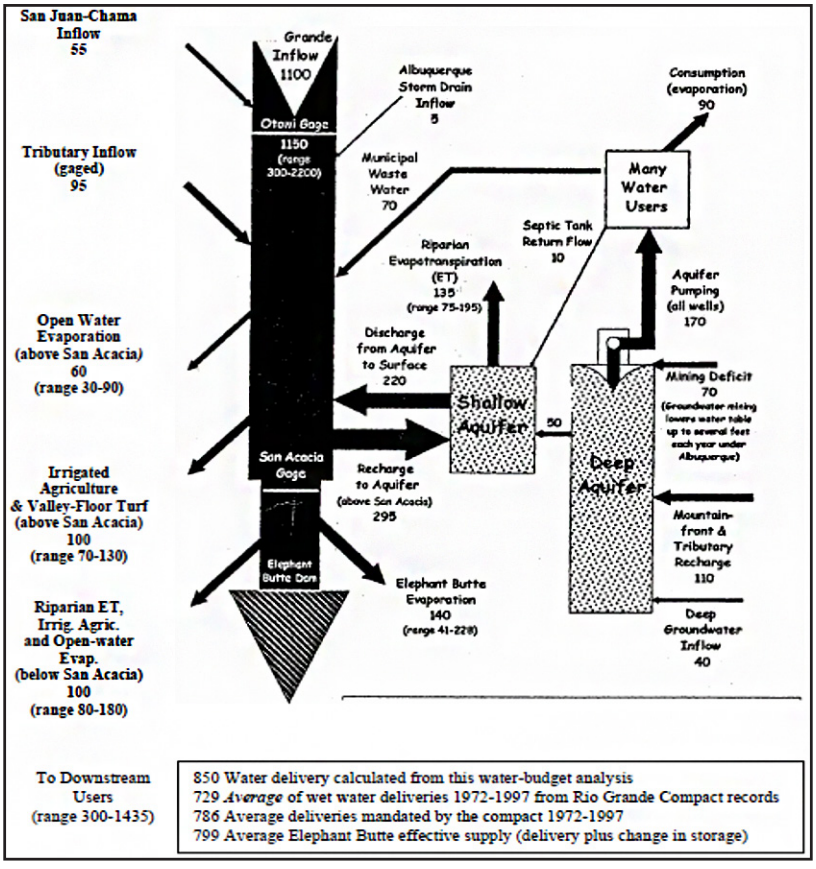

Figure 9. MRGWA water budget-wiring diagram.

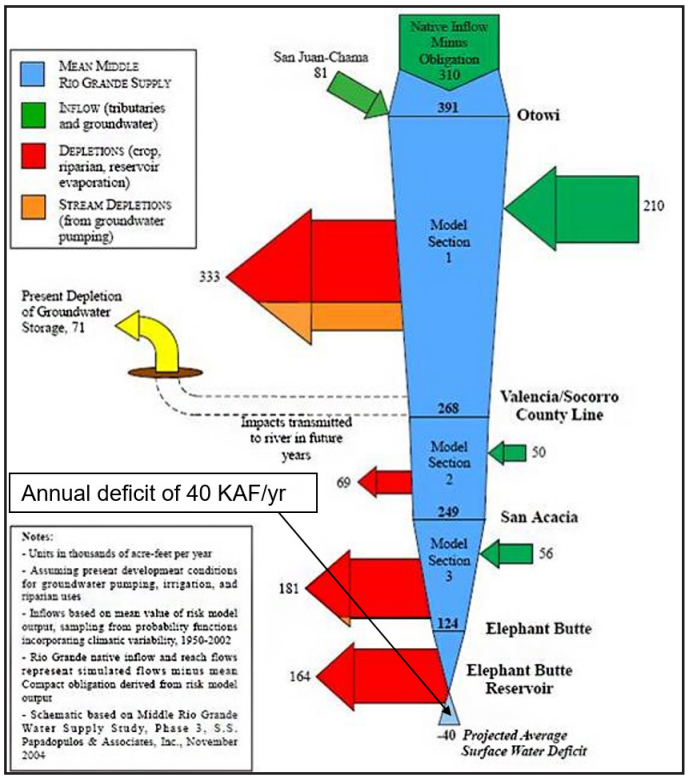

Figure 10. SSPA water budget by proportional flows. Budget for avg. conditions in 2000.

Figure 11. MRGWA 2014 water budget update.

Used URGSiM (USBOR 2013, Appendix E) – System dynamics model developed by SNL, especially Jesse Roach (now at Tetra Tech)

- Used in this study for monthly accounting – not forecasting
- Updated to include hydrologic information through 2012
- Allows calculation of flows that are difficult/impossible to measure including: ET, ground water recharge, evaporation

Considered 3 time frames:

- 1975-1997 – similar to MRGWA (1999) budget
- 2000-2012 –period that more closely resembles "average" precipitation & flows
- 2008-2012 – includes changes due to: 1) ABCWUA SJC diversion, 2) record drought

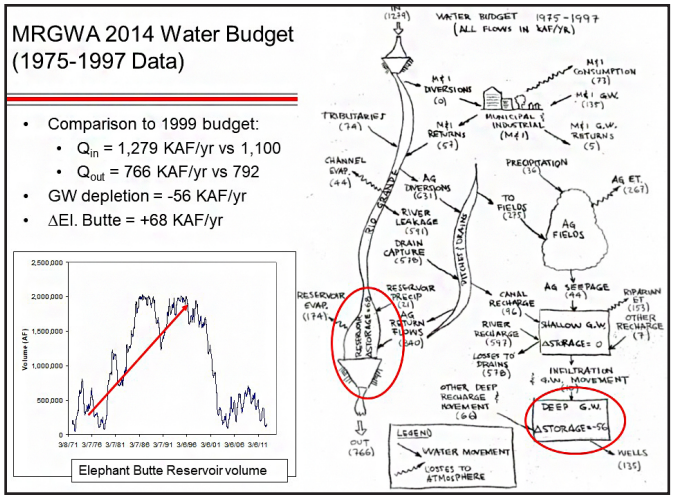

Figure 12. MRGWA 2014 water budget (1975-1997 data).

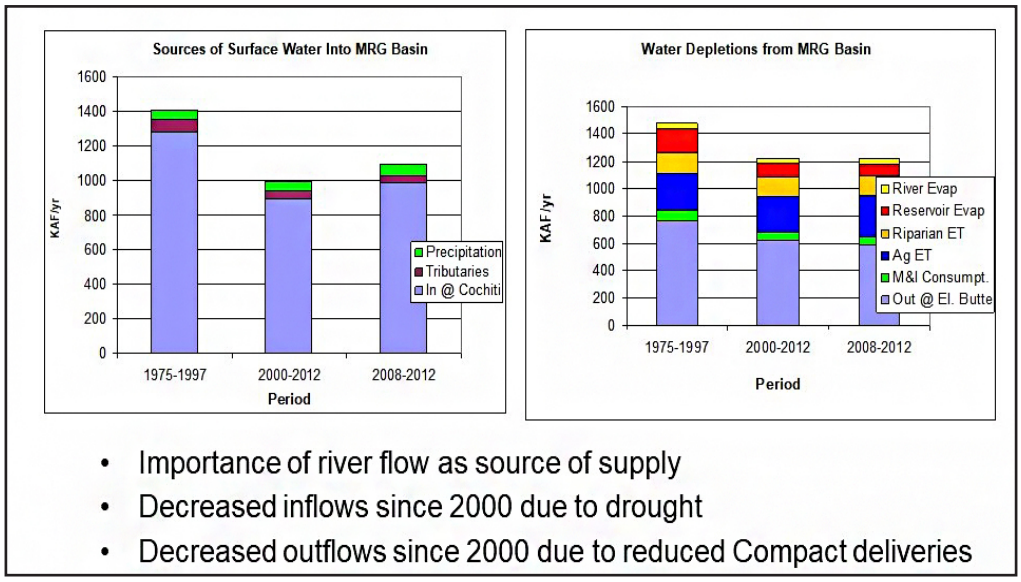

Figure 13. Changes over three budget periods.

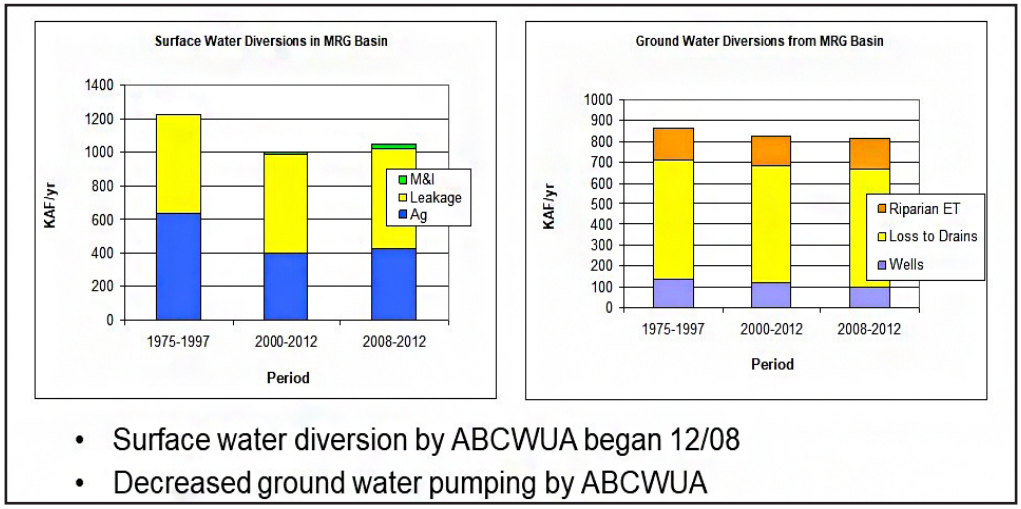

Figure 14. Changes over three budget periods (cont.).

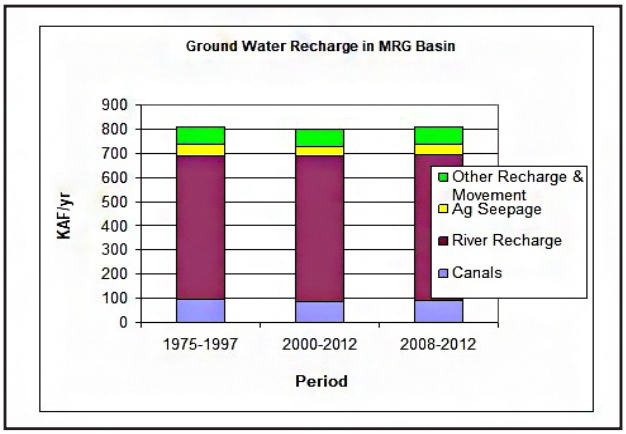

Figure 15. Little change in groundwater recharge over three budget periods.

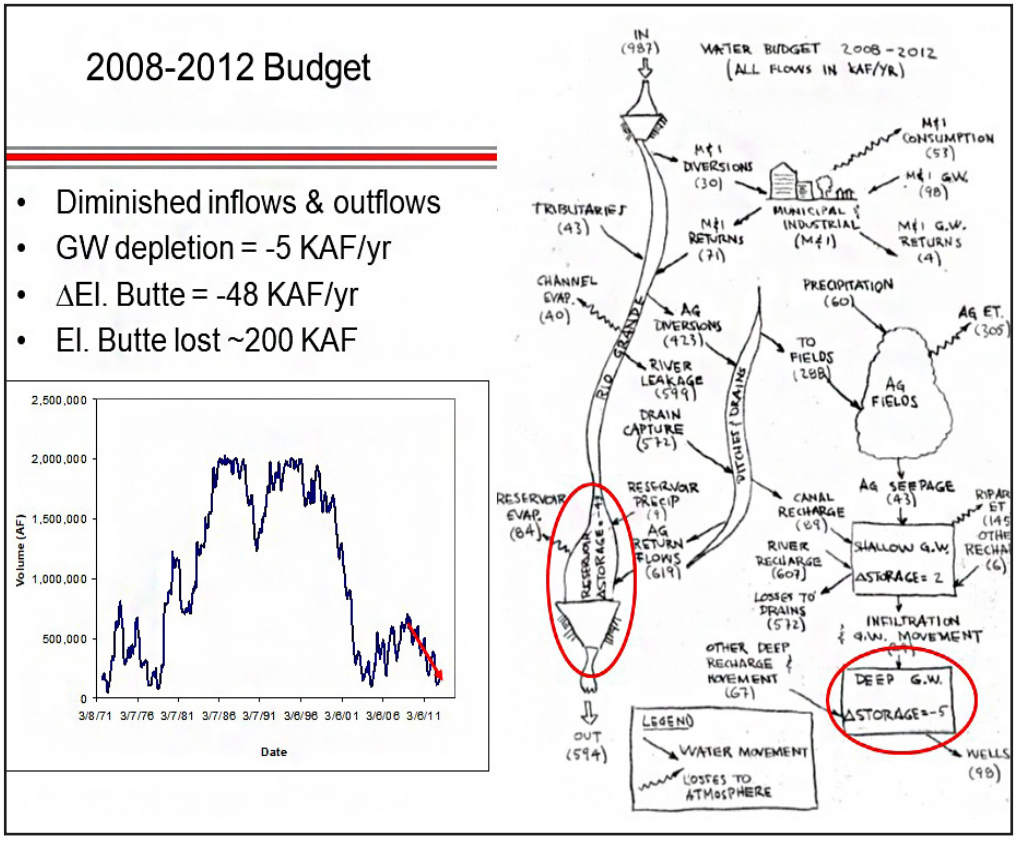

Figure 16. 2008-2012 budget.

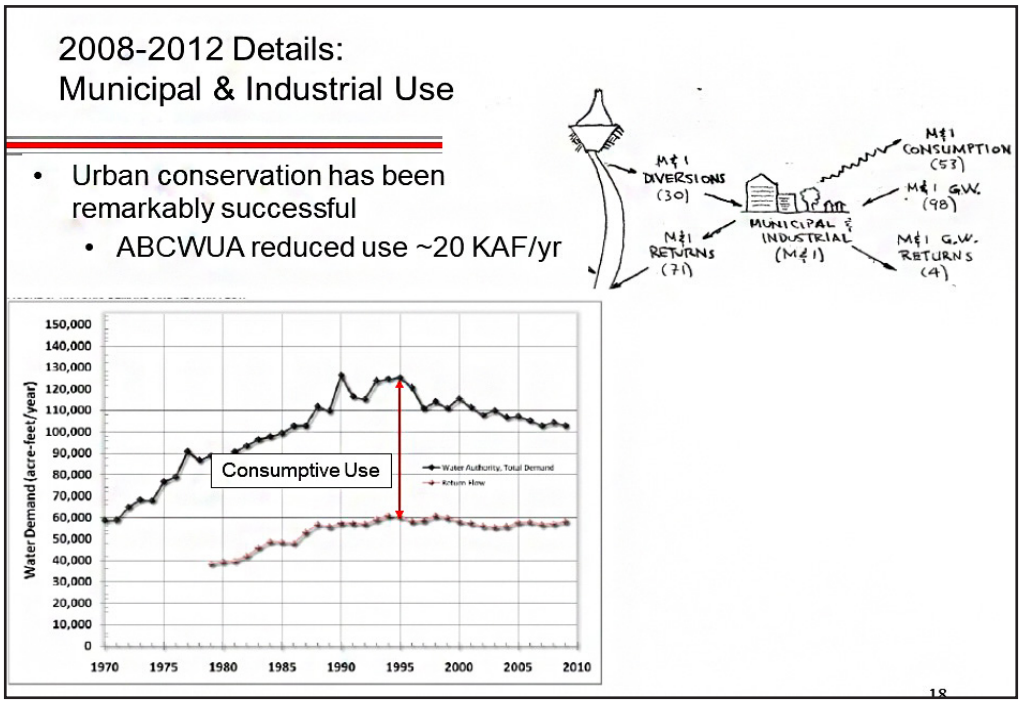

Figure 17. 2008-2012 details: municipal and industrial use.

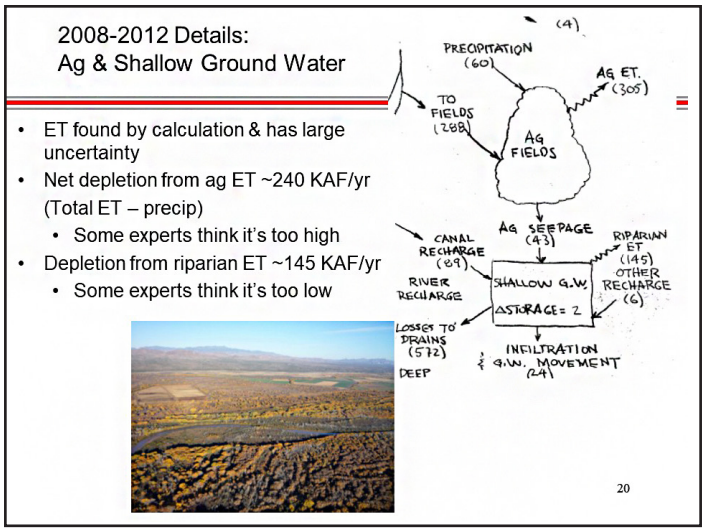

Figure 18. 2008-2012 details: ag. and shallow groundwater.

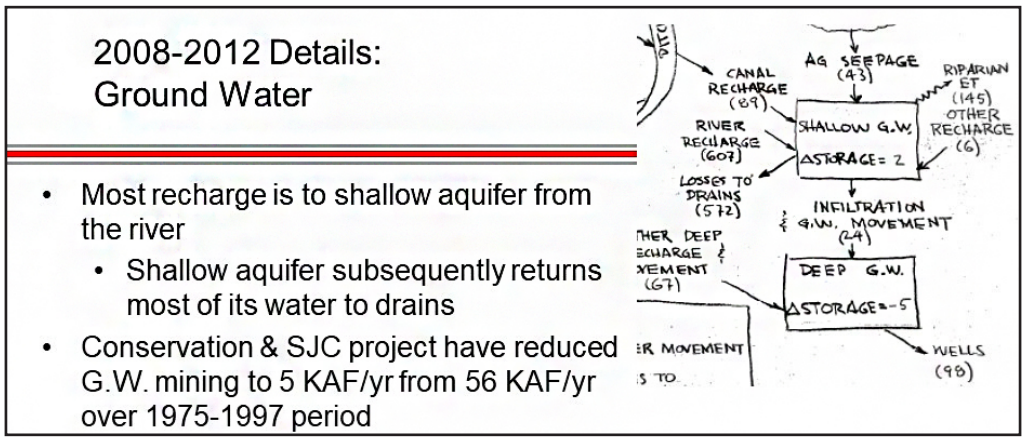

Figure 19. 2008-2012 details: groundwater.

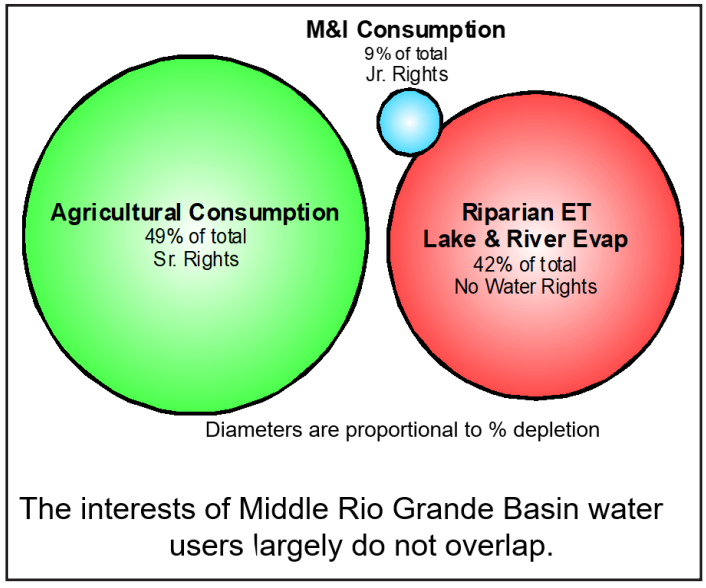

Figure 20. The MRG water problem as a venn diagram.

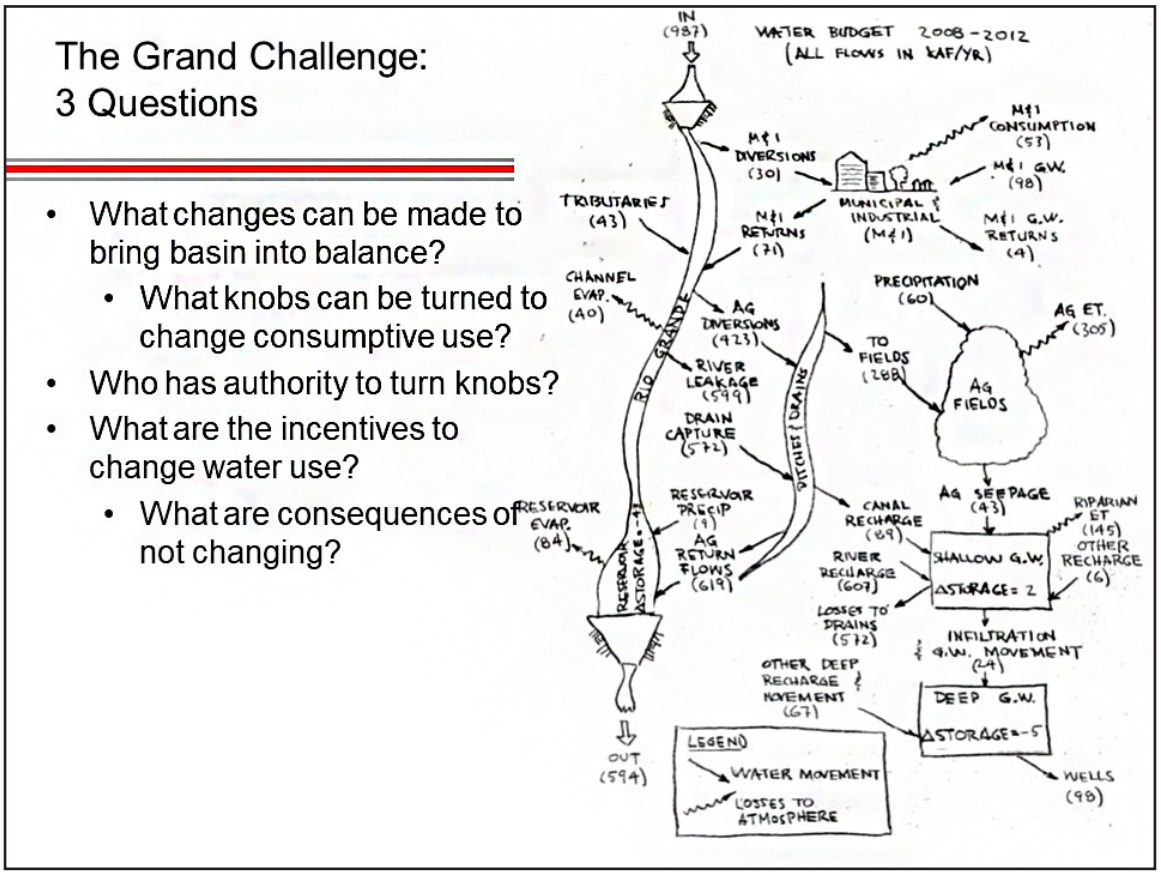

Figure 21. The Grand Challenge: three questions.

- Water budget hasn't changed much in past 15 years within resolution of the calculations
  - Biggest uncertainties are in ET losses
  - Remarkable success for urban conservation
  - Basin is still out of balance ~40-50 KAF/yr
- Effects of drought principally manifested as reduced river flow
  - Little change in consumptive use
- Wiring diagram shows complexity of system
- Water budget exercise raises 3 questions:
  - How can we bring basin into balance?
  - Who can make changes?
  - What are incentives for balancing basin?

Figure 22. Concluding thoughts.