MIDDLE RIO GRANDE WATER ASSEMBLY
POST OFFICE BOX 25862 ALBUQUERQUE, NM 87125-5862 505.454-0555

Submission to the Steering Committee

for the

Middle Rio Grande Regional Water Plan Update

Update - June 27, 2015

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Part One

Submission Cover Letter

MIDDLE RIO GRANDE WATER ASSEMBLY

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June 27, 2015

Ron Brown, Chair
Steering Committee for
The Middle Rio Grande
Regional Water Plan Update

Dear Mr. Brown:

This is a replacement update of the Water Assembly submission on June 9, 2015. The aggregate content is substantially the same. We have fixed some minor errors and rearranged the material so as to make it easier to understand. Our recommendation is that the package be included as a part of the Steering Committee's official report package to the New Mexico Interstate Stream Commission at the end of June, 2015.

The package now consists of six parts (instead of the previous four):

This submission cover letter is the **first part** of the package and contains a very brief indication of what's included in the package.

The **second part** of the package contains a set of ten guiding principles for the Regional Water Plan Update that was presented by the Water Assembly. I understand that the Steering Committee concurred with these guiding principles during one of its very early meetings. This part is unchanged from June 9.

The **third part** of the package presents a set of key Regional Water Planning Considerations or driving forces for the update. These were drawn from our presentation to the Steering Committee on March 3, 2015and the "Water Issues to Be Addressed" part from June 9.

The **fourth part**, also drawn from the June 9 "Water Issues to Be Addressed," enumerates a set of future strategies (Projects, Programs and Policies) that should be addressed through the future course of MRG regional water planning update.

The **fifth part** of the package is a detailed explanation of several Middle Rio Grande technical data issues and problems that have not but should be addressed through coming months/years of the Regional Water Plan update process. These were circulated to the Steering Committee some weeks ago. This is the same document as June 9 Part three, except that strategies and considerations have been moved out into the new parts three and four..

The **sixth part** of the package is a six-page summary of the Sixteenth Water Assembly. Because climate disruptions are observable, the Assembly held a public convocation to discuss five different consequences. The meeting topic was "Climate Disruption and Our Water Future: Mitigate Adapt or Suffer – A Call for New Strategies". Speakers focused on addressing where more adaptive capacity is needed, whether current policies facilitate or impede adaptation, what types of system changes we might devise, and what types of lifestyle or social changes might be needed. That public meeting convocation on March 21, 2015 was attended by nearly 100 people. This part in unchanged from June 9

Going forward - As the Regional Water Plan Update process continues in the coming months, the Water Assembly intends to map the content of these documents and the recorded Sixteenth Water Assembly audience notes into a recommended family of policies and associated actions that, if implemented, should go a long way in improving the Middle Rio Grande Region's water future.

As background, the Water Assembly is an all-volunteer non-profit 501(c)3 corporation established in 1997 to promote and perform regional water planning through an open, inclusive and participatory process. Our region is the complex three county area surrounding Albuquerque, New Mexico (Sandoval, Bernalillo and Valencia Counties). We maintain our diversity of interest, beyond that of the Steering Committee, by organizing ourselves into six advocacy groups: Agricultural Business and Production; Cultural and Historic Water Use; Environmental Preservation and Improvement; Industrial, Institutional and Business; Residential Water Use; and Technical Specialties.

In partnership with the Middle Rio Grande Council of Governments (now called MRCOG), we led the seven year effort leading to the 2004 Regional Water Plan for the three-county area. With volunteer expert hydrologists and others, we developed a regional water budget that showed a substantial annual deficit in our spending of water (consumptive uses far exceeding renewable supplies). With the water budget as a firm technical basis, the water planning included conduct of more than 100 public meetings across the 4000 square mile region, 100 briefings to public agencies, 500 Water Assembly team meetings and 60 meetings with the MRGCOG Water Resources Board. It included over 30,000 Water Assembly volunteer hours, managing $1.2 million in state, local government and private funds for extensive analysis studies and computer modeling. The publicly developed Regional Water Plan was accepted by all 20 local governments in the region and by the New Mexico State's Interstate Stream Commission.

In the years since the Plan was accepted, we have been working to encourage effective implementation of its 43 recommendations. We've conducted annual public convocations regarding sensitive and controversial water issues. We have also conducted public informational water forums on current topics such as desalination, aquifer storage and retrieval, and climate adaptation

In Summary - We appreciate the work being done by the Steering Committee, and its consideration of ongoing inputs from the Water Assembly, including this package. While not being an official member of the Steering Committee, the Assembly has participated in every Steering Committee meeting, preparing notes, presenting information, and answering questions. Over the years we have learned that effective regional water planning is a tough challenge. Our water issues are large, multi-faceted, and deeply rooted. We believe it is important to acknowledge the difficulties and address them head-on.

Respectfully Submitted,

Bob Wessely, President

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Part Two

Guiding Principles

Guiding Principles for Updating Our Regional Water Plan

February 13, 2015 Draft
MRG Water Assembly
Courtesy John Brown, adapted from his essay on governing water like a commons

Planning should begin with a set of guiding principles. The following suggestions come from the experience of the past regional water planning efforts here in the MRG.

1. Regional water planning requires an open, public and participatory process to engage as many residents and diverse interests as possible, all of whom are stakeholders. Respect for the rights of senior owners must be maintained in all deliberations and decisions.
2. Trust is gained among parties with divergent interests through repeated face-to-face interactions. The MRG region's steering committee (SC) should aim to be as inclusive as possible. Outreach efforts should be extensive, not perfunctory.
3. The SC should, early in its work, revisit the public welfare statement in the existing RWP, with a view to establishing a collective understanding, even if imperfect, of elements of a desired future for the region. These would constitute benchmark standards against which proposed policy changes, programs and projects should be judged.
4. Honor should be given to the current RWP, developed over seven years with extensive input and money. It contains over 40 recommended strategies in several categories which were evaluated for various feasibilities in accord with the RWP Handbook. They should be treated as a baseline – accepting, adding to, revising, or deleting them as needed.
5. The SC should identify the driving forces for this Update. What was dealt with insufficiently in 1997-2004 and what has changed since 2004 that affects our water future? After identifying such issues, the SC should consider how to draw public attention to them.
6. New strategies are likely to be proposed as a result of work by the SC, the Water Assembly, Public Meetings and others to address climate change impacts, new understandings about variability, etc. A challenge will be to determine how such information and data, which might require new strategies, or emphases, is incorporated in the Update.
7. Implementation will require coordinated action among many parties. What approval and implementation processes should be used to accomplish the goals of the Plan? To assure benefit and follow through, it will be necessary to create a framework for the evolution of rules over time.
8. One way to build trust would be to share data, developing a regional water budget to show where the problems are and the ramifications of addressing those problems.
9. The plan should contain a means for monitoring and measuring the progress of water delivery and management agencies in achieving its goals. The challenge will be to determine how this monitoring and evaluation will be accomplished, enabling future changes in policies or strategies if goals are not being met or require changes.
10. Although it may be tempting to jump straight to identifying and justifying infrastructure projects, participants must remember that such projects are a product, or outcome – rather than a driving force – of the planning process.

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Submission to the Steering Committee

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June 27, 2015

Part Three

RWP Update Considerations

Middle Rio Grande Regional Water Plan Update
Key RWP Update Considerations

When the MRG RWP was presented to the ISC in August 2004, it was also given a list of unresolved issues in the region. On March 3, 2015, Bob Wessely gave a presentation to the MRG RWP Steering Committee which included this list together with other update considerations. Issues included "Coordination of Actions," "ESA Requirements" and "Lack of Completed Adjudications." More than ten years later, those issues have not been resolved. Several issues were also presented by the ISC team in January, including "Compact compliance" and "Already permitted water rights requiring water right transfers for offsets." Below are the two presentation lists.

I. Presentation of March 3, 2015

A. List of Unresolved Issues (Copied from presentation to ISC, August 2004)

1. Primarily Local Issues

- Inter-Jurisdictional Coordination of Actions (intra- and multi-level)
- Public/Political Support for Making Difficult Choices/Decisions
- Economic and Wet Water Impacts from Water Rights Transfers
- Export/import to/from Other Regions
- Shortage of Local Resources to Implement Needed Actions

2. Primarily State and/or Federal Issues

- Means to Resolve Impending Rio Grande Compact Shortfall
- ESA Requirements (e.g., silvery minnow, willow flycatcher)
- Ambiguity of Native and Non-Native Americans' Water Rights
- Lack of Completed Adjudications
- Fundamental Policies such as Domestic Wells, Use It/Lose It
- Appropriate Methods/Constraints for Transferring Water Rights
- Authorization for Albuquerque Drinking Water Project
- Funding Mechanisms for Local Plans and Projects

B. What's Changed? Why Update?

- Urban Use of Surface Water (ABCWUA / DWP)
- MRGCD Water Diversion Upgrades
- Improved User Conservation – Agricultural and Urban
- Population Changes – Quantity and Distribution
- Legal Decisions and Statutory Changes
- Improved Hydrological and Climate Knowledge
- Experience with Periodic NM Drought and Climate Change
- Impending and Approved Development Projects
- Known Shortfalls in 2004 Plan; e.g., implementation
- Stationarity Assumptions Flawed; Plan for Extremes

C. Objectives for RWP Update

- Manage Water to Maintain Our New Mexican Values
- Sustainable Water Supply for the Region -
  At Reasonable Price, Very Long Term
- Identify and Account for Infrastructure, Behavioral,
  Informational and Attitudinal Changes Since 2004
- Deal with Known, Unaddressed Items in 2004 RWP
- Address and Adapt to Climate Change Impacts
- Guide Managers and Others to Cooperate and
  Coordinate Land Use and Water Plans and Actions

II. 1/23/15 ISC Presentation

Key Issues in the Region

• Rio Grande Compact limitations
• Already permitted water rights requiring water right transfers for offsets
• Drought, especially in 2011, 2012, 2013
• Kirtland Air Force Base jet fuel spill
• Watershed and Bosque health
• Many small drinking water systems with infrastructure needs outside of ABCWUA
• Endangered Species Act compliance
• Others?

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Submission to the Steering Committee

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Part Four

Recommended Future Strategies

(Projects, Programs, and Policies)

New Mexico Regional Water Plan Update Recommended Future Strategies Checklist
Submittal from the Middle Rio Grande Water Assembly for Region 12

Organization: Middle Rio Grande Water Assembly
Address: PO Box 25862 Albuquerque, NM 87125
Contact Name: Bob Wessely
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Phone: (505) 454-0555

Based upon our water planning experience, the Middle Rio Grande Water Assembly submits the following projects, programs, policies (PPPs) as part of the planning exercise in updating the regional water plans. These are drawn from the previously submitted technical data and discussions with the Steering Committee.

PPP A. Unresolved Issues - Tackle the Stumbling Blocks

When the MRG RWP was presented to the ISC in August 2004, it was also given a list of a list of unresolved issues in the region. On March 3, 2015, Bob Wessely gave a presentation to the MRG RWP Steering Committee that included this list together with other update considerations. Issues include "Coordination of Actions," "ESA Requirements" and "Lack of Completed Adjudications." More than ten years later, those issues have not been resolved. Several issues were also presented by the ISC team in January, including "Compact compliance" and "Already permitted water rights requiring water right transfers for offsets." Additionally, our region is facing dramatic climatic disruptions. Priority must be given to addressing these issues, with joint concerted action being needed.

Proposal: Assuming that demand exceeds supply, under what rules should reductions be made? Parity or priority? Is it fair to ask a senior water right holder to reduce usage by the same percentage as a junior water right holder? What are the impacts to the local regions when transfers are made? Establishing a process for this discussion and decision-making should be started.

Unless and until ownership of water rights is determined, planning for shortages will always entail that question. While any number of parties could start an adjudication, the state should initiate action and include the regions affected. Designing the process, including cost, would be the first step, to be done this year. Appropriations to fund the entire process would be sought as a continuing line item.

PPP B. Water Budget/Water Assessment/Water Balance

Background: The original MRG Water Budget, combining surface water and groundwater, found that the region was running a substantial deficit --at least 55,000 af annually-- which in turn provided the rationale for our regional water plan. After learning about the deficit, we focused our attention on reducing demand and/or augmenting supply. *Balance Use With Renewable Supply* became the mantra, and Chapter 10's Recommendations started with the *Urgent Shortfall Reality*.

In the fifteen years since the Water Budget was developed and accepted, significant changes have been made, as was shown in the draft Water Budget Update presented to the steering committee by Dr. Bruce Thomson. Both demand and supply have been reduced yet still show a significant gap, contrary to the Administrative Water Supply (AWS) that shows none. Indeed, while laudable in the ideal, the AWS is seriously inadequate to consider actions for closing the gap between supply and demand. For instance, the AWS does not includes riparian ET and open water evaporation, some 44% of consumptive use in our planning region in 1995 according to Dr. Shomaker.

WRRI at NMSU and other universities are currently developing a statewide water assessment, funded by the State Legislature:

> http://www.nmlegis.gov/Sessions/15%20Regular/firs/SB0156.PDF
>
> With FY15 state funding, the NM WRRI is now developing a statewide water assessment. The statewide water assessment is a data resource and planning tool that provides easily accessible integrated data for precipitation, evapotranspiration, groundwater, recharge, surface flows, produced water, return flows, brackish groundwater, and reused water. The data will be used to develop system dynamics models with scenario testing for managing existing water and developing new water sources. The statewide water assessment is crucial to helping the state plan for a sustainable water future. It will deliver data for informed water management decisions that complements and augments the work of existing state agencies such as the Office of the State Engineer. NM WRRI cooperators on current related projects include New Mexico State University, University of New Mexico, New Mexico Tech (including the NM Bureau of Geological and Mineral Resources, and the Petroleum Recovery Research Center), Sandia National Laboratories, U.S. Geological Survey, and the NM Office of the State Engineer.

As Dr. Thomson explained it:

> The Statewide Water Assessment is an accounting exercise not a simulation model. It uses existing data on water supply, precipitation, and diversions, together with calculated estimates for unmeasurable flows (i.e. ET) to provide an accounting of how water is being used. By the middle of the summer, it will provide a water budget for any period in the past ranging from decades to one month. Its present stage of development is to provide a water balance for each of the river basins in the state (Rio Grande, Pecos, Upper Colorado, etc.). Disaggregating the data to the county & water planning region will be next year's task but it will take a lot of work. At present I don't think there are any plans to develop the tool into a forecasting model that would enable prediction of impacts of climate change or changes in water use/demand.

What with such resources being expended, this appears to be a reasonable effort to be engaged with. While not yet ready for the regions, such a robust tool will enable decision making to be done with realistic numbers. Regions should wait until the Water Assessment is completed before attempting to analyze programs, policies and projects in updating the regional plan. In the meantime, the Water Assembly has a draft updated Water Budget, which can be used as a substitute.

Proposal: During next five years, and in preparation for the next review and update of the regional water plan, several regional reports would be undertaken and updated, such as considering the impacts from a reduction in irrigation water in the MRG (in 1997, the Bureau of Reclamation estimated that irrigation alone provided 0.7 acre-foot per acre of recharge, not to mention the additional amount from the ditches).

Supply and demand data will be broken out into annual numbers, which would help show the variability of supply and demand. (see *Volume 1 - The Strategic Plan, Chapter 3 - California Water Today;* Water Portfolio & Water Balances - Figure 3-10 California Water Balance by Water Year, 2001-2010; http://www.waterplan.water.ca.gov/docs/cwpu2013/2013-prd/Vol1_Ch03_CA-Water-Today_PubReviewDraft_Final_JW.pdf)

Such studies and data would add to the large body of information and studies to be used for creating scenarios.

PPP C. Develop Interactive Water Budget Model

While there have been plans developed by specific entities, the regional coordination envisioned clearly has not happened. There is no one database to work from to consider the impacts and benefits of proposals, nor is there any regional compilation of approved projects with concomitant promises. Nor is there any way to link land use decision with water resources. Without such basic tools, there is little to no way to show whether an existing policy, program, project or plan makes any difference, much less what effect a new one might have. Creating a regional model for public use is in keeping with the RWP and the policies of the ABCWUA.

Proposal: Create an open-access, nonproprietary, web-based application for viewing the potential outcomes of specific water management decisions as reflected in changes in land use, including a geographic information system model for geo-spatial visualization complete with hosting and data collection

PPP D. Modify the MRG Administrative Area Guidelines to encourage reuse and recycling

The MRG Administrative Area Guidelines (MRGAA), promulgated by the Tom Turney, State Engineer in 2001, were never meant to be carved in stone. Currently, the Guidelines allow a 2.5' decline in the aquifer annually in this Critical Management Area. Huge declines have been mapped by the USGS throughout the basin. Water levels are rebounding in some of the ABCWUA well fields, but pumping has consistently exceeded what was proposed and analyzed as a part of the San Juan Chama Drinking Water Project. Additional and future uses will be served with groundwater. Ultimately, the problems in making Compact deliveries, serving senior water rights, providing for endangered species may be joined with issues of land subsidence and its consequences of breaking pipes, roads and houses.

Proposal: To help us adapt better, the State should modify the MRGAA Guidelines to encourage reuse and recycling of water. For instance, one modification could be to not allow a 1-1 return flow credit (especially using junior water) to offset impacts to senior water right holders. That would likely result in less water being pumped and more recycling and reuse occurring. Less waste flows could be offset by additional reservoir releases to offset the flow depletions from

past actions. Reduced flow depletions in future years would provide more water for endangered species. Policy changes such as these should be modeled to see what the impact on river flows and groundwater levels would be.

PPP E. Develop an Institutional Framework and Roadmap For Action

While the Water Assessment is being worked on, why not focus on the building blocks needed to create a way that the various players could work together? Why not tackle the lack of a common structure with which to use the assessment?

Consider the number of the Recommendations in the 2004 RWP that have to do with allocating, planning and modeling:

R2-1—Adjudication and Water Rights Settlement (A-71)
Regional Water Planning Program (A-58)
R2-6—Water Resource Database (A-73)
R2-7—Watershed Management Plans (A-66, A-33)
R2-8—Comprehensive, Integrated, and Continued Water Planning (A-53)
R2-9—Storm Water Management Plans (A-34)
R2-10—Cooperative Regional Water Management (A-67)
R2-12—Land Use Management and Planning (A-52, A-30, A-28, A-144)
R3-1—Measure All Water Uses (A-7, A-8, A-73)
R7-4—Water Modeling (A-38, A-143, A-144)

In 2009, a recommendation was made that the region had to "work on the challenges of meeting long-term demand" and "to be strategic about how to meet the future needs of this urban area."[1]

In 2015, the recently-adopted *Futures 2040 MTP* recommended:

- Coordinate regional water plans and the 2040 MTP
- Facilitate regional dialogue about balancing agricultural and residential/commercial water consumption
- Provide information to policy makers, planning commissions, and agency staff on scenario planning efforts and the impact of growth patterns on the natural and built environment
- Facilitate a regional dialogue about the link between land use patterns and water consumption
- Increase coordination with water utility organizations on regional planning efforts
- Analyze water infrastructure costs associated with different growth patterns
- Support the use of grey or recycled water in parks, golf courses, and other open spaces
- Investigate the most efficient methods to conserve and reuse water in the region

In addition to summarizing the efforts that have been made in the interim, the proposal is to proceed to create a common infrastructure for water planning. Rather than proposing new projects to be built, what that could mean would be to create some sort of framework that would be necessary to use the water assessment tool in regional efforts. That task would consider how

[1] Susan Kelly, Utton Transboundary Resources Center, University of New Mexico School of Law, *Urban Water Administration in the Albuquerque Urban Area*, Decision-Makers Field Guide 2009, http://uttoncenter.unm.edu/pdfs/Urban_Water_Admin.pdf

to incorporate issues such as water rights ownership, lack of common data sets and the lack of a common institutional framework. It could move on to consider ways to link local land use decision makers with available water resources, and include impacts of climate change. It should include considering changes to the institutional arrangements for water governance. A review of documents such as the Middle Rio Grande Ecosystem: Bosque Biological Management Plan and the Update's recommendations would enable a robust, well-rounded review of proposals to manage our resources. Then, with the water assessment in hand, options to either decrease demand or increase supply could be evaluated and decided upon using a scientifically-based approach together, as well as to integrate climate disruptions into our planning.

Proposal: Develop a Roadmap For Action

As the main update exercise, the Steering Committee prioritized alternatives from the 2004 Plan but really did not capture changes that might need to be dealt with. There is no clear guide to as to how to proceed, other to submit programs, policies or projects to the ISC.

The proposal is for the region to focus on the categories in the 2004 Plan, and determine if they are sufficient or unnecessary, and then move on to consider changes. As a guide, the recently updated California Plan included a roadmap, which could be adopted here almost verbatim.

1. Strengthen Integrated Regional Water Management
2. Use and Reuse Water More Efficiently
3. Expand Conjunctive Management of Multiple Supplies
4. Protect and Restore Surface Water and Groundwater Quality
5. Practice Environmental Stewardship
6. Improve Flood Management Using an Integrated Water Management Approach
~~7. Manage the Delta to Achieve the Coequal Goals for California~~
8. Prepare Prevention, Response, and Recovery Plans
9. Reduce the Carbon Footprint of Water Systems and Water Uses
10. Improve Data, Analysis, and Decision-Support Tools
11. Invest in Water Technology and Science
12. Strengthen Tribal/State Relations and Natural Resources Management
13. Ensure Equitable Distribution of Benefits
14. Protect and Enhance Public Access to the State's Waterways, Lakes, ~~and Beaches~~
15. Strengthen Alignment of Land Use Planning and Integrated Water Management
16. Strengthen Alignment of Government Processes and Tools
17. Improve Integrated Water Management Finance Strategy and Investments

This could become a model for the State to use in all 16 of the regions as well as in the State Water Plan.

PPP F: Recognition of Value of Irrigation

As water is transferred from agriculture to municipal uses, there is little consideration as to the impacts of such transfers on either the ecosystem or the communities. In addition to updating the assessment of the impacts, the proposal is to provide value to those who participate in programs to continue farming with the aim toward recharging the aquifer, aiding with a water quality program, maintaining open spaces, keeping traditions alive, feeding us locally, helping to improve air quality, etc.

PPP G: Reducing Evaporative Loss from Elephant Butte Reservoir

Although Elephant Butte Reservoir is not in the MRG planning region, the evaporative loss is counted as part of the basin's consumption. Reducing the loss would help to close the gap between demand and supply. The proposal is to consider ways to store more water upstream under the Rio Grande Compact. Using tools such as URGWOM, the same deliveries could be accomplished while ensuring more water during dry periods.

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June 27, 2015

Part Five

Technical Data

Technical Data - Updating the Middle Rio Grande Regional Water Plan

Addressing The Issues With A Focus

Summary of Technical Data

The following presents detailed technical data gathered from multiple sources. Those data point out serious issues that should be addressed in the continuing update for the Middle Rio Grande Regional Water Plan. This page summarizes the issues that are embedded in or surfaced by the data that appears on the following pages.

*** The Administrative Water Supply (AWS) promulgated by the NMISC is not useful for meaningful water planning in the Middle Rio Grande Region**

- Extrapolating from zero supply/demand gap is 2010 is contrary to fact
- Withdrawals do not reflect the Region's compact-driven water supply constraints
- The Rio Grande Compact allows 405 kafy depletion between Otowi and Elephant Butte
- Riparian evapotranspiration and open water evaporation are significant in the region

*** Climate assessment for the Rio Grande predicts significant reductions in surface water supply below 2010.**

- Even without climate change, records show frequent occurrences of multi-decadal drought.
- The planning must deal with great year-to-year variability in available surface water.
- The planning should acknowledge the likelihood of frequent intense events – storms, droughts, wildfires

*** New Mexico's compact credit balance has dropped to zero for the first time since the early 2000s**

*** We will have wet water shortages**

- Substantial population growth is predicted and is seen to be economically important to the Region
- Overpumping/subsidence drove the Region to use surface water to offset some pumping
- All available San Juan / Chama surface water is already claimed and in use
- Reversion to previous pump rate will cause infrastructure damage from increased land subsidence and dry up the Valley.
- Water obligations to meet Endangered Species Act Biological Opinion will add wet water stress.

*** We will have paper water shortages**

- Groundwater pumping permits carry requirements to retire surface water rights and uses when impact reaches the river
- Existing promises to retire rights already exceed all irrigated acreage in the Compact region, including Native American acreage.

*** The Region must plan for further use reduction and/or larger quantities of re-use.**

*** The planning needs to emphasize the 2004 Plan's recommendations that are still valid.**

*** The Plan should establish the institutional framework for vigorous implementation and coordination of its recommendations.**

Technical Data

Preface: The purpose of the Regional Water Plan Update is "to focus on identifying strategies that will address the gap between supply and demand." Addressing this purpose, members of the Water Assembly, formed to develop and implement the *Middle Rio Grande Regional Water Plan*, have prepared the following information to submit as a part of the *MRG Regional Water Plan Update*.

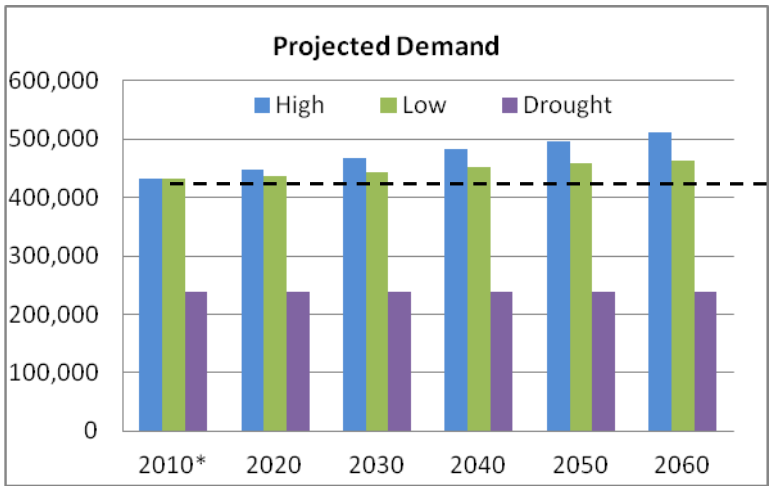
While we appreciate the need to have a Common Technical Platform, the MRG has the benefit of scientific studies that other regions may not yet have, and we cannot ignore those. The Update Handbook allows for this: "The region may provide the state with other studies or data, if available, that the region believes would improve the quantification of water use." Otherwise, what basis do any resultant recommendations have?

Following the summary of problems and issues is some additional background information, beginning on page 12, which contains snips from the RWP Update Handbook, the Administrative Water Supply and the MRG Water Supply Study (2004). On page 22, is the Water Budget Update and a Water Balance Idea.

Closing the Gap

Problems and Issues

In updating the regional water plans, the regions are to use the same technical data, called the Administrative Water Supply (AWS). The AWS for the MRG was presented on 1/23/15:



Black dashed line is the administrative water supply
In the materials, a red dashed line on the chart represents the "Severe Drought Impacted Administrative Water Supply = based on the ratio of the minimum drought of record to the 2010 administrative water supply." I added the purple column to replicate the line, estimating it to be 55% of the 2010 AWS.

From the Update Handbook:

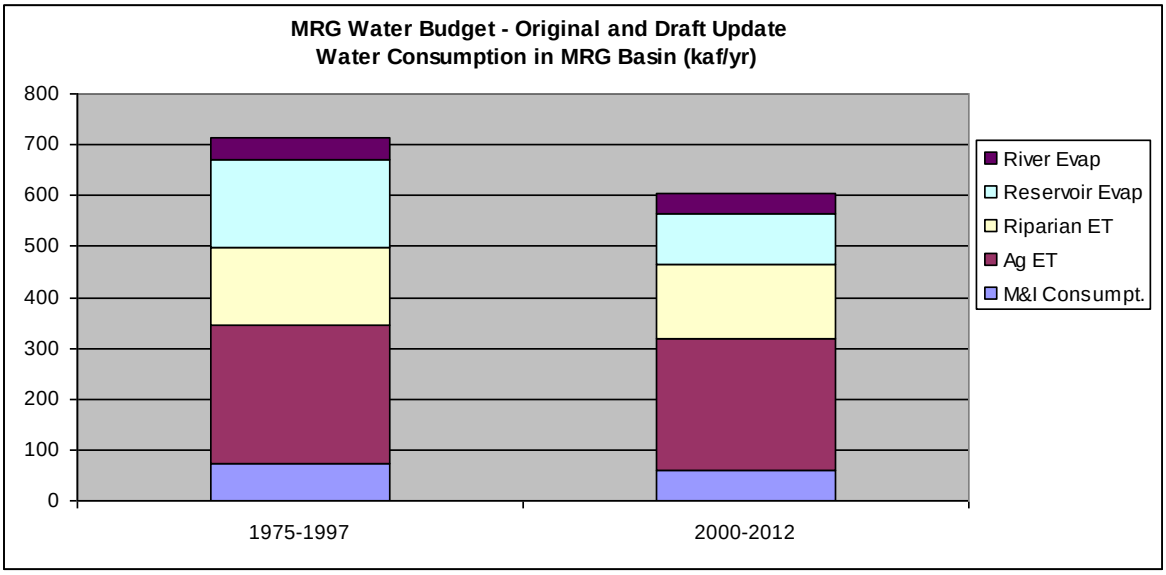
> In almost all areas of the state of New Mexico, projected demand is expected to exceed available supply, and therefore, the update should continue to focus on identifying strategies (projects, programs, and policies) that will address the gap between supply and demand.

The purpose of the regional water plan updates is to calculate the gap between supply and projected demand and to identify strategies (projects, programs, and policies) that address that gap and other water management issues identified by the regions.

When one looks at the Administrative Water Supply (AWS), included in more detail in the Background Information below, there is no gap as of 2010. Rather, it assumes that supply equaled withdrawals equaled use equaled demand in 2010 -- not exactly the conclusion in the draft updated Water Budget, which was that the region been draining Elephant Butte by ~43 kaf per year to achieve that "balance."

Middle Rio Grande Water Budget - Draft
Dr. Bruce Thomson, et al
6/25/2014

Note that the average water budget deficit of 48 KAF/yr for the period 2008-2012 is close to the 40 KAF/yr deficit estimated for the year 2000 by SSPA (2004). Although significant decreases in M&I consumptive use has been achieved and water diversion for irrigation has been reduced, the overall water supply for the MRG basin remains out of balance with the demand. It is clear that further measures for reducing basin wide consumptive use will be required to bring the basin into balance based on current water uses. Furthermore, even more aggressive measures will be required in the future to meet the conflicting situations of increased demand due to projected growth and decreased future supplies as a result of long term drought and climate change.

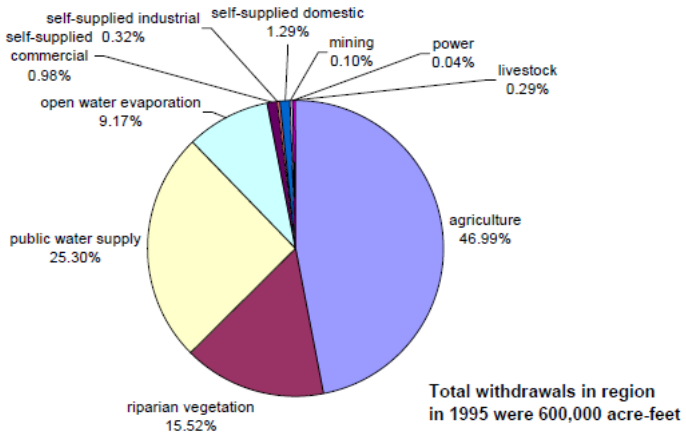


That gap is also quite similar to the gap found in the 1997 Water Assembly's Water Budget and the 2004 Water Budget prepared for the ISC (see Background Information).

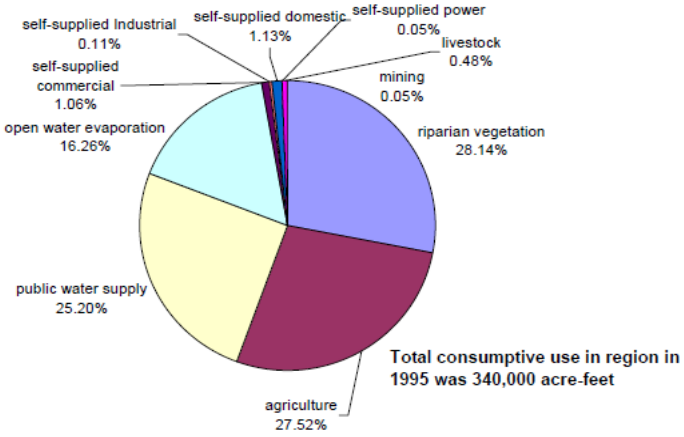
In the AWS, agricultural demand remains at the same amount through 2060, drought or no drought. Does that make sense? The Climate Assessment done for the Rio Grande shows that surface water supply will certainly be reduced from what it was in 2010. Over the next 40 years, many water rights will have been transferred. Likely, that's why the urban usage goes up over that same time period -- water is serving a growing population.

No accounting is included for the consumptive uses by the riparian areas or open river water evaporation, although according to John Shomaker's report done for the original regional water plan, those amounted to some 25% of withdrawals and 44% of depletions in our planning area in 1995.

Distribution of withdrawals by category in total region, 1995



Distribution of consumptive use by category in whole region, 1995



Historical and Current Water Use in the Middle Rio Grande Region
Prepared by John Shomaker & Associates, Inc. and PioneerWest, June 2000
http://www.waterassembly.org/archives/MRG-Plan/H-Rio%20Grande%20Supporting%20Documents/SH%201-11%20Third%20Party%20Documents-Reports-Etc/SH-4%20%20Nims%20et%20al%20%28Shomaker%29.pdf

The various water budgets done for our region, including the one done for the ISC and the one being updated now, include riparian areas or open river water evaporation.

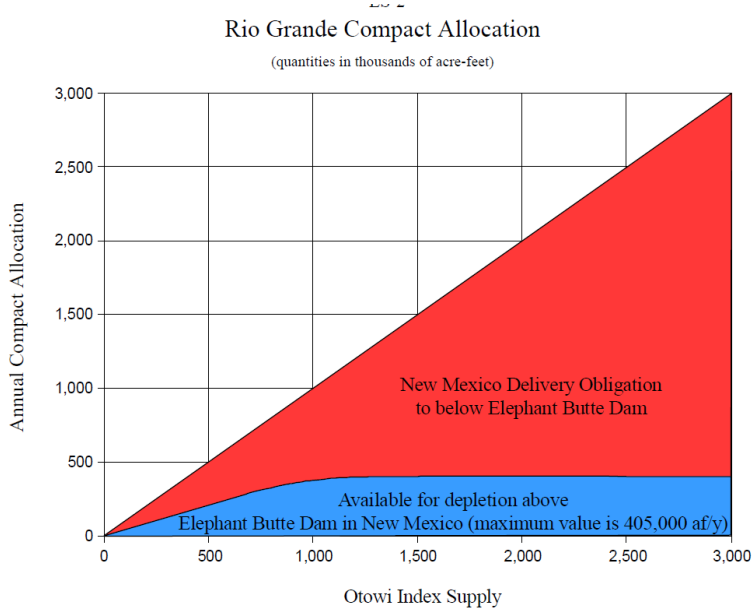
> Although those uses remain unquantified, since they are not included in either the supply or demand determination, they will not substantially affect the quantification of the gap.[2] (Update Handbook)

[2] Such unquantified consumption must be occurring or else why would the ISC spend so much time and treasure on winnowing the bosque and dredging the channel into Elephant Butte?

It would be useful to have the supply and demand numbers to see if there is a gap to address. Still, since the surface water supply is declining, uses reliant on it will face stresses different than those which can use groundwater supplies. (Which increased reliance on will face other constraints, such as increasing the potential for land subsidence, costs to desalinate, and need to acquire additional water rights.) Having a clearer idea of the sources of supply can help in directing recommendations. What might be done to limit the demands on the aquifer? If stormwater -- which supplements our allotment from the Rio -- were to be treated as a supply source, what changes might be needed to policies, infrastructure, etc.?

Given the percentage that such unquantified uses represent of overall consumption, ignoring such use, and thus not planning for it, may well lead us into the type of troubles the State is facing in the Lower Rio Grande.

The Rio Grande Compact constrains how much we in the MRG, plus those in Socorro, Sierra and Santa Fe Counties, can consume – included or not in the OSE categories. Consumption tops out at 405 kaf (see Background Information for more detail).



If one were to just use the AWS, without knowing the source of the supply, it would appear that our region alone withdrew / demanded / used / consumed more than the maximum allowed under the Compact!

Provides habitat and reduces depletions, ensuring deliveries! Furthermore, if there is no usage, how can we justify asking for funds to address the alternatives in Chapter 10.2.6 Bosque and Other Riparian Habitats?

Table 6-5. Projected Water Use, 2020 through 2060 Middle Rio Grande Water Planning Region

		Water Use (acre-feet)					
Use Sector	**Projection**	**2010***	**2020**	**2030**	**2040**	**2050**	**2060**
Total regional demand	High	431,640	447,972	467,016	482,412	496,723	511,064
	Low	431,640	436,313	444,421	451,670	457,911	464,069

Groundwater, SJC water and precipitation below Otowi Gage are all sources of water in addition to the River. While not broken out in the AWS data presented in January, the 2010 data set used to establish the baseline is found in *New Mexico Water Use by Categories 2010.*[3] In the report, surface and groundwater withdrawals are reported. Of note, while groundwater withdrawals in Bernalillo County represented 48% of its total, they were only 13% in Valencia County.

MRG 2010 (af)	WSW	WGW	TW
Sandoval County	53,789	25,330	79,120
	67.98%	32.01%	
Bernalillo County	88,466	81,502	169,967
	52.05%	47.95%	
Valencia County	160,262	23,225	183,488
	87.34%	12.66%	
MRG	302,517	130,057	432,575
	69.93%	30.07%	

Key: WSW=withdrawal, surface water; WGW=withdrawal, groundwater; TW=total withdrawal

Clearly, solutions to reduce consumptive uses or to augment existing supply will impact users differently depending on the source.

We share the responsibility of meeting the Compact obligations with two other planning regions. Like with the unquantifieds, we have not been given data to see whether all of the basin's demands exceed the allowable amount. The 2010 Water Use Report shows:

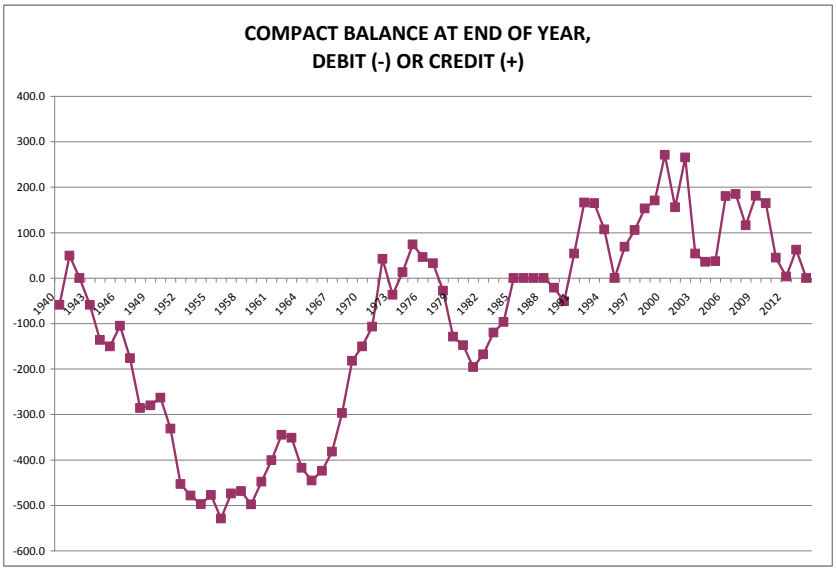
	WSW	**WGW**	**TW**
Sierra County	122,045	27,761	149,806
Socorro County	118,470	35,444	153,914

67% of Sierra County's total is evaporative loss from Elephant Butte Reservoir

Looks like the use of surface water alone in the basin, even after removing the SJC water, is more than 405 kaf. If this is the case, what might we do about it? Should we have any recommendations? After all, how else can we justify projects to reduce the evaporative loss from the reservoir?

In line with the draft Water Budget Update cited above, one result of our basin's over-consumption has been the dramatic lowering of water levels in Elephant Butte Reservoir, lessening Sierra County's consumptive use but reducing the State's credit balance to zero.

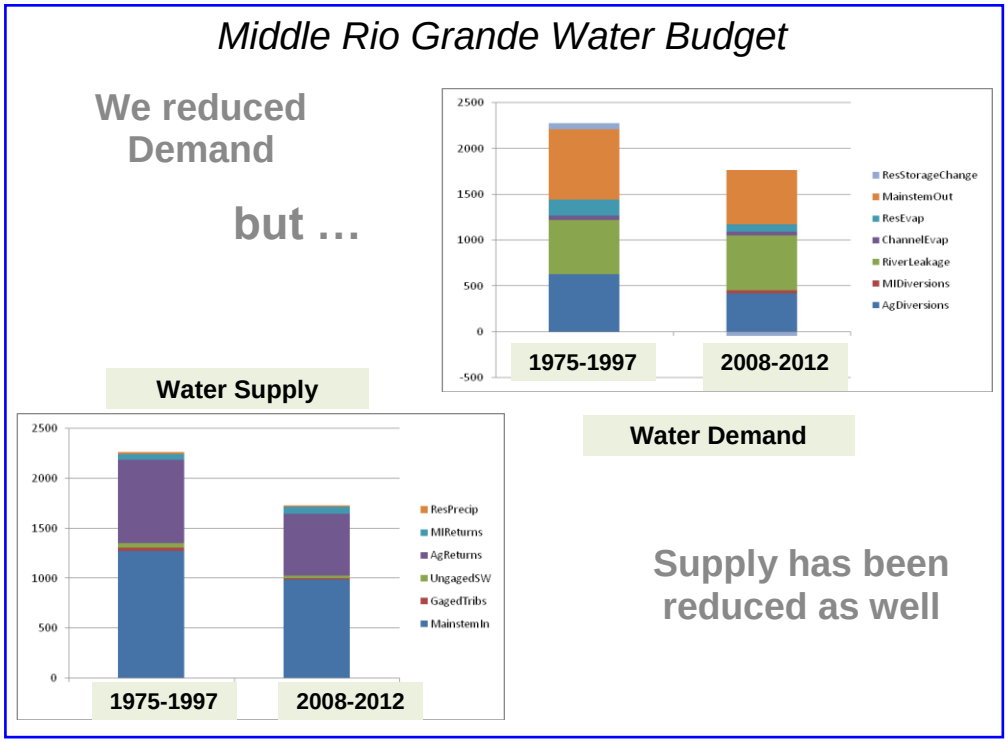
[3] Longworth, John W., P.E.; Valdez, Julie M.; Magnuson, Molly L., P.E.; and Richard, Kenneth, New Mexico State Engineer Office, Technical Report 54, October 2013. http://www.ose.state.nm.us/Pub /TechnicalReports/TechReport%2054NM%20Water%20Use%20by%20 Categories%20.pdf)



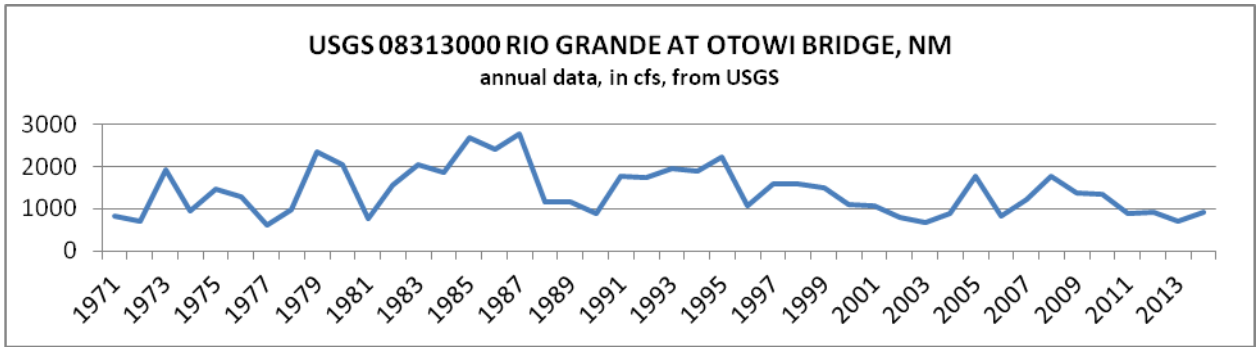
5/1/15 - ISC, using NM's proposed accounting method (Method 2)

While we can go into debit spending, should conditions continue as projected, that may be a hole we cannot dig our way out of without some real hardship. With a Special Master from the US Supreme Court already investigating Rio Grande water accounting issues below Elephant Butte, it is not difficult to see his jurisdiction expand to include the Middle Rio Grande Basin should there be Compact issues.

The draft updated Water Budget shows that while we have reduced our consumption since the earlier version, supply has likewise declined.



The availability of surface water is highly variable year to year, which is not captured when using one data point.



Regional Water Planning has to take into account that variability, rather than use a stationary data point.

Climate Change must be Considered!

Climate change undermines a basic assumption that historically has facilitated management of water supplies, demands, and risks: the idea that hydrologic variables in future time periods will be similar to past time periods. Such assumptions are problematical if not risky. In the recently-approved *Futures 2040 MTP* for our region, climate change was discussed as it related to transportation, housing and water. Included in the materials was a presentation on what changing climate conditions mean with respect to water supply, and from which are included a few slides:

Futures 2040: The Metropolitan Transportation Plan
for the Albuquerque Metropolitan Planning Area
April 2014
http://www.mrcog-nm.gov/images/stories/pdf/transportation/2040MTPScenario_Planning/spring-14-futures-2040-meeting-presentation-2.pdf

Upper Rio Grande Impact Assessment

- All 112 scenarios result in higher temperatures
- Earlier snowmelt runoff
  - Changes in timing of river flows
- Higher temperatures increase water demands for irrigated agriculture
- Precipitation is highly variable
- More intense droughts and more extreme events

Water Availability in 2100

According to the Upper Rio Grande Impact Assessment:
- Rio Grande flows decrease by 1/3
- San Juan-Chama flows decrease by 1/4

Water Consumption

- How we grow impacts how much water we consume
- Analyze consumption patterns by land use and housing mix
- Daily residential consumption dropping locally and nationally
  - 1994: 250 gallons per capita
  - Today: ~135 gallons per capita

Source: Albuquerque Bernalillo County Water Utility Authority

Water Sustainability / Environment

Look at ways to improve water conservation through reuse, delivery and development patterns. Better understand the current water resources and future availability and how transportation decisions affect our environment.

Some Other Considerations

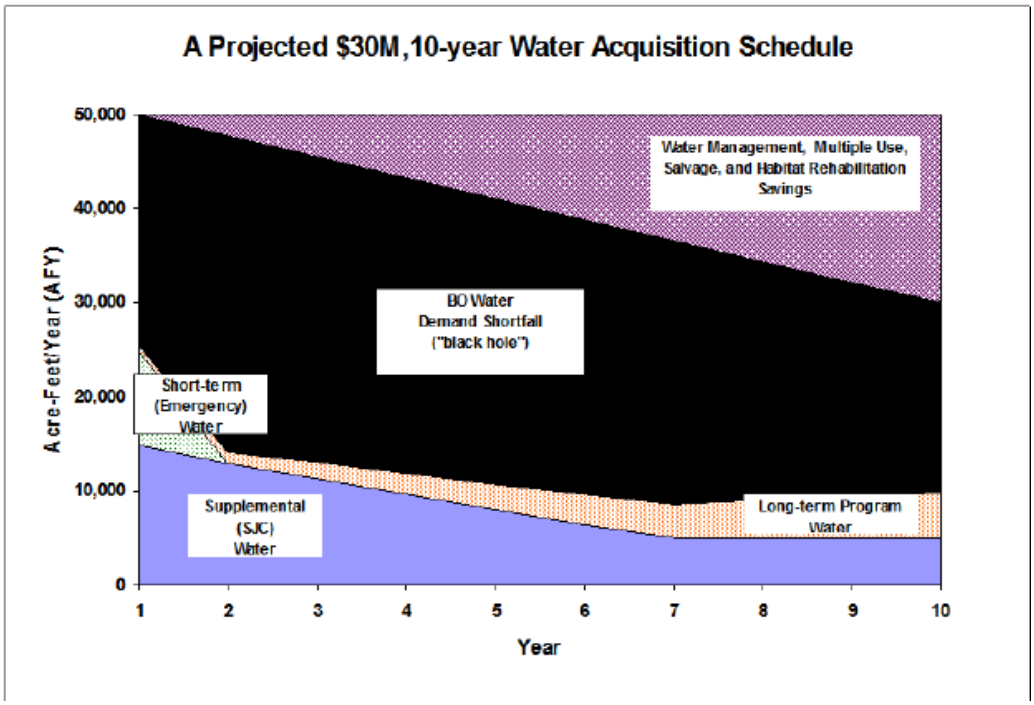
_Mesa del Sol has a 38,000 housing unit build out
_Albuquerque's core could densify considerably in major centers and transit corridors.
_Sandoval is projected to grow by 100%
_Los Lunas has adopted TOD supportive zoning
_Belen has annexed 5,000 vacant acres
_Edgewood/Moriarty low density, rural character

Not included in the AWS is any acknowledgement of the water requirements to satisfy the 2003 Biological Opinion (BO) issued by the USFWS for water operations along the Middle Rio Grande (MRG). In 2005, the Water Acquisition and Management Subcommittee (WAMS) of the Middle Rio Grande Endangered Species Collaborative Program (Program) produced its final report. The report presented its assessment methods and findings of water volume needs, source options, acquisition alternatives, and management approaches to meet the 2003 BO. It included the results from a team of hydrologic modelers from NMISC, USBR, USACE, MRGCD, and other experts from the region that projected water volumes needed to meet that BO. In short, modeling wet, average, dry, and Rio Grande Compact Article VII water years for good, average, and poor snowmelt runoff years and for wet, average, and dry monsoon years, the model projected an average annual requirement of 50,000 acre feet. The maximum water requirement (97,000 acre-feet) would occur during a year under Article VII with poor snowmelt runoff and a dry monsoon season. The minimum requirement (21,000 acre-feet) would occur in a wet year with good runoff and a wet monsoon season. As apparent in these results, the 2003 BO required supplemental water supplied to the MRG even under the wettest climatic conditions. That 10-year BO has now expired and its replacement has not been produced. Whether the replacement BO will include similar water requirements is unknown.

In 2005, the Program's management projected a total of $30 million as being available to meet the cost of water to meet the BO requirement. In response, the WAMS produced 10-year "ballpark water costs" using three sets of assumptions based on 2005 water costs and alternative potential water sources to the MRG. Sources considered included varying combinations of potential options existing in 2005: (1) supplemental San Juan-Chama (SJ-C) water; (2) short-term, emergency drought water; (3) long-term water expected to be purchased by the Program or others to meet the BO; (4) potential increased water yield to the river from agricultural forbearance and municipal conservation; and (5) potential increased water yield to the river due to improved water management, multiple use, water salvage, and habitat rehabilitation savings. Projected costs (without consideration of inflation after 2005) for the three assessed alternatives to meet the BO ranged from nearly $57 to $190 million for 10 years.

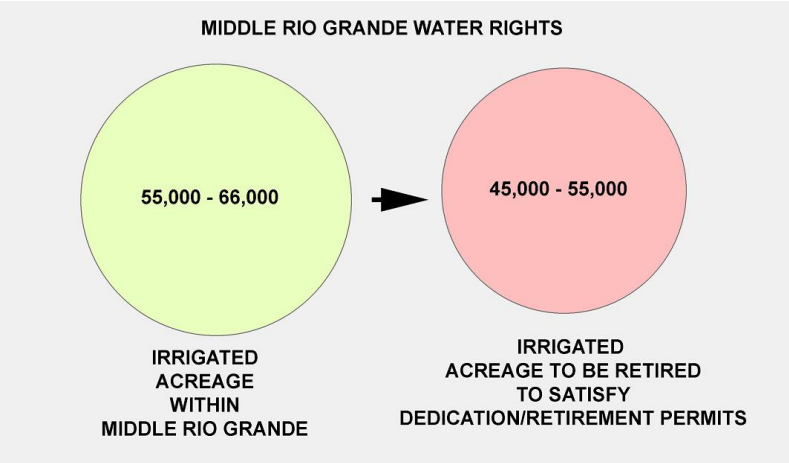
The WAMS also produced a $30 million 10-year water acquisition schedule that assumed declining short-term water transfers, no forbearance benefits, 5 percent inflation on water rights purchases, and a decreasing SJ-C water flow-through supply to meet the average water year demand for the BO (50,000 acre feet). The result of this assessment is summarized in the following figure. In considering that figure, it should be additionally recognized that the top wedge was consider by the WAMS members then, and which continues true today, as highly speculative. As such, that volume can reasonably be added to what is called the water supply "black hole" in the figure. How this average annual 35,000 acre-feet gap in water supply to meet

the 2003 (and possible future) BO requirements using water sources to the MRG has not been resolved.



Also not included in the discussion on supply are paper water permits. However, the State has handed out more permits to allow groundwater pumping to cities than there is wet water to offset the resultant depletions. And that's without even considering the projected reduction in surface water supply due to climate change.

A former State Engineer, Tom Turney, and the current Rio Grande Basin Manager for the Interstate Stream Commission (ISC), Rolf Schmidt Petersen, have both publicly stated that it will take nearly all of the lands currently irrigated between Cochiti Reservoir and Elephant Butte Reservoir to satisfy the outstanding permits already issued by the State Engineer to urban areas.



Tom Turney, former State Engineer
NM Water & Natural Resources Interim Legislative Committee (September 20, 2008)

See also***A Basin-wide Approach to Water Management in the Middle Rio Grande Valley,*** Rolf Schmidt-Petersen, NMISC Rio Grande Basin Manager, August 22, 2007, http://nmwaterdialogue.org/library/documents/schmidt-petersen-8-22-07.pdf/at_download/file

Removing lands which are irrigated by Pueblo members but from which water cannot be transferred to satisfy water permits, removing lands which do not have senior transferable water rights, and accounting for those lands from which water rights have already been sold and transferred, the resultant acres available to service outstanding water permits are reduced even further.

Justice Kennedy from the New Mexico Court of Appeals, in writing the decision in the Drinking Water Protest, summed up what needs to be done:

> **Footnote 5** We note that some analysis of detriment, conservation of water, and concerns for public welfare, relative to the SJCP water being used for a new purpose than groundwater recharge under RG-960, is part of the administrative and district court review of the Permit. This review gives us pause to consider **that there are substantial issues awaiting consideration with regard to future policies governing water that has yet to be developed.** Owing to our rulings in this Opinion, these issues concerning future overall management of the Rio Grande Basin and its water resources remain largely unresolved by this action. Protestants' desire for a global review in this case of meta-issues regarding the effects of a growing population, changing water needs, and methods of delivery to that population, and the ultimate effect of diminishing resources, full allocation and increasing demand are limited to the issues raised, preserved, and briefed herein. (emphasis added)
>
> John Carangelo, Assessment Payers Association Of The Middle Rio Grande Conservancy District, Amigos Bravos, and Rio Grande Restoration, Protestants-Appellants, v.Albuquerque-Bernalillo County Water Utility Authority, Applicant-Appellee, and New Mexico State Engineer, John R. D'antonio, Jr., Respondent-Appellee, 320 P.3d 492 (2013), 2014-NMCA-032, http://www.nmcompcomm.us/nmcases/NMCA/2014/14ca-032.pdf

Background Information

http://www.ose.state.nm.us/Planning/RWP/documents/Revised%20RWP%20Handbook%20ISC_Dec_2013_Final.pdf

Update Handbook

snippets

F. Water Supply (Prepared by the State) The state will prepare the administrative water supply summary for each region based on the NMOSE Water Use by Categories report. The state will confer with regional planning stakeholders to obtain input from the regions and ensure that additional relevant data and studies from the region are identified and made available to the state.

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G. Water Demand (Prepared by the State) The state will confer with regional planning stakeholders to obtain input from the regions and ensure that relevant regional data and studies are identified and made available to the state. The information listed in each section below will be addressed.

G.1 Present Uses Given that the administrative water supply will be based on current water usage, there will be some inherent redundancy between Sections F.5 and this section. However, while Section F.5 will examine the water supply based on overall current uses, this section will address specific categories of uses in greater detail to provide the basis for projecting anticipated future demands.

• Water diversions by category of use as follows:

- Commercial (self - supplied)
- Domestic (self - supplied)
- Industrial (self - supplied)
- Irrigated agriculture
- Livestock (self - supplied)
- Mining (self - supplied)
- Power (self - supplied)
- Public water supply
- Reservoir evaporation

Information for all the above categories will be obtained from the most recent NM OSE Water Use by Categories reports. Riparian and open water evaporation (i.e., for rivers that are not included in the reservoir evaporation category) are not included in these reports . The NM OSE Water Use by Categories reports provide diversions, and statewide depletion data are currently not available. Where depletion data are available and important for Compact accounting or other purposes, those data will be discussed, but the quantification based on diversions will provide a consistent, statewide methodology for use in the state water plan update.

• Water use information presented in the most recent NM OSE Water Use by Categories report will be used to define regional water use. The region may provide the state with other studies or data, if available, that the region believes would improve the quantification of water use. The region should provide an explanation as to why the new data improves or clarifies the NM OSE data. Where the water use information provided in the NM OSE Water Use by Categories report
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does not match the geographical boundaries of a planning region, the state will sort the source data into the appropriate geographical units.

G.3 Water Conservation To assist the region in understanding its water use and developing goals for future reduction in demand to be achieved through conservation, this section will identify current per capita demand, based on the most recent NM OSE Water Use by Categories report, for public water suppliers in the region. Additional discussion of water conservation is provided in Section I.1

H. Identified Gaps between Supply and Demand (Prepared by State)

…

The state will compare the estimated water supplies and projected demands for each region to provide an overview of the water needs for the regions and the state. This overview may not reflect local shortages or region-specific issues. The regions will have an opportunity to consider whether additional studies or scenario planning may be needed and, if so, they may include them when they develop their lists of funding priorities.

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MRG RWP Data from ISC Presentation

January 23, 2015

Table 6-5. Projected Water Use, 2020 through 2060 Middle Rio Grande Water Planning Region

		Water Use (acre-feet)					
Use Sector	**Projection**	**2010***	**2020**	**2030**	**2040**	**2050**	**2060**
Total regional demand							
Public water supply	High	132,572	145,553	160,083	171,429	181,770	192,666
	Low	132,572	139,197	145,406	150,791	155,268	159,932
Domestic (self-supplied)	High	8,599	9,913	11,573	13,039	14,432	15,640
	Low	8,599	9,057	9,622	10,160	10,664	11,123
Irrigated agriculture	Low/High	266,481	266,481	266,481	266,481	266,481	266,481
Livestock(self-supplied)	High	1,250	786	906	1,011	1,074	1,136
	Low	1,250	648	773	887	950	1,011
Commercial (self-supplied)	High	12,077	14,039	16,380	18,394	20,369	22,188
	Low	12,077	12,990	13,951	14,862	15,703	16,452
Industrial (self-supplied)	High	4,469	4,787	5,104	5,422	5,740	6,057
	Low	4,469	1,627	1,850	2,074	2,296	2,520
Mining (self-supplied)	Low/High	543	543	543	543	543	543
Power (self-supplied)	High	472	647	672	757	897	897
	Low	472	597	622	697	832	832
Reservoir evaporation	High	5,170	5,220	5,270	5,331	5,411	5,451
	Low	5,170	5,170	5,170	5,170	5,170	5,170
Total regional demand	High	431,640	447,972	467,016	482,412	496,723	511,064
	Low	431,640	436,313	444,421	451,670	457,911	464,069

* Actual use (Longworth et al., 2013)
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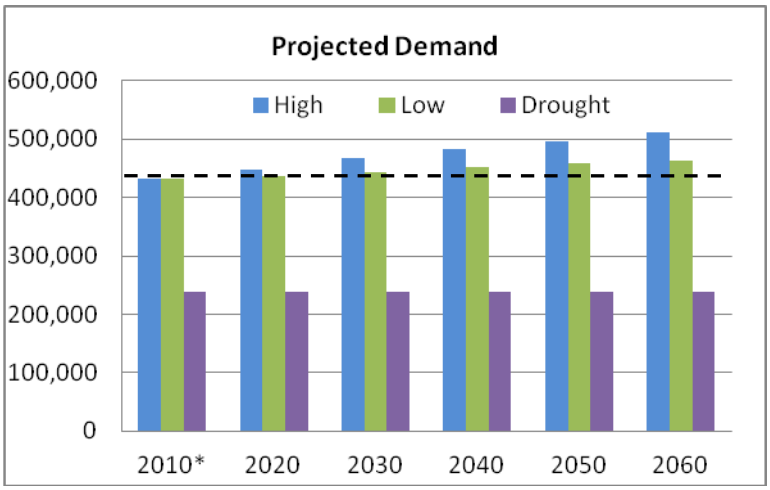

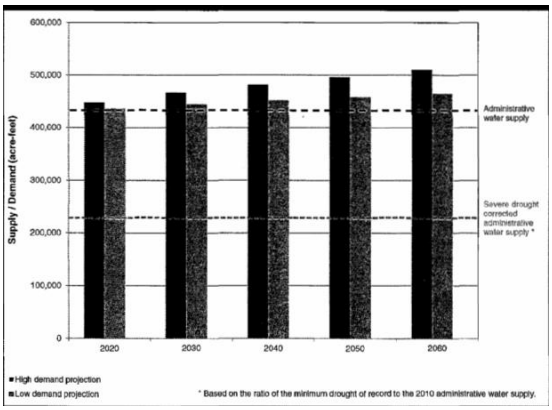

Black dashed line is the administrative water supply
emh added purple column, which is 55% of 2010 AWS to represent the "Severe Drought Impacted Administrative Water Supply = based on the ratio of the minimum drought of reocrd to the 2010 administrative water supply."
(red dashed line on chart in materials (right))

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New Mexico Water Use by Categories 2010 by Longworth, John W., P.E.; Valdez, Julie M.; Magnuson, Molly L., P.E.; and Richard, Kenneth, New Mexico State Engineer Office, Technical Report 54, October 2013.
(http://www.ose.state.nm.us/Pub/TechnicalReports/TechReport%2054NM%20Water%20Use%20by%20 Categories%20.pdf)

Table 5. Summary of water use in acre-feet in New Mexico counties, 2010. (acre-feet)

Use Sector	WSW	WGW	TW
Sandoval County			
Public water supply	219	15,696	15,915
Domestic (self-supplied)	0	2,743	2,743
Irrigated agriculture	48,322	624	48,946
Livestock(self-supplied)	62	79	141
Commercial (self-supplied)	17	2,848	2,865
Industrial (self-supplied)	0	3,066	3,066
Mining (self-supplied)	0	275	275
Power (self-supplied)	0	0	0
Reservoir evaporation	5,170	0	5,170
Total	**53,789**	**25,330**	**79,120**
	67.98%	**32.01%**	**100.00%**
Bernalillo County			
Public water supply	45,152	64,991	110,143
Domestic (self-supplied)	0	2,996	2,996
Irrigated agriculture	43,309	2,604	45,913
Livestock (self-supplied)	4	252	257
Commercial (self-supplied)	0	9,032	9,032
Industrial (self-supplied)	0	1,072	1,072
Mining (self-supplied)	0	89	89
Power (self-supplied)	0	466	466
Reservoir evaporation	0	0	0
Total	**88,466**	**81,502**	**169,967**
	52.05%	**47.95%**	**100.00%**
Valencia County			
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Public water supply	0	6,554	6,554
Domestic (self-supplied)	0	3,686	3,686
Irrigated agriculture	160,215	11,407	171,622
Livestock (self-supplied)	47	841	888
Commercial (self-supplied)	0	221	221
Industrial (self-supplied)	0	331	331
Mining (self-supplied)	0	179	179
Power (self-supplied)	0	6	6
Reservoir evaporation	0	0	0
Total	**160,262**	**23,225**	**183,488**
	87.34%	12.66%	100.00%

Key: WSW=withdrawal, surface water; WGW=withdrawal, groundwater; TW=total withdrawal

MRG 2010	**WSW**	**WGW**	**TW**
Public water supply	45,371	87,241	132,612
Domestic (self-supplied)	0	9,425	9,425
Irrigated agriculture	251,846	14,635	266,481
Livestock (self-supplied)	113	1,172	1,286
Commercial (self-supplied)	17	12,101	12,118
Industrial (self-supplied)	0	4,469	4,469
Mining (self-supplied)	0	543	543
Power (self-supplied)	0	472	472
Reservoir evaporation	5,170	0	5,170
Total	**302,517**	**130,057**	**432,575**
	69.93%	**30.07%**	**100.00%**

Table 5. Summary of water use in acre-feet in New Mexico counties, 2010.

	WSW	**WGW**	**TW**
Sierra			
Public water supply	0	1,668	1,668
Domestic (self-supplied)	0	168	168
Irrigated agriculture	21,397	23,662	45,059
Livestock (self-supplied)	28	536	564
Commercial (self-supplied)	0	1,709	1,709
Industrial (self-supplied)	0	0	0
Mining (self-supplied)	0	17	17
Power (self-supplied)	0	0	0
Reservoir evaporation	100,620	0	100,620
Totals	**122,045**	**27,761**	**149,806**

Socorro			
Public water supply	0	2,294	2,294
Domestic (self-supplied)	0	356	356
Irrigated agriculture	110,836	30,385	141,221
Livestock (self-supplied)	63	988	1,051
Commercial (self-supplied)	0	1,348	1,348
Industrial (self-supplied)	0	51	51
Mining (self-supplied)	0	23	23
Power (self-supplied)	0	0	0
Reservoir evaporation	7,570	0	7,570
Totals	**118,470**	**35,444**	**153,914**

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http://www.ose.state.nm.us/Basins/RioGrande/MRGWSS/Executive-Summary.pdf
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Middle Rio Grande Water Supply Study

Prepared by S.S. Papadopulos & Associates, Inc.
November 2004
S. S. PAPADOPULOS & ASSOCIATES, INC.

Summary of Conclusions

Key water supply and hydrologic concepts illustrated or derived from this study, with implications for water planning are:

• On average, *the historically available water supply is not adequate* (including San Juan-Chama Project water and groundwater withdrawals) to meet the present demands in the Middle Rio Grande region.

• To achieve a balance between *renewable supply* and Year 2000 demand, a minimum of 71,000 acre-feet per year, and perhaps as much as 110,600 acre-feet per year of additional supply or reduction in demand is required.

• Given the historic variability of water budget terms, under Year 2000 conditions Rio Grande Compact *debit conditions are expected to occur 3 out of every 5 years.*

• *Under conditions of increased water use in any sector, a reduction of water use from other sectors is required* to avoid increasing the Rio Grande Compact debit.

• The groundwater supply within the Study Area is not an independent, disconnected water supply. *Use of groundwater, regardless of location, results in diminished flows of the Rio Grande* that will occur in the present and continue into the future.

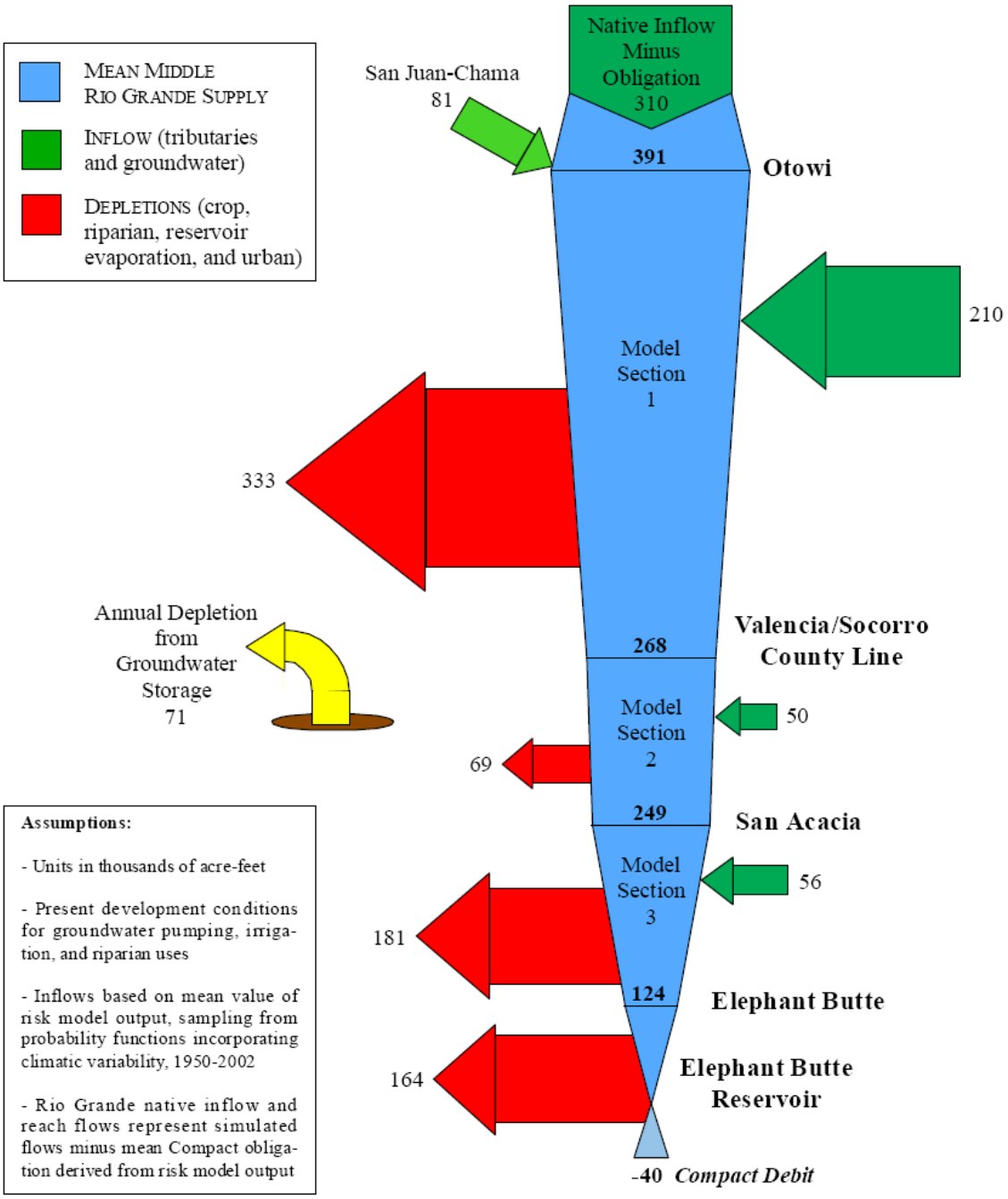
• *The water supply is only depleted by consumptive use*; reductions in diversions and return flows resulting in better delivery efficiency do not necessarily improve the water supply.

• *Under drought conditions, annual Compact debits increase in frequency and magnitude,* and water availability limits irrigated agricultural usage 1 year out of every 5.

• Assuming implementation of regional water planning alternatives, Compact deliveries are significantly improved, with Compact deliveries being met at the 50th percentile. However, *implementation of the joint alternatives as proposed and included in the planning region reports will be challenging, if feasible*.

In summary, the water supply of the Middle Rio Grande is marked by limitation and variability. Supply appears inadequate to meet demand, and though the regional water plans are a strong beginning in addressing regional water issues, further measures will probably be required to meet regional demand in 2040.

Figure ES-2
Mean Annual Middle Rio Grande Water Supply
Present Development Condition



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Other Data Source Suggestions
very initial draft
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Assessment of Climate Change in the Southwest United States*,* 2014*,*
http://www.swcarr.arizona.edu/

West-Wide Climate Risk Assessment: Upper Rio Grande Impact Assessment*,* December *2013,* http://www.usbr.gov/WaterSMART/ wcra/docs/urgia/URGIAMainReport.pdf

Report from Town Hall on Water Planning, Development & Use*,* May 2014,
http://nmfirst.org/LiteratureRetrieve.aspx?ID=207920

Hard Choices: Adapting Policy and Management to Water Scarcity*,* Policy Options Report from the 57th Annual New Mexico Water Conference, April 30, 2013,
http://www.tomudall.senate.gov/files/ documents/SenUdallWaterConferenceReport.pdf

Senate Memorial 8 - **Maximizing the Middle Rio Grande Water Supply Study**, 2014,
http://www.mrcog-nm.gov/images/stories/pdf/water/senate-8-water-study-2014.pdf

The City of **Flagstaff's *Resiliency and Preparedness Study*** addressed the question of how to reduce vulnerability to and build local resilience against risk from climate variability and weather related impacts? http://www.flagstaff.az.gov/documentcenter/home/view/38841

Middle Rio Grande Water Supply Study
Prepared by S.S. Papadopulos & Associates, Inc. for the New Mexico State Engineer and Interstate Stream Commission
November 2004
http://www.ose.state.nm.us/Basins/RioGrande/MRGWSS/Executive-Summary.pdf

Middle Rio Grande Water Assessment Final Report - 1997**,** by Steve Hansen & Chris Gorbach, Albuquerque Area Office, U.S. Bureau of Reclamation)

Falk, S.E., Bexfield, L.M., and Anderholm, S.K., 2011, **Estimated 2008 groundwater potentiometric surface and predevelopment to 2008 water-level change in the Santa Fe Group aquifer system in the Albuquerque area, central New Mexico:** U.S. Geological Survey Scientific Investigations Map 3162, 1 sheet,
//pubs.usgs.gov/sim/3162/downloads/SIM3162.pdf

other usgs studies

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Framework For Public Input To A State Water Plan
Prepared By The New Mexico Office Of The State Engineer And The Interstate Stream Commission, December 2002, http://www.seo.state.nm.us

" Many groundwater users, including municipalities and industries, in the Middle Rio Grande were allowed to begin pumping without securing water rights. Because of return flows of treated wastewater and the delayed impact of groundwater pumping on river depletions, this practice has not resulted in net river flow diminishment. However, the accumulated eventual need for groundwater users to acquire and transfer water rights is very large and exceeds the quantity of currently transferable water rights. Under current practices, only pre-1907 water rights can be transferred. The 1930 water rights developed by the Middle Rio Grande Conservancy District have never been available for transfer. Further, the ability of
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return flows from pumped groundwater to offset river depletions caused by pumping depends on ever increasing groundwater pumping. When pumping levels off, which it must, return flows will no longer be sufficient to offset the depletion of the Rio Grande caused by historic pumping."

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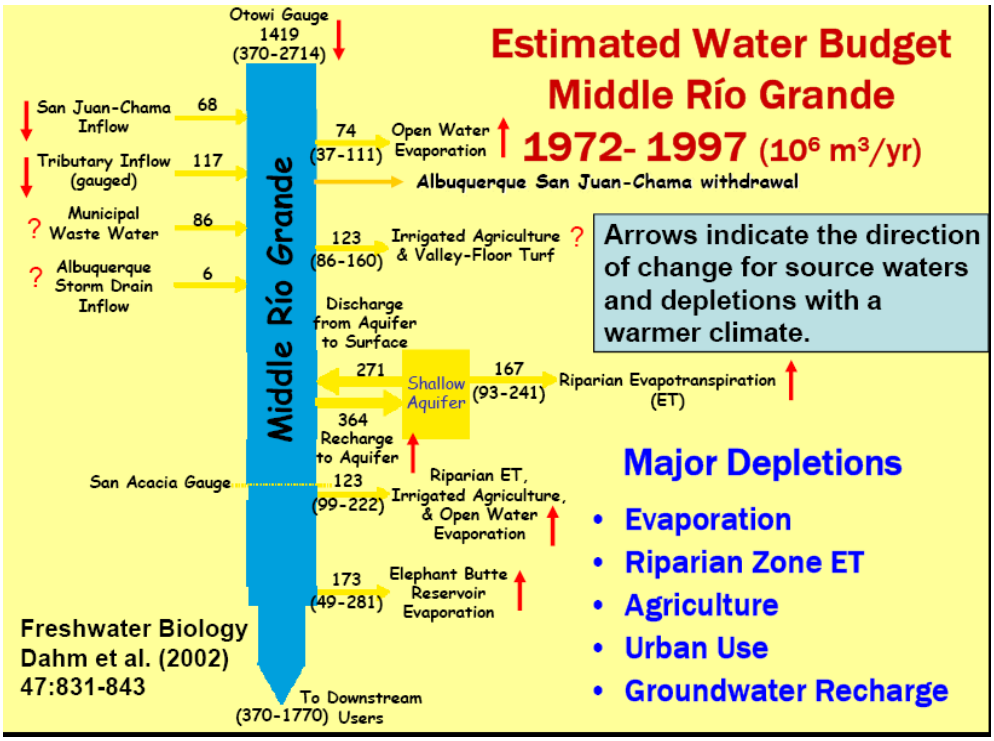
Dr. Clifford Dahm modified the Water Assembly Water Budget to account for climate change's impact on the surface water supplies.



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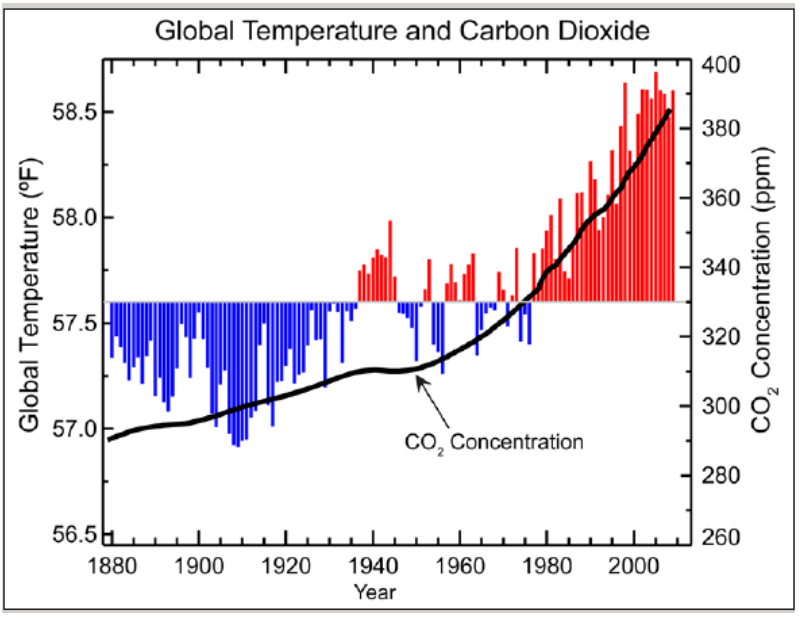
Futures 2040: The Metropolitan Transportation Plan for the Albuquerque Metropolitan Planning Area

April 2014

http://www.mrcog-nm.gov/images/stories/pdf/transportation/2040MTPScenario_Planning/spring-14-futures-2040-meeting-presentation-2.pdf

Changing Climate Conditions

Rio Grande Basin (1971-2011)
• Average temperature increased by 0.7^0F per decade
• Twice the global average

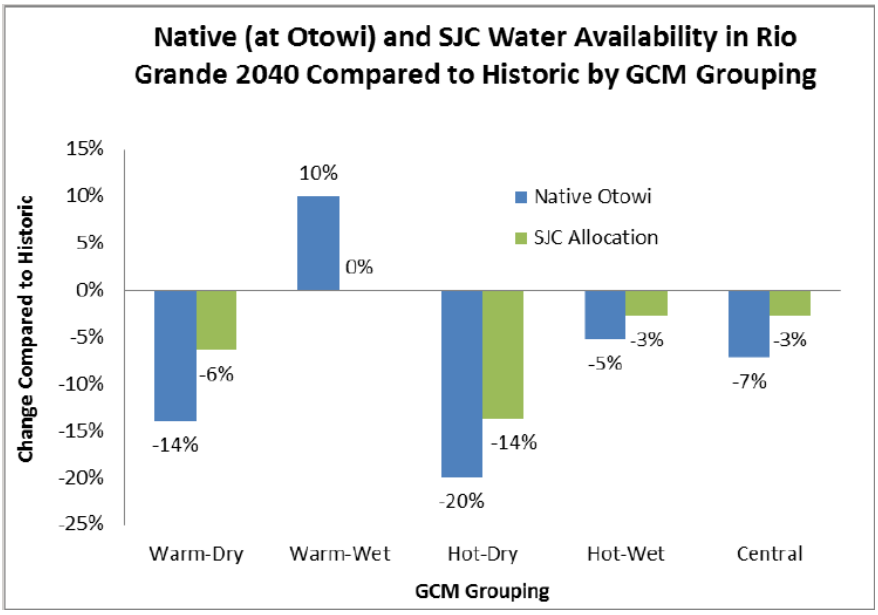


Source: NOAA

Upper Rio Grande Impact Assessment

• All 112 scenarios result in higher temperatures
• Earlier snowmelt runoff
  - Changes in timing of river flows
• Higher temperatures increase water demands for irrigated agriculture
• Precipitation is highly variable
• More intense droughts and more extreme events

Water Availability in ABQ Area: 2040



Water Availability in 2100

According to the Upper Rio Grande Impact Assessment:

•Rio Grande flows decrease by 1/3
•San Juan-Chama flows decrease by 1/4

Water Consumption

• How we grow impacts, how much water we consume
• Analyze consumption patterns by land use and housing mix
• Daily residential consumption dropping locally and nationally
▫1994: 250 gallons per capita
▫ Today: ~135 gallons per capita
Source: Albuquerque Bernalillo County Water Utility Authority

Water Sustainability / Environment

Look at ways to improve water conservation through reuse, delivery and development patterns. Better understand the current water resources and future availability and how transportation decisions affect our environment.

Some Other Considerations

_Mesa del Sol has a 38,000 housing unit build out
_Albuquerque's core could densify considerably in major centers and transit corridors.
_Sandoval is projected to grow by 100%
_Los Lunas has adopted TOD supportive zoning
_Belen has annexed 5,000 vacant acres
_Edgewood/Moriarty low density, rural character

See also, *West-Wide Climate Risk Assessment: Upper Rio Grande Impact Assessment*, December *2013*, http://www.usbr.gov/WaterSMART/ wcra/docs/urgia/URGIAMainReport.pdf

Water Balance Idea

One lesson Frank Titus repeatedly repeated was that we needed to plan for extremes rather than averages. Averages don't exist, water wise. In its recent update, California created a water balance using ten consecutive years of water use and water supply to show the variability and plan for it.

With such a tool, long-range regional plans could consider options to deal with the long range effects of climate changes, water supply reductions, and intense monsoonal events while short term regional plans could be developed to be implemented depending upon a given set of seasonal or annual climatic conditions.

6/25/2014

Middle Rio Grande Water Budget - Draft

Bruce Thomson, Jesse Roach, Dagmar Llewellyn, Nabil Shafike, Dave Jordan,

"Although averaged data for weather and hydrologic conditions are used in everything from the weather page in the newspaper to technical hydrologic reports, it is apparent from data such as that in Figure 2 that there is no such thing as an average year. Weather, stream flows, reservoir

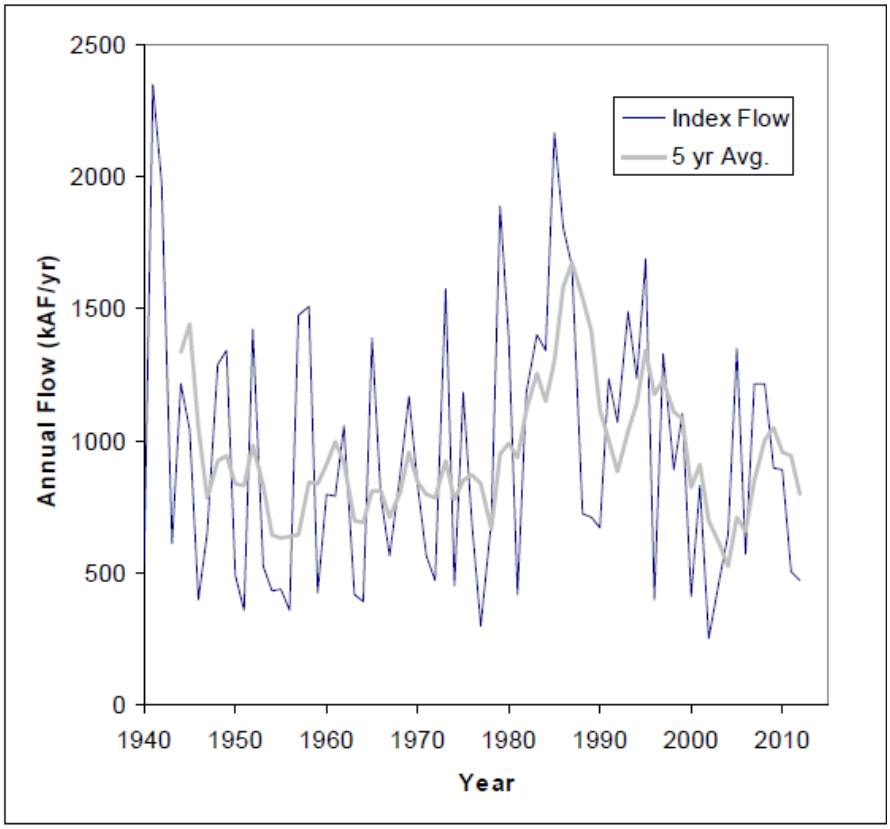


Figure 2 Annual index flows at Otowi gage together with the 5 year moving average (NM Interstate Stream Commission).

operations, as well as water diversions change on daily, monthly, annual, and decadal scales. Although water budgets are necessarily constructed using averaged data, selection of the period over which data is to be averaged will influence the results. Although averaged data for weather and hydrologic conditions are used in everything from the weather page in the newspaper to technical hydrologic reports, it is apparent from data such as that in Figure 2 that

there is no such thing as an average year. Weather, stream flows, reservoir operations, as well as water diversions change on daily, monthly, annual, and decadal scales. Although water budgets are necessarily constructed using averaged data, selection of the period over which data is to be averaged will influence the results.

”The flow data in Figure 2 illustrates two important points. The first point and most obvious is the high degree of variability in the flows. It is not uncommon for annual flows at Otowi Gage to vary by a factor of three over a period of one or two years, from less than 500 KAF/yr to greater than 1,500 KAF/yr. This variability makes management of surface water resources very difficult since there are no large storage reservoirs on the main stem of the Rio Grande. The flow variability at Otowi also illustrates the conceptual difficulty of developing a water budget for the MRG basin as there is no such phenomenon as an “average year.” Thus, a water budget prepared for a single year or even a series of years will vary widely which introduces complexity and limits its utility as an educational tool. Previous budgets are based on average conditions and though inflows and outflows can be averaged to filter out annual variability, the process of averaging makes it difficult to identify long term trends. … The climate also changes over periods of time with periods of drought or wet weather influenced by oceanic and other cycles that are only now beginning to be understood.

“The second, and more subtle point illustrated by Figure 2 is that there may be a long term decline in Rio Grande flows over the last 2 decades. It will not be possible for years to determine whether this is simply due to natural climate variability or a trend that is a result of climate warming. But as with changes in water use by population growth and changes in human use it is difficult to detect or quantify changes in the hydrologic cycle using a water budget based on long term averages.”

October 29, 2014
RIO GRANDE VALLEY STATE PARK, CENTRAL TO MONTAÑO PROJECT:
ENVIRONMENTAL MONITORING PLAN AND BASELINE DATA REPORT

Prepared for City of Albuquerque Open Space Division
Prepared by SWCA Environmental Consultants

“Precipitation from summer rainstorms has little effect on overall Rio Grande flow rates (Western Regional Climate Center 2014). …

“Groundwater in the Albuquerque Reach has declined significantly due to pumping by municipalities. Historically, groundwater recharge was high as a result of increased irrigation within the floodplain. …

“Climate change is likely to significantly affect the MRG and its ecological function over the coming years as drought intensifies and temperatures increase across New Mexico. Recent key articles on changing Southwest and New Mexico climate by Gutzler (2013) and Llewellyn and Vaddey (2013) document how the climate of the Southwest is becoming warmer and less predictable, and how drought is becoming more common and more severe than in the past. The average annual ambient temperatures for the Upper Rio Grande Region of New Mexico (Colorado border to Truth or Consequences) has increased from 1971-2012 by 2.5º F, and in mountainous areas, that increase has been even greater at 2.7º F (Llewellyn and Vaddey 2013).

“Long-term episodic droughts have occurred in the Southwest region for centuries (Gutzler 2013), but the region is strongly affected by ongoing and projected century-scale climate

change (Llewellyn and Vaddey 2013). Gutzler (2013) and Llewellyn and Vaddey (2013) attribute this climate change to human-caused increases in greenhouse gases and report on a strong regional warming trend in recent temperature data that modifies natural drought/high precipitation fluctuations by enhancing evaporative losses and decreasing snowpack in mountainous regions to the north.

“As climate warms, intense storms are expected to increase in the region (Gutzler 2013), and a greater fraction of total annual precipitation is expected to come from single intense rainfall or snowfall events as compared to more frequent low-intensity events. The periodic drought and intense rainfall patterns projected for the region are expected to result in significantly diminished stream flow and drier surface conditions (Seager et al. 2008, Llewellyn and Vaddey 2013), causing the Southwest climate to become even more arid over the coming decades. The impacts of a warming and drying climate are likely to be significant for the MRG bosque, and likely far greater than other human caused environmental impacts.”

MIDDLE RIO GRANDE WATER ASSEMBLY
POST OFFICE BOX 25862 ALBUQUERQUE, NM 87125-5862 505.454-0555

Submission to the Steering Committee

for the

Middle Rio Grande Regional Water Plan Update

June 27, 2015

Part Six

Summary of the Sixteenth Water Assembly

Summary of the Sixteenth Water Assembly

"Climate Disruption and Our Water Future

Mitigate, Adapt or Suffer: A Call for New Strategies"

Introduction

Researchers studying the 2002 drought that killed millions of pinons in the Southwest noticed that some trees fared better than others. Recently they figured out why: a genetic difference made the survivors more resistant to the hot and dry conditions. Their discovery offers the hope that foundation trees like pinons and cottonwoods, trees on which many other species depend, can be adapted to conditions in a warmer world.

Actions to mitigate global warming and to adapt to the changes already underway are taking place on many fronts, from better batteries to store solar energy to energy-conserving building retrofits. There's much more that can and needs to be done, especially in New Mexico, because global warming is going to hit our state hard. Indeed, it likely already has, as evidenced by this century's record-breaking heat, drought, fires and floods. And without bold and concerted action to reduce emissions of heat-trapping gasses, it's going to get worse. [4]

While global warming will have many social, economic and environmental consequences, in New Mexico an overriding one will be its deleterious impact on already overtaxed water supplies. That's why it's imperative that it be addressed in regional and statewide water plans.

Those plans are now being updated, but the Interstate Stream Commission, which is overseeing and coordinating the process, has said a lack of funding precludes them considering climate change consequences and appropriate responses.

We beg to differ. Enough is known about global warming's impacts in the Middle Rio Grande and other regions to do such planning effectively. In fact, the ISC laid the groundwork for such planning in a 2006 report that recommended incorporating climate change projections into strategic planning and implementing adaptive management capacity. There's no reason to wait. It's time to make global warming a priority in state and regional water plans. [5]

For our part, the Middle Rio Grande Water Assembly held a conference on March 21, 2015 to discuss some of the climate change consequences we're facing and to explore ways of dealing with them. This summary report is based on speaker-provided notes and audience comments. (See "Recent Events: Sixteenth Water Assembly" at www.WaterAssembly.org to see the conference agenda with links to speaker biographies, slides and discussion notes.) The report is intended to inform the ongoing update to the Middle Rio Grande Regional Water Plan, state agencies, and other regions that are updating their respective plans.

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[4] The American Association for the Advancement of Science has prepared an overview of what we know about global warming and what to do about it. (See http://whatweknow.aaas.org/get-the-facts/.)

[5] New Mexico's on-again, off-again efforts at addressing climate change are documented in a Natural Resources Defense Council report. (See http://www.nrdc.org/water/readiness/files/water-readiness-NM.pdf.) The report calls on the state to create a comprehensive climate change adaptation plan.

Executive Summary

The extreme weather we've experienced of late -- record-setting heat, drought, fires, and even floods – may well be a foretaste of what global warming has in store for us.

Based on a scenario somewhere between business as usual and the agreed on (and increasingly unlikely) goal of limiting warming to 2 degrees Celsius, scientists project a reduction in average river flows of up to fourteen percent by the decade of the 30s, and up to twenty-nine percent by the 80s. While nature has occasionally imposed comparable cutbacks, these global warming-induced declines will amount to permanent changes. Natural variability will still operate but on a much lower baseline, meaning it's likely that in the future wet years will be closer to historic averages, average years like what today we consider drought, and dry years simply off the charts.

Less water will lead to degraded watersheds, as water-stressed trees succumb to insects, fire, or just plain thirst. We see this happening already with the huge number of pinons killed off by bark beetles 10 years ago and the more recent record-setting Las Conchas and Whitewater-Baldy fires. And without trees and other vegetation to hold back water at the top of area watersheds, even small storms will result in increased flooding and erosion.

When rain does come it's likely to be more intense, which will exacerbate an already difficult situation. The late monsoon storm of Sept. of 2013, a storm that led to near-record flooding and disaster declarations in 12 counties, may well have been a harbinger of what's to come.

Such storms, however, will not counter the overall trend of hotter and drier, a trend that may already be evident in the Elephant Butte Irrigation District where since 2003 annual irrigation allotments have dropped from 3 inches to half an inch per acre and groundwater levels have declined 20 feet or more.

These climate change consequences are practically guaranteed to get worse, because even if all fossil fuel emissions were to cease tomorrow the total to date has already committed us to a significant amount of warming. We're just going to have to adapt as best we can. Fortunately, there is much we can do.

Fostering resiliency – the ability to endure and bounce back from environmental stresses -- is key, and by improving the condition of our forests, fields, rivers and cities we can increase their resiliency to climate extremes. We can improve watershed health by thinning overgrown forests, and when fires do happen, as surely they will, we can mobilize for rehabilitation and prepare for post-fire flood mitigation. We can create a mosaic of habitats along the Rio Grande, and in the process establish buffers that will help cushion high water flows and protect vulnerable infrastructure. We can adopt development practices that make the most out of what little precipitation we get.

Most importantly, we can recognize that the status quo is not a viable option and that we need a new approach to water management and the governance structure for carrying it out, one that promotes collaboration over conflict. And while adaptation must focus on our most critical and impacted resource, we must also recognize – and act on – the reality that no amount of adaptation will suffice if we don't take immediate steps to keep the problem from getting worse.

We have choices: to mitigate, adapt or suffer. Let's make the right ones.

Climate Disruption and Our Water Future

Mitigate, Adapt, or Suffer

Climate change is the seminal issue of our time. It will affect everyone and everything, and because it's caused by the combustion of fossil fuels fixing it will entail wrenching changes to our economy and way of life.

On March 21, 2015 the Middle Rio Grande Water Assembly – which, in partnership with the Mid-Region Council of Governments, in 2004 developed the Middle Rio Grande Regional Water Plan -- held a one-day conference to discuss some of the water-related consequences of climate change and to explore means of mitigating and/or adapting to them. This report summarizes the conference proceedings. Our intent is that it serve as a catalyst for action in our region and statewide.

Water Assembly president **Bob Wessely** began the conference with an **Introduction** and overview of the day's agenda and background on the assembly and regional plan. After pointing out the region's importance – nearly half the state's citizens reside here and it accounts for sixty percent of the state's economy – Bob listed some of the reanclusons for updating the regional plan, including improved water conservation and known shortcomings in the original plan. He concluded by noting that the plan's climatological underpinnings were no longer valid and that we must plan for extreme and potentially unprecedented conditions.

Bob was followed by UNM Civil Engineering professor and Water Resources Program director **Bruce Thomson**, who discussed the **Technical Water Supply and Demand Situation**, how it relates to water budgets, and whether captured stormwater flows could constitute a new source of water.

The value of a water budget is that it provides a quantitative analysis of a basin's water inflows and outflows and whether the two are balanced. Scale, Bruce said, is important in preparing a water budget because what works at a household level may not work or make much of a difference on a regional or statewide scale. Using conservation and stormwater capture as an example, he observed that while it could make a difference in a household water budget where keeping the water bill low is a primary concern, at the urban level conservation can lead to decreased revenues and higher rates, while at the state level it may conflict with downstream water delivery obligations. The grand challenge, he said, lies in figuring out what changes can achieve balance in a basin's water budget, who has the authority to make changes and what the incentives are. He concluded that within a basin all water provides an important service to someone, and that there is no new water to be had.

Bruce was followed by UNM professor of Meteorology and Climatology **David Gutzler**, whose presentation was titled **Hydroclimatic Variability and Change**. David said a stable climate does not equal a static one, and he showed how five hundred years of tree ring data documented fluctuations of up to twenty percent in precipitation and river flows. (It seems that coping with large changes in water supply is nothing new in this part of the world!) Those fluctuations, however, were temporary. Global warming, on the other hand, is expected to permanently lower average river flows, and soon. Using a sort of mid-range climate change scenario under which global average temperatures increase between 3 and 3.5 degrees Celsius by 2100, David said average river flows would decrease by up to 14 percent by the 2030s and up to 29 percent by the 80s. (Mid-continent temperature increases would be double the global average.)i

Offering a brief and concise summation of the climate change problem and what it means, David, who was one of the lead authors of the most recent United Nations report on the issue, said “it’s real, it’s us, it’s bad, scientists agree, there’s hope.”

The next speaker was former NM Water Dialogue director **John Brown**, who explored some of the potential policy and management responses to climate change in a talk titled **Scarcity and Water Governance**. John’s contention was that increasing water volatility and scarcity presents the region, which is characterized by many different water users and management agencies, with a choice: a kind of anarchy where every water user, institution, agency and government pursues their own narrow self-interests (to the detriment of the region as a whole), or what he called polycentric governance, which would be based on extensive cooperation and collaboration.

The latter does not just happen, he said, but results from well-researched and documented design principles, including building trust through interaction and focusing first on shared interests.

John also recommended some guidelines for updating the regional plan and ensuring its implementation, such as committing to build on the existing plan and affirming its public welfare statement, including a comprehensive water budget and creating a coordinating body to monitor progress.

John was followed by **Melinda Harm Benson**, an associate professor in UNM’s Geography Department. Melinda’s talk was titled **A Framework of Resilience**.

The subject of resilience comes up often in discussions about climate change, and for good reason. Climate change will subject humanity to environmental conditions we’ve never before experienced. Resilient communities will be better able to withstand those environmental stresses.

Melinda discussed the role of adaptive capacity in making communities more resilient, and, when the limits of resiliency are reached, of the importance of transformability, which is the capacity to create a new system. And, according to Melinda, the concept and practice of sustainability – meeting the needs of the present without compromising the ability of future generations to meet their needs – is no longer relevant because it’s premised on conditions remaining largely the same. That’s no longer the case. What’s needed, she said, is a new paradigm for a world of continual change. A conceptual framework of resiliency can fill that need.

Five Consequences of Climate Change

Susan Rich, Forest and Watershed Health Coordinator for the State Forestry Division, led off the discussion of climate change consequences and possible solutions with a talk on **Watershed Degradation**.

Because watersheds are where our water comes from, their condition is vitally important. Healthy watersheds, Susan said, are characterized by healthy vegetation and soils, an active nutrient cycle and intact hydrology. Unhealthy watersheds are characterized by overstocked, unhealthy forests, invasive plants crowding out native ones, barren, compacted and eroding soils and a disrupted hydrology. Degraded watersheds equal degraded water quality.

Susan said we can counter watershed degradation by taking actions that maximize the function of watersheds to act as “sponges” that store and slowly release water. Keeping soils moist increases their biological activity and ability to serve as natural water filters. Forests can be made more resilient by

thinning, and biodiversity can be increased by focusing on drought and disease resistant species. We also can plan for disruptions, so that when fire does happen we're more prepared for it.

We know what to do to improve watersheds, Susan said, we just need to prioritize it. Emphasizing the connections between watershed health and the water we depend on will help garner the public and political support needed for carrying out these activities.

Michael Jenson, who works with the Bosque Ecosystem Monitoring Program (BEMP), discussed a second consequence of climate change in a talk titled **Intense Precipitation Events and Flooding**.

Michael explained that while global warming's higher temperatures and shifting weather patterns in general will lead to drier conditions in New Mexico, when it does rain it's more likely to come in the form of a downpour because the atmosphere will be carrying more water vapor due to increased evaporation. A recent possible example of that phenomenon, he said, was the September, 2013 storm that rolled through Albuquerque and produced near-record river and areal flooding and led to a disaster declarations in twelve counties.

Fortunately, ongoing Rio Grande restoration and Silvery Minnow projects helped slow and disperse the storm's flood waters, greatly lessening their impact. The lesson, Michael said, is that we need to do more to prepare for the future, and he cited projects such as the Rio Grande Water Fund, the Valle de Oro site plan, and the Albuquerque/Bernalillo County Water Utility Authority's rainwater harvesting pilot program as examples of the kinds of things we need to do. He also recommended the use of something called a Vulnerability Assessment Tool (VAST), for identifying vulnerable infrastructure and other assets so that steps can be taken to safeguard them.

J. Philip King, professor and associate department head with NMSU's Department of Civil Engineering, examined the third and fourth consequences of climate change in a talk on **Drought and Surface Water Shortages and the Decline of Groundwater Flows**.

Phil's essential point was that the cycle of drought, which increasing temperatures have certainly made worse, amounts to a death spiral for the state's major agricultural district.

Making liberal use of charts and graphs to prove his point, he documented the dramatic decline in Elephant Butte Reservoir's water storage and distribution since the onset of drought in 2003, as well as in groundwater levels, which many farmers have turned to in a desperate effort to maintain production and protect their investment. Those efforts ultimately are doomed to fail, Phil said, because of the positive feedbacks that lead to ever-decreasing water supplies, water quality and mounting costs.

Turning to a discussion of the fundamental law governing use of the river, the 1917 Rio Grande Compact, and noting that climate change was not considered when the Compact was authored, Phil said climate change will lead to persistent Elephant Butte Project shortages, and may lead to continuing Compact shortfalls as well.

Prospects are better for the region's booming border and its municipal and industrial water users, assuming nascent plans for a binational desalination plant get off the ground, but the only certainties, Phil said, is that the status quo is no longer an option and that understanding the dynamics of drought and climate change are critical to adaptation.

Kim Eichhorst, BEMP co-director and UNM research associate professor, addressed the fifth consequence of climate change in a talk titled **Ecosystem Degradation**.

The Rio Grande, Kim said, has been altered significantly from its natural state by human intervention. To control flooding, provide water for agriculture and make land available for development, we've dammed it, straightened it and forced it into a single channel. As a result of these and other changes fire danger is increasing, groundwater levels are declining, and up to ninety-nine percent of the river's historic wetlands have disappeared. The loss of the river's natural mosaic of habitats, Kim said, equals a loss of resilience in the face of drought and changing climatic conditions.

Kim said efforts have been undertaken in recent years to undo some of the damage and that the results are encouraging. At sites where flooding has been reintroduced, for example, native trees and shrubs are out-competing the invasives that formerly dominated.

To increase ecosystem resilience, Kim said, we need to recreate the river's mosaic of habitats. As is the case with improving watershed conditions, we already know a lot about what to do and how to do it. We just need to make it a priority.

Conclusion

Climate change is fast emerging as THE major driver of increasing water scarcity and declining water quality, and addressing it is something we can't afford to put off any longer. Water planning or any other activity that fails to take it into account is pointless. We need to take immediate steps to mitigate the problem to keep it from getting worse, and to adapt the inevitable changes that already are underway.

To restate David Gutzler's assessment of climate change, it's real, it's us, it's bad, and scientists agree. Most importantly, there's hope, but only if we cast aside the denial and false hopes that so far have prevented meaningful progress.