9

Scenarios of Alternative Actions

This chapter presents information about the scenarios. Following the evaluation of the alternative actions as described in Chapter 8, various scenarios were created. A scenario is a collection of alternative actions, chosen and sized so as to collectively meet the mission, goals, and objectives of the region according to a particular vision. Chapter 9 covers the following topics:

- Scenario Development—describes the processes and modeling that led to a set of initial advocacy-oriented scenarios along with a description of those scenarios.
- Scenario Convergence Process—details the convergence of those candidate scenarios known as the Converged Scenario.
- Preferred Scenario—describes the Preferred Scenario which was derived from the Converged Scenario through joint sessions of the Middle Rio Grande Water Assembly (Water Assembly) Action Committee (AC) and the Water Resources Board.

Illustration of the Preferred Scenario Implications—presents an evaluation of the Preferred Scenario in terms of its successes and shortcomings in meeting the mission and goals of the regional water plan.

9.1 Scenario Development

9.1.1 Constituency Groups and Vision Statements

Scenarios are descriptions of journeys to possible futures, how the future might unfold. They reflect different assumptions about how current trends will unfold, how critical uncertainties will play out and what new factors will come into play. While scenarios do not predict, they may paint pictures of possible futures and explore the differing outcomes that might result if basic assumptions are changed. They form an appropriate tool in analyzing how driving forces may influence the future and in assessing the associated uncertainties. The role of policy choices in shaping the future is highlighted wherever possible. Using the alternative actions, scenarios can be told in many ways. The two most common methods used in scenario analysis have been qualitative and quantitative. Qualitative scenarios present descriptive narratives while quantitative scenarios present tables and figures incorporating numerical data including data generated by the Middle Rio Grande model (MRG model) developed by the Cooperative Modeling Team (CMT) in conjunction with the Water Assembly. Refer to Supporting Document M for a description of the model.

As described in Section 7.4, the five constituency groups (CGs) developed visions for a desired future. The constituency groups were Urban Users and Economic Development Advocates (UUEDA), Agricultural, Cultural and Historic Water Use Advocates (AC&HWA), Environmental Advocates (EA), and the Specialists Constituency Group (SCG). The fifth group called itself Water for the Future advocates (WFA). These vision statements included balancing of future consumptive use of water among sectors, as well as descriptive text. Each vision statement was used by the scenario development committees (SDCs) as a part of the input to the scenario development process. Refer to Supporting Document K for a description and guidelines for constituency groups, the Scenario Template, Information Packet and Supplemental Data Packet used by each CG to come up with their scenario.

9.1.2 Cooperative Modeling

This section describes the computer modeling that the Water Assembly employed to help develop the scenario and resultant plan. Modeling was used to select from among alternative actions, to choose proposed sizes of alternative actions, and to understand how multiple actions interacted with each other.

The Water Assembly built a sophisticated computerized model, the MRG model, for the purpose of understanding the "what if" implications of various scenarios. This model addressed about half of the alternative actions. In so doing, the model helped the SDCs and the general public to understand the results of particular actions, action intensities, and action couplings. By showing cumulative effects of multiple actions, the model also served as a sufficiency check on the scenario being considered.

While the model is a helpful tool in providing a sense of the implications of choices, it is important to recognize that the model is limited. The model does not give a reliable image of the future. It has many assumptions and approximations built into it and it only deals with a portion of the alternative actions.

Numerous data outputs are available in the real time of using the model. Key graphic results that were particularly monitored included cumulative effect upon downstream wet-water flows (Rio Grande Compact balances), cumulative effects upon the aquifers (depletion quantities), and cost implications over time.

Table 9-1 provides a listing of the available controls that the user of the model can set and which alternative action(s) the control supports. Table 9-2 indicates the alternative actions that were not addressed by the model, and whose implications had to be subject to the analysis and judgment of the scenario developers.

Through the New Mexico Small Business Assistance Program, numerous small businesses associated with Water Assembly participants arranged to obtain substantial support from Sandia National Laboratories (SNL) to develop the model. The SNL team of experts worked with the Water Assembly's CMT to develop and refine the model. The CMT consisted of a representative from each CG and from each working team (WT), plus a representative from the Mid-region Council of Governments (MRCOG). In addition, the UNM Utton Transboundary Resource Center provided facilitation support for the model development and utilization process. Representatives on the CMT are listed in Chapter 4. The CMT met approximately biweekly with the SNL team to review and guide the model development. The purpose was to help assure correctness in the model and credibility among the model users.

In addition to critique and testing by the CMT, the resultant model and model attributes were reviewed and critiqued by experts from numerous entities in and around the region. These entities included S. S. Papadopulos and Associates on behalf of the Interstate Stream Commission, CH2M Hill on behalf of the City of Albuquerque, the U.S. Bureau of Reclamation, the U.S. Geological Survey, the Middle Rio Grande Conservancy District, and D.B. Stephens and Associates on behalf of MRCOG.

A full description of the human interface, functionality, mathematics, and reference data for the model is presented in Supporting Document M.

9.1.3 Scenario Development Committees

This section summarizes how the region assembled the list of candidate alternative actions into a converged scenario. The Water Assembly created a SDC for each specified scenario.

As described in Section 8.1, the Alternatives Working Team (AWT) developed a set of 44 candidate alternative actions. The AWT analyzed these actions according to several criteria, and also obtained extensive public input on their acceptability and desirability. In parallel, the Water Assembly developed several budgeting approaches for balancing water use with renewable supply (Section 7.4). The public gave input to constituency groups as they developed vision statements and the resultant budgets.

Out of nearly a dozen important goals presented in the MRG regional Water Plan Mission, Goals and Objectives (Appendix A), SDCs identified three goals that were of key importance on selecting the set of initial scenarios. The three goals are:

B. Preserve Water for a Healthy Native Rio Grande Ecosystem

C. Preserve Water for the region's Agricultural, Cultural, and Historical Values

D. Preserve Water for Economic and Urban Vitality

In response to those three goals, three scenario key orientations were chosen. One SDC developed an environmentally-oriented scenario, based upon the previous EA budget and vision statement. A second SDC built an agriculturally-oriented scenario, based upon the previous AC&HWA budget and vision

Table 9-1 Listing of the MRG model's available controls and which of alternative action(s) the control supports (Source: The Middle Rio Grande Water Assembly)

Category	Alternative	Slider bar or button
Residential/ Non-Residential	**A-22**, Conservation Incentives **A-61**, Domestic Well Controls; A-18, Urban Conservation **A-15**, Preserve Deep Water for Drinking	Existing Population to Convert to Low Flow Appliances Low Flow Appliances in New Homes Existing Homes Changing Yards to Xeriscape Xeriscaping of New Homes Reduce Size of Yards in New Homes Reduction in Consumption by Xeriscape
	A-28, Infill/Density	Convert Existing Commercial Property to Low Flow Appliances Low Flow Appliances in New Construction Convert Existing Commercial Property to Xeriscaping Xeriscaping of New Construction Reduce Landscaping for New Commercial Property Reduce Acreage of Parks and Golf Courses
	A-21, Water Pricing	Price Elasticity of Demand Average Price of Water
	A-27, Re-Use Treated Effluent **A-26**, Domestic Wastewater	City of Albuquerque Water Re Use Plan
	A-44, Water Harvesting	Existing Acreage Convert to Rooftop Harvesting Rooftop Harvesting for New Construction
	A-24, Re-use Greywater	Existing Population to Convert to On-Site Greywater Use On-Site Greywater Use for New Construction
Bosque	**A-1**, Bosque Management	Sandoval County Bosque Acreage Bernalillo County Bosque Acreage Valencia County Bosque Acreage Bosque Treatment Time Horizon

Table 9-1 (continued) Listing of the MRG model's available controls and which of alternative action(s) the control supports (Source: The Middle Rio Grande Water Assembly)

Category	Alternative	Slider bar or button
Agriculture	**A-9,** Conveyance Systems	Length of Conveyance Channel to Line and Cover
	A-60, Acequia Conservation Programs	Length of Conveyance Channel to Line
	A-10, Irrigation Efficiency	Desired Farm Acreage to Line/Pipe Delivery Canals
		Desired Acreage to Laser Level
		Desired Drip Irrigation Acreage
		Irrigated Crop Acreages
	A-11, Low-Water Crops	
Reservoirs	**A-45**, Reservoir Management	Abiquiu Shared Pool Authorization
	A-38, Surface Modeling	Abiquiu Reauthorization
		Compact Renegotiation
		Year Renegotiation Takes Effect
		Minimum Reservoir Volume
		New Northern Reservoir
		Year New Reservoir or Recharge Project is Complete
	A-46, Aquifer Storage	Artificial Recharge
		Year New Reservoir or Recharge Project is Complete
Desalination	**A-39**, Desalination	Desired quantity of desalinated water
		Water source
		Desal Interest Rate
		Year desalinated water is available
Population Growth	**A-52**, Growth Management	Population Growth Rate Adjustment, Sandoval County Municipal Users
		Population Growth Rate Adjustment, Bernalillo County Municipal Users
		Population Growth Rate Adjustment, Valencia County Municipal Users
		Population Growth Rate Adjustment, 3-County Self-Supplied Users
Drought	Affects all alternatives	Year Drought Begins
		Years Drought Will Last
		Drought Intensity

Table 9-1 (continued) Listing of the MRG model's available controls and which of alternative action(s) the control supports (Source: The Middle Rio Grande Water Assembly)

Category	Alternative	Slider bar or button
Transfers	**A-69**, Importation of Water	Treated Socorro & Sierra Bosque Acreage Future Socorro & Sierra Crop Acreage Time Horizon for Change Cost to Retire an Acre of Farm Land

Table 9-2 Alternative actions by category, broken out according to how modeled (Source: The Middle Rio Grande Water Assembly)

Category	Alternative Action	Alt. Id No.	Modeled	Not modeled	Indirectly modeled
Increase Water Supply	Watershed Plans	A-66		X	
	Bosque Management	A-1	X		
	Reservoir Management	A-45	X		
	Surface Modeling	A-38			X
	Aquifer Storage	A-46	X		
	Reuse Greywater	A-24	X		
	Reuse Treated Effluent	A-27	X		
	Desalination	A-39	X		
	Importation of Water	A-69	X		
	Water Harvesting	A-44	X		
	Soil and Vegetation Management	A-33		X	
	Vegetation Removal Products	A-2			X
	Storm Water Management	A-34		X	
	Vegetation Management	A-40		X	
	Wetlands	A-36		X	
	Weather Modification	A-42		X	

Table 9-2 (continued) Alternative actions by category, broken out according to how modeled (Source: The Middle Rio Grande Water Assembly)

Category	Alternative Action	Alt. Id No.	Modeled	Not modeled	Indirectly modeled
Decrease or Regulate Water Demand	Urban Conservation	A-18			X
	Urban Water Pricing	A-21	Model includes single pricing rather than block pricing.		
	Conservation Incentives	A-22			X
	Education	A-56			X
	Irrigation Efficiency	A-10	X		
	Agricultural Metering	A-7			X
	Conveyance Systems	A-9	X		
	Metering Water Supply Wells	A-8		X	
	Domestic Well Controls	A-61			X
	Acequia Conservation Programs	A-60			X
Change Water Uses to Increase Supply/Decrease Demand	Low-Water Crops	A-11			X
	Land Use	A-30		X	
	In-Fill/Density	A-28	X		
	Preserve Deep Water for Drinking	A-15			X
Water Rights Regulation	Instream Flow	A-63		X	
	Conjunctive Management	A-144			
	Water Rights Adjudication	A-71		X	
	Evaporative Loss Accounting	A-51		X	
	Domestic Wastewater	A-26		X	
	Well Head Protection	A-50		X	
Water Quality Protection	Water Quality	A-47		X	

Table 9-2 (continued) Alternative actions by category, broken out according to how modeled (Source: The Middle Rio Grande Water Assembly)

Category	Alternative Action	Alt. Id No.	Modeled	Not modeled	Indirectly modeled
Implementation of Water Plan & Management of Water Resources	Water Bank/Authority	A-67		X	
	Growth Management	A-52			X
	Public Involvement Program	A-53		X	
	Maintain Water Resource Database	A-73		X	
	Active Water Resource Management	A-143			
Water Funding	Severance Tax	A-59			X
	regional Water Planning Program	A-58			X

Notes:

Daniel B. Stephens & Associates, Inc. performed a detailed evaluation of the 25 alternatives listed in italics.

The Water Assembly Alternatives Working Team and the Analysis Team performed a qualitative evaluation of the 19 alternatives listed in regular print.

The full feasibility analysis of each alternative can be found in the fact sheets, located at MRCOG offices or at www.WaterAssembly.org/9information.html.

This table was prepared by the Water Assembly Public Participation and Communication Team (PPC), April 2003.

statement. A third developed an urban-oriented scenario, based upon the previous UUEDA budget and vision statement. Then, in light of these previous three scenarios, a fourth SDC came up with a blended scenario, based upon a synthesis of the previous three budgets and visions. The fifth SDC, was instruction to create a scenario from any basis they wanted to use. This SDC called itself Water for the Future Advocates (WFA).

In order to seek some reasonable balancing and as a reality check on the resultant scenarios, two people from each constituency group were assigned to participate in each SDC. So, for example, the UUEDA constituency group included two members from the EA and two from the AC&HWA. In addition, the SDCs used a modeling tool to help bring a technical reality basis to the resultant scenarios. The public commented upon the resultant scenarios in community conversations series 6 (see chapter 4).

The synthesis SDC through ad hoc sessions with advocates worked to develop a single converged scenario using the base scenarios as bounds, along with comment received from the public, available technical data, and evaluation tools. The resulting scenario was reviewed and critiqued in regional forum series 6.

The critiquers identified a number of shortfalls. The specialists constituency group worked out a better convergence through technical analysis and joint sessions with the Water Assembly and the Water Resources Board. Descriptive material for this final converged scenario appears below. Supporting Document K contains the additional analyses and joint meeting reports that lead to this final converged scenario.

9.1.4 Initial Scenarios

A purpose of the five initial scenarios was to set a boundary framework for converging on a single scenario. During initial scenario development the SDCs used the MRG model to provide sufficiency guidance. While not able to make exact predictions, the model aided the first four SDCs in estimating when the scenario would meet the mission without violating downstream obligations. The model parameter settings that were used for the first four scenarios are presented together in Table 9-3. Details of the individual scenarios can be found in Supporting Document K.

Table 9-3 Individual scenario variable settings and outputs (Source: The Middle Rio Grande Water Assembly)

Alternatives	Model Sliders	Agricultural SDC	Environ-mental SDC	Urban SDC	Synthe-sis SDC
A-18: Urban Conservation (modeled)	Residential				
	Existing Population to Convert to Low Flow Appliances	20%	90%	40%	80%
	Low Flow Appliances in New Homes	Yes	Yes	Yes	Yes
	Existing Homes Changing Yards to Xeriscape	40%	90%	30%	80%
	Xeriscaping of New Homes	Yes	Yes	Yes	Yes
	Reduce Size of Yards in New Homes	20%	20%	40%	50%
	Reduction in Consumption by Xeriscape	50%	66%	50%	50%
A-21: Urban Water Pricing (modeled)	Price Elasticity of Demand	-0.15		-0.30	Model default
	Average Price of Water	Increase to $2.00	Increase to $1.97/1,000 gallons	$2.49/ 1,000 gallons	Model default ($1.09)
	Existing Acreage Convert to Rooftop Harvesting	20%	30%	20%	15%
	Rooftop Harvesting for New Construction	Yes	Required	Yes	No
	Existing Population to Convert to On-Site Graywater Use	20%	30%	20%	5%
	On-Site Graywater Use for New Construction	Yes	Required	No	No
	Nonresidential				
	Convert Existing Commercial Property to Low Flow Appliances	20%	90%	80%	80%

Table 9-3 (continued) Individual scenario variable settings and outputs (Source: The Middle Rio Grande Water Assembly)

Alternatives	Model Sliders	Agricultural SDC	Environmental SDC	Urban SDC	Synthesis SDC
	Low Flow Appliances in New Construction	Yes	Yes	100%	Yes
	Convert Existing Commercial Property to Xeriscaping	40%	90%	90%	80%
	Xeriscaping of New Construction	Yes	Yes	100%	Yes
	Reduce Landscaping for New Commercial Property	20%	50%	50%	50%
	City of Albuquerque Water Re Use Plan	Yes	Yes	Yes	Yes
	Reduce Acreage of Parks and Golf Courses	20%	Reduce size of new urban parks and golf courses by 20%	30%	10% reduction
	San Juan Chama				
	Use San Juan Chama Water?	Yes	full use by Albq.	Yes	Yes
	San Juan Chama Supply	75,800 af		75,844 afy	75,844 afy
	Bosque				
	Bernalillo Acreage	All (0)	21,000 acres	all	9,451
	Sandoval Acreage	All (0)		all	4,160
	Valencia Acreage	All (0)		all	8,180
	Bosque Treatment Time Horizon	20 yrs.	20 years	15 years	100% over 20 years
A-9: Conveyance Systems (modeled)	Agriculture				
	Control – Conveyance				
	Length of Conveyance Channel to Line and Cover	0	50 miles of MRGCD ditches	0 mi	Zero

Table 9-3 (continued) Individual scenario variable settings and outputs (Source: The Middle Rio Grande Water Assembly)

Alternatives	Model Sliders	Agricultural SDC	Environmental SDC	Urban SDC	Synthesis SDC
	Length of Conveyance Channel to Line	0*	125 miles of MRGCD ditches	300 mi	150 miles
A-10: Irrigation Efficiency (modeled)	Control – Irrigation Efficiency				
	Desired Acreage to Laser Level	20,000 acres	30,000 acres	20,000	15,000
	Desired Farm Acreage to Line/Pipe Delivery Canals	0	5,000 acres	15,000	5,000
	Desired Drip Irrigation Acreage	0		5,000	0
A-11: Low Water Use Crops (modeled)	Control – Crop Acreages				
	Alfalfa	15,000 acres	Reduce alfalfa acreage	Reduce to 10,000acre	Reduce default by 6,000 acres
	Corn				Default
	Sorghum				Default
	Wheat				Default
	Oats	10,000 acres	Increase acreage for oats		Default
	Fruit			Raise up to 2,500 acre	Default
	Nursery				Default
	Melons				Reduce default by 5,000 acres
	Pasture	10,000 acres	Reduce acreage	Hay - Reduce to 7,500 acre	Default
	Peppers				Default
	Misc. Vegetables	5,000 acres	Increase acreage for vegetable crops		(Baseline minus 11,000 acres)

Table 9-3 (continued) Individual scenario variable settings and outputs (Source: The Middle Rio Grande Water Assembly)

Alternatives	Model Sliders	Agricultural SDC	Environmental SDC	Urban SDC	Synthesis SDC
	Total Crop Area	44,000 acres	Reduce to 34,000 acres	25,000	As computed by model
	Total Crop Consumption	82,.000 af	72,000 af	58,000 af/year	
	Desalination				
	Desired quantity of desalinated water	Not selected	22,500 afy	22,500 af	15,0000 afy
	Water Source		Tularosa Basin	Estancia	Tularosa Basin
	Interest Rate			2%	
	Year Desalinated Water is Available		2015	2025	2030
A-52: Growth Management (modeled)	Population				
	Bernalillo	Reduce by 10%	Reduce growth rate projections by 25%	85%	Model Default
	Sandoval	Reduce by 10%	Reduce growth rate projections by 20%	95%	Model Default
	Valencia	Reduce by 10%	Reduce growth rate projections by 20%	100%	Model Default
	self-supplied	Reduce by 10%	Reduce growth rate projections by 20%	85%	
				1,196,146	
	Drought				
	Year Drought Begins	2000	2000	2040	2002
	Years Drought Will Last	25	5	5	10

Table 9-3 (continued) Individual scenario variable settings and outputs (Source: The Middle Rio Grande Water Assembly)

Alternatives	Model Sliders	Agricultural SDC	Environmental SDC	Urban SDC	Synthesis SDC
	Drought Intensity	5%	35%	20%	Equivalent to 1950's drought
	Transfers				
	Treated Socorro & Sierra Bosque Acreage	20,000 ac.	17,500 acres	20,000	No transfers assumed
	Future Socorro & Sierra Crop Acreage			12,500	
	Time Horizon for Change		10 years	15 years	
	Cost to Retire an Acre of Farm Land			$20,000	
	Reservoirs				
	Control – Reauthorization				
	Abiquiu Shared Pool Reauthorization		Yes	No	no changes
	Abiquiu Reauthorization		(no increase until environmental impacts are assessed)	Yes	
	Compact Renegotiation		Yes	Yes	
	Year Renegotiation Takes Effect		2010	2010	
	Minimum Reservoir Volume		400,000 af in EB	292,000	
	Control – New Storage				
	New Northern Reservoir			Yes	
	Artificial Recharge		2015	Yes	
	Year New Reservoir is Completed			2030	

9.2 Scenario Convergence Process

The next step in the process was to blend the five initial scenarios into a Converged Scenario. A Synthesis SDC was established to create a draft converged scenario by blending the five initial scenarios. This draft was then reviewed, critiqued, and updated through a series ad hoc Water Assembly sessions. The critiques included use of the model, but more importantly, specifically addressed the subset of alternative actions that had not been included within the computer modeling.

The initial Converged Scenario was presented at the combined regional Forum Series 6 and 7th Annual Assembly on June 7, 2003. The scenario is here described by the list of model parameter controls (Table 9-4), the list of recommendations for the unmodeled alternative actions (Table 9-5), and the four key resulting data sets (graphs) from the model for the scenario (Figures 9-1 and 9-2). Additional information is available in Supporting Documents K.

There are actually two versions of the Converged Scenario, each portraying a different drought forecast. Version 1 hypothesizes a 25-year drought, with 25 % reduction in inflows, coming in at 12% below the 2200-year average. Version 2 hypothesizes that water use will remain level with the last 25 years of a wet cycle.

The Converged Scenario includes the alternative actions that have been incorporated into the MRG model, as well as some unmodeled alternatives. In deciding what to include in the model, participants in the process determined that these alternative actions were likely to have the greatest potential for helping to manage water to ensure future supplies. The other alternative actions, some with only slightly less potential, have not been included in the model. The unmodeled alternatives are important not only for their potential to save water, but also because they incorporate values other than water savings, such as protection of the habitat of the Rio Grande.

When the model runs with this scenario, it does not provide a sufficient flow of water out of the region to comply with the Rio Grande Compact. The next task was to consider how to improve the mix of alternative actions (both modeled and unmodeled) to assure compliance with the Rio Grande Compact and to meet the mission to balance water use with a renewable supply.

9.3 The Preferred Scenario

This section presents a summary of the management actions employed in the Preferred Scenario, including those in the model, broken out by categories.

After the Converged Scenario of Section 9.2 was critiqued through the Regional Forum, the Specialists Constituency Group and the Analysis Team resolved some of the issues that had been raised. The scenario was then brought before a series of joint sessions of the Action Committee and the Water Resources Board for turning into a final Preferred Scenario. This section presents the final Preferred Scenario of water management actions. This scenario, along with the technical analyses, the public preference ratings, the alternative actions, and the alternative actions' ancestry, was used as the major input for the plan recommendations that appear in Chapter 10. See Supporting Document K for more detailed information on the scenario development process. The alternatives discussed in Section 8.1 are referenced by their number, such as A-1. Considerations used in working toward the Preferred Scenario, are included as Supporting Document P. In this way, readers can see some of the issues and questions considered in the development of the scenario.

9.3.1 Vision and Assumptions

Prefacing the Preferred Scenario of water management actions is the vision followed by a set of three key assumptions which underlie the choice of actions and their respective intensities. The three assumptions are inflows and precipitation, population growth, and diversion of imported San Juan-Chama Project water. The planning time frame is fifty years.

Table 9-4 Convergence Scenario model settings (Source: The Middle Rio Grande Water Assembly)

Residential	**Setting**	**Bosque**	**Setting**
Convert existing Resid. Prop. to Low Flow Appliances	80%	Bernalillo Acreage	0
Low Flow Appliances in New Homes	yes	Sandoval Acreage	0
Convert Existing Homes to Xeriscaping	30%	Valencia Acreage	0
Xeriscaping of New Homes	yes	Bosque Treatment Time Horizon	20
Reduce Size of Yards in New Homes	40%		
Reduction in Consumption by Xeriscape	50%	**Reservoirs**	
Average Price of Water (per 1,000 gallons)	$3.00	Abiquiu Shared Pool Authorization	yes
Convert Existing Acreage to Rooftop Harvesting	25%	Abiquiu Reauthorization	no
Rooftop Harvesting for New Construction	yes	Compact Renegotiation	change
Convert Existing Homes to On-Site Graywater Use	5%	Year Renegotiation Takes Effect	2015
On-Site Graywater Use for New Construction	yes	Minimum Reservoir Volume	400,000
		Control – New Storage	
Non-Residential		New Northern Reservoir	no
Convert Existing Comm. Prop to Low Flow Appliances	80%	Artificial Recharge	yes
Low Flow Appliances in New Construction	yes	Year New Res. or Recharge Project is Complete	2010
Convert Existing Commercial Prop to Xeriscaping	30%		
Xeriscaping of New Construction	yes	**Desalination**	
Reduce Landscaping for New Commercial Property	5%	Desired quantity of desalinated water	22,500
Apply City of Albuquerque Water Re Use Plan	yes	Desalination Interest Rate	6%
Reduce Acreage of Parks and Golf Courses	80%	Water source	Tularosa

Table 9-4 (continued) Convergence Scenario model settings (Source: The Middle Rio Grande Water Assembly)

Residential	Setting	Bosque	Setting
		Year desalinated water is available	2020
San Juan / Chama Diversion Project			
Use San Juan Chama Water?	yes	**Drought**	
San Juan Chama Supply	60,000	Year Drought Begins	2002
		Years Drought Will Last	25
Agriculture		Drought Intensity	25%
Control – Conveyance			
Length of Conveyance Channel to Line & Cover	0	**Transfers from Socorro & Sierra**	
Length of Conveyance Channel to Line	150	Treated Bosque Acreage	17,500
Control – Irrigation Efficiency		Future Crop Acreage	12,500
Desired Farm Acreage to Laser Level	44,000	Time Horizon for Change	50
Desired Farm Acreage to Line/Pipe Delivery Canals	7,500	Cost to Retire an Acre of Farm Land	$20,000
Desired Drip Irrigation Acreage	2,500		
Control – Crop Acreages		**Population**	
Total Crop Area	44,000	Bernalillo	100%
Total Crop Consumption	95,000	Sandoval	100%
		Valencia	100%
		Self-supplied	100%

Table 9-5 Converged Scenario Unmodeled Alternative Actions (Source: The Middle Rio Grande Water Assembly)

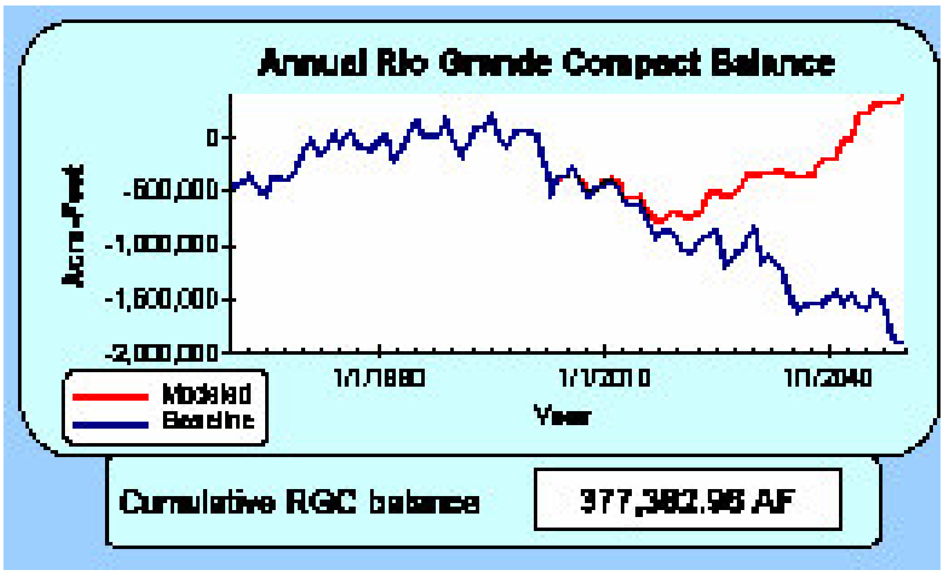
Category	Alternative Action	Alt. Id No.	Convergence
Increase Water Supply	Watershed Plans	A-66	high minus
	Soil and Vegetation Management	A-33	high minus
	Storm Water Management	A-34	high minus
	Vegetation Management	A-40	low
	Wetlands	A-36	medium plus
	Weather Modification	A-42	low
Decrease or Regulate Water Demand	Metering Water Supply Wells	A-8	no consensus
Change Water Uses to Increase Supply/Decrease Demand	Land Use	A-30	split opinion
	Instream Flow	A-63	no consensus
	Water Rights Adjudication	A-71	High
	Evaporative Loss Accounting	A-51	Low
Water Quality Protection	Water Quality	A-47	High
	Domestic Wastewater	A-26	medium minus
	Well Head Protection	A-50	High
Implementation of Water Plan & Management of Water Resources	Water Bank/Authority	A-67	split opinion
	Public Involvement Program	A-53	high minus
	Maintain Water Resource Database	A-73	High
	Active Water Resource Management	A-143	High

Key:

high = important, consensus
high minus = important to at least two groups
medium = fairly important, consensus
medium plus = important to at least one group, fairly important to majority
medium minus = fairly important to at least one group, not to rest
low = not important at this time
no consensus = groups were in all three categories
split opinion = groups in high and low categories

Figure 9-1 Modeled results of the draft converged scenario—Version 1 (Source: The Middle Rio Grande Water Assembly)

These graphs show cumulative results for the model. The darker line shows the baseline and the other the changes when the scenario is run. These cumulative effects are plotted against the baseline condition that assumes no changes to current water practices. Note that the scale is different between the Rio Grande Compact Balance and the Annual Groundwater Depletion chart. The range in the charts indicate that there is a potential range in future water supply due to variations in climate. Version one hypothesizes a 25-year drought, with 25 percent reduction in inflows, coming in at 12% below the 2200-year average:



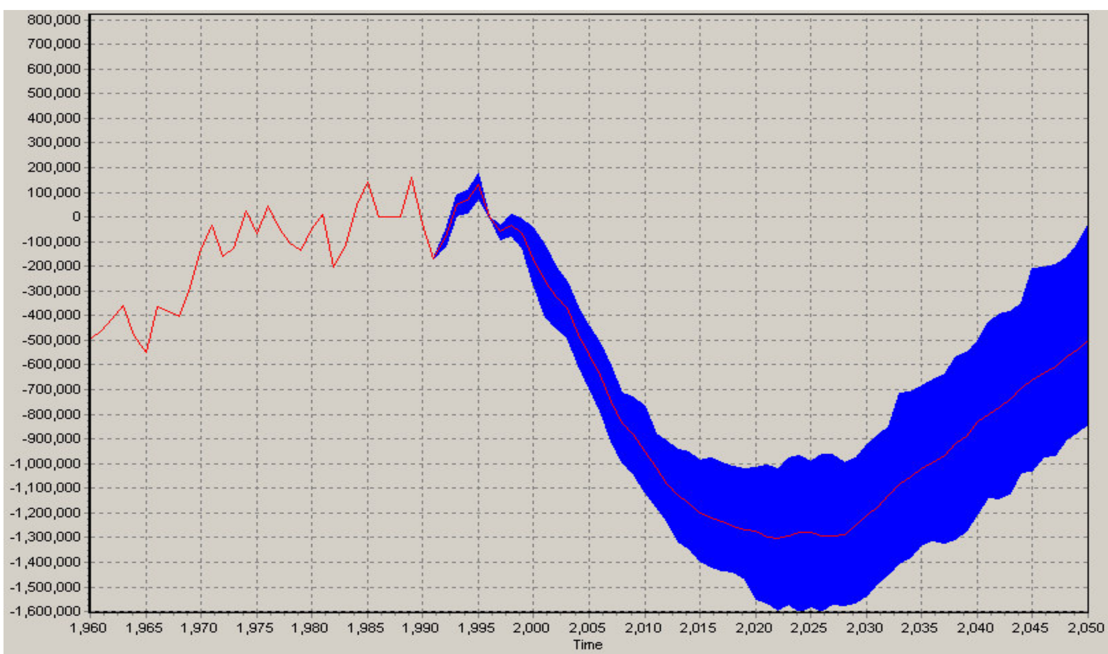
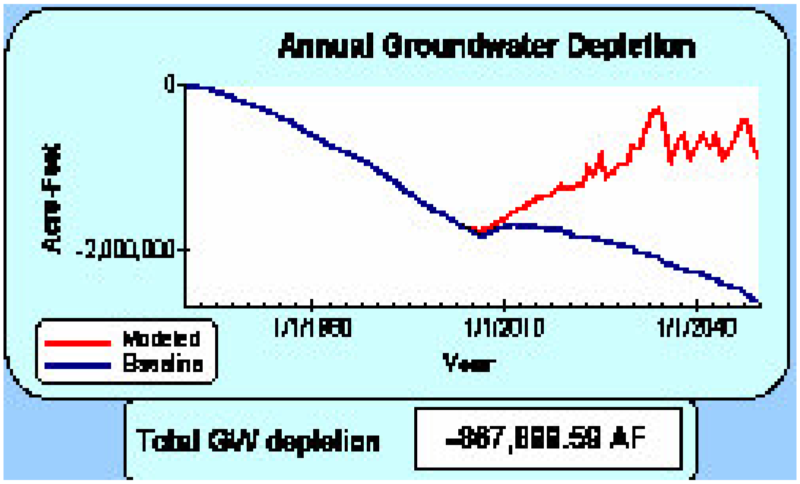


Figure 9-1 (continued) Modeled results of the draft converged scenario—Version 1 (Source: The Middle Rio GrandeWater Assembly)



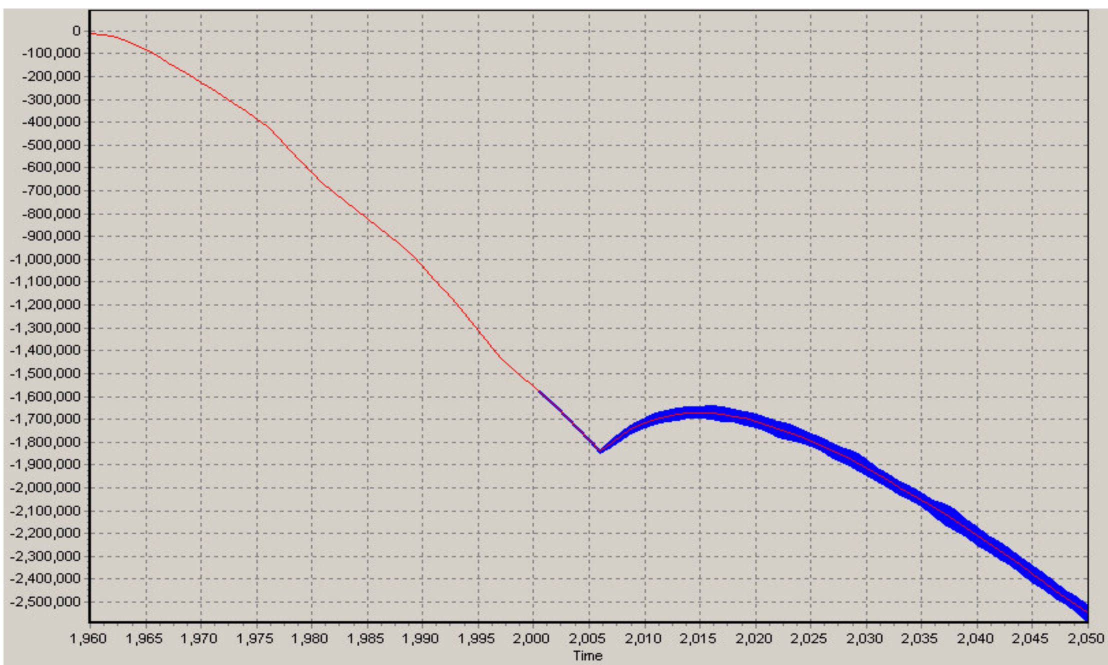
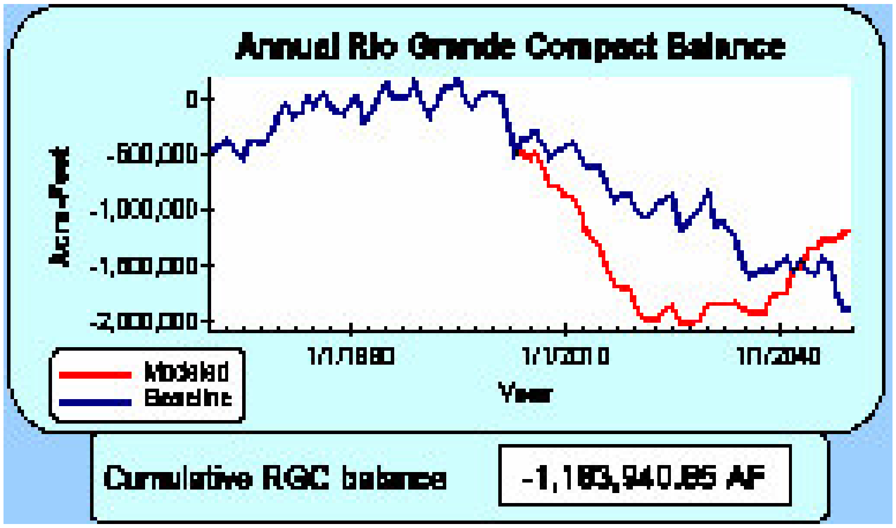


Figure 9-2 Modeled results of the draft converged scenario—Version 2 (Source: The Middle Rio Grande Water Assembly)

Version 2 hypothesizes that conditions will remain level with the last 25 years of a wet cycle.



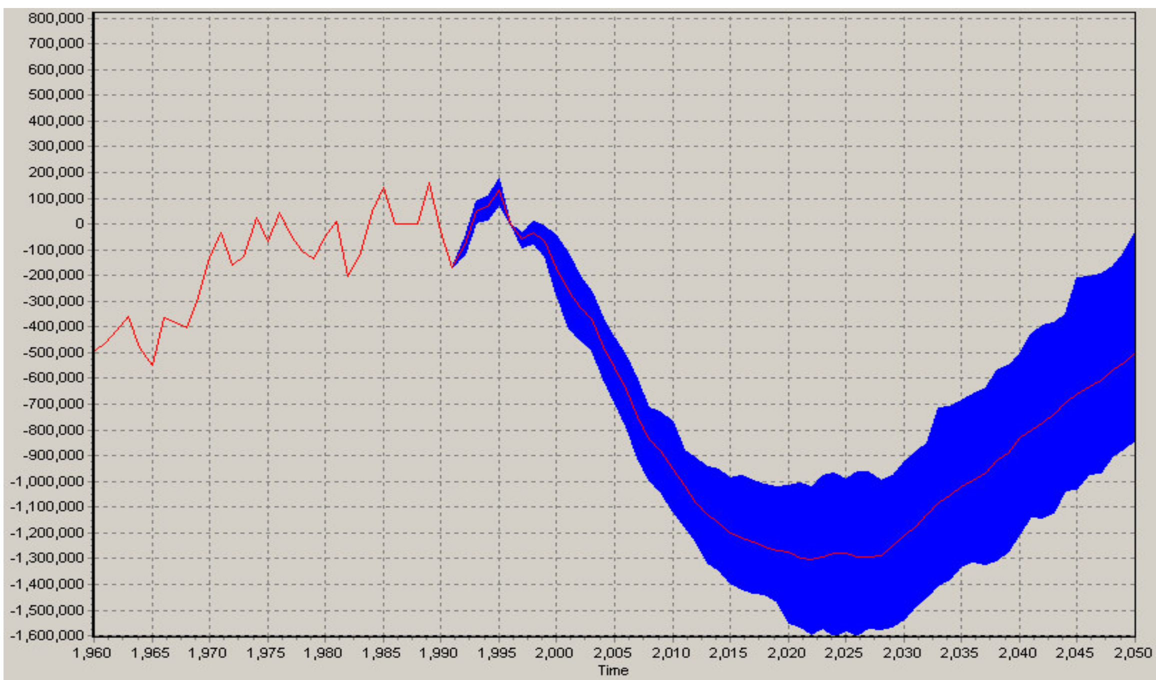
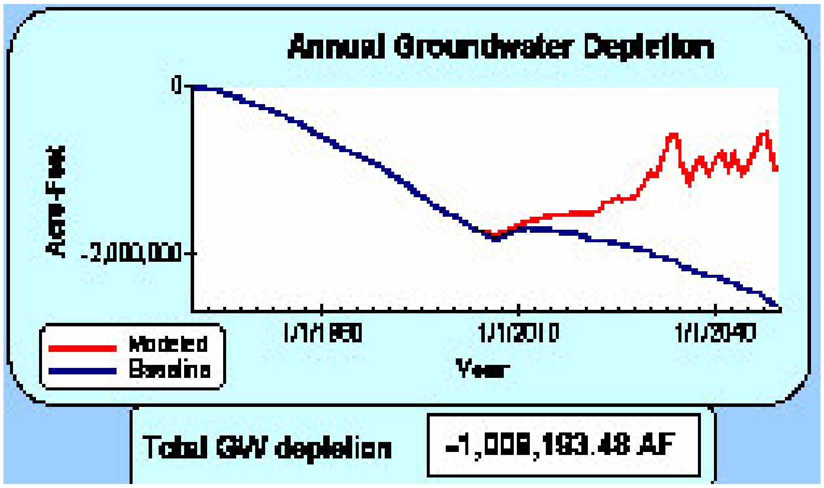
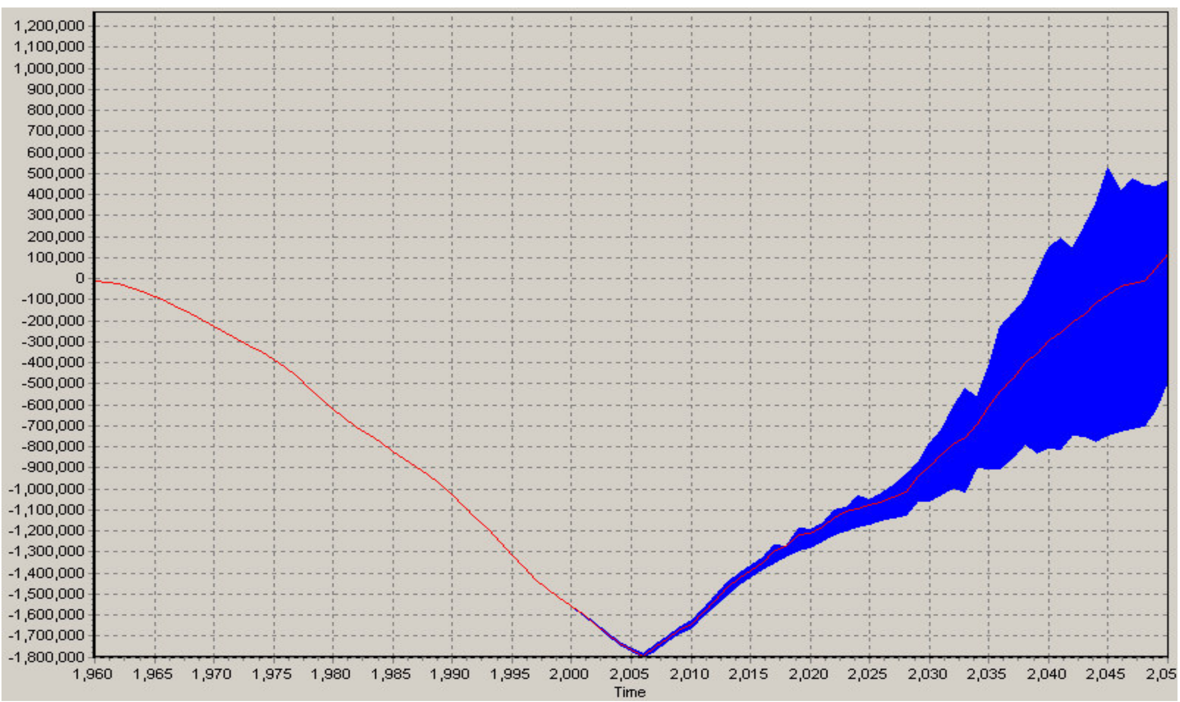


Figure 9-2 (continued) Modeled results of the draft converged scenario—Version 2 (Source: The Middle Rio GrandeWater Assembly)





Vision

The mission of the regional water plan, targeted by this scenario, is to balance water use with renewable supply. The region is presently substantially out of balance. The average annual consumption is estimated to be 316 thousand acre-feet. Study estimates of the average annual deficit range from 41 to 70 thousand acre-feet per year. We are using 55 thousand as our working estimate of the deficit, which is 17% of our consumption. To achieve balance we will need to reduce our use and/or increase supply.

This plan presents the region's position on water development, water conservation, and some environmental issues affecting water resources and water quality. A main goal of this document is to help water managers, planners, legislators and other parties formulate the management strategies and policies needed to direct their efforts into the new century. This document should also be a valuable resource for those in the general public interested in contributing to water-related decisions at all levels of government. There are a number of actions suggested.

We know that we must live within the constraints imposed by the Rio Grande Compact and that we must cease depletion of the aquifer so it can be used to even out fluctuations in our annual supplies. We must respect water right holders. Potential lawsuits by downstream neighbors, issues of water quality, sharing water with tribal entities when their rights have not been quantified, Endangered Species Act requirements, and variability in weather are other considerations. Population increases will add new users, adding further demands.

To fulfill the mission of the water plan, and lessen the long-term consequences of ongoing deficit spending, the deficit between supply and demand of 55,000 acre feet must be curtailed as soon as possible. Unless new sources of water are found, any new uses of water will have to come from existing uses and achieve this reduction goal.

The Middle Rio Grande Water Budget (Appendix B), from which this reduction goal was derived, was prepared in 1999. The results of continuing to add annual deficits to the accumulated debt of approximately half a cubic mile, or 1.7 million acre feet, is illustrated in a recent USGS report. "The recent (1999 to 2002) water levels presented in this report indicate that beneath the Albuquerque metropolitan area, ground water on either side of the Rio Grande currently flows toward the major pumping centers from all directions" (Bexfield and Anderholm 2003). In order to keep this accumulating debt from affecting our own water future --in addition to our children's—we need to balance the budget now, rather than delay what needs to be done any further.

Inflows/Rainfall Assumptions

The scenario requires a projection of the level of surface inflows and within-region rainfall for the planning period. As with any projection, there are substantial uncertainties in what will really happen. The projected levels of inflows and rainfall are important because they guide the intensity of remedial actions recommended to meet the mission within its constraints. A projection that is too wet will set the region up for ongoing "emergencies"; a projection that is too dry will impose unnecessary costs upon the region. The Preferred Scenario contains two different projections. We consider the implications of both. The two projections are termed "Recent Historical" and "Tree Ring", based on the key sources of data for each. Rechecking these projections should be a particular focus of updates to this regional water plan. Global climate change modeling, may have further impact on the accuracy of the projections (Karl and Trenberth 2003). In order to refine our projections of the future, we recommend that a small study be funded to confirm or refute the hypothesized proportionality between tree ring rainfall data and surface inflow data.

Recent Historical Prediction

We have three main choices in our selection of recent historical data for the scenario prediction. These are the last quarter of the twentieth century, the last half of the twentieth century, and the entire twentieth century. The last quarter was clearly a very wet period. The last half included some drought times and some wet times. The whole century is similar to the last half, but has some incompleteness in available data. We choose to use the last half of the century approach for the Recent Historical Prediction in this scenario. Specifically, we choose to use the recorded data from 1950 through 1998, which averaged 9 inches per year in the MRG Region.

Tree Ring Prediction

A broadly published tree ring study conducted at El Malpais (southwest of Grants, NM) reports year-by-year rainfall for the past 2200 years. For our tree ring prediction, we hypothesize that rainfall levels at El Malpais were approximately proportional to the MRG Region's inflows and rainfall. In essence, we hypothesize that when El Malpais went through long dry (or wet) periods, the MRG and southern Colorado also were dry (or wet). For the Tree Ring Prediction in this scenario, we choose the inflows and rainfall to be based on 8 inches of precipitation (94% of the Recent Historical Prediction). However, this tree ring scenario is a secondary scenario, not the baseline.

Drought Planning

For the purpose of drought planning, we conjecture a relatively short period of reduction in inflows and precipitation. For reference, we consider the historical period from 1950 to 1956, the famous 1950s drought. For drought planning we will assume a ten-year drought period with inflows and precipitation being 6 and 5 inches respectively (67% of the above two projection patterns). This pattern may still be optimistic in terms of intensity and of duration of drought.

Population Assumptions

The Preferred Scenario assumes that population growth will occur over the 50-year planning horizon at rates projected by the Bureau of Business and Economic Research at the University of New Mexico. Using these rates, the regional population grows from about 710,000 people in 2000 to about 1.27 million people in 2050. We recognize that resource limitations, demographic evolution, and/or policies we recommend, if implemented, might affect the fulfillment of the BBER population projections. The projections therefore need to be monitored over the years on a regular basis.

Imported San Juan-Chama Project Water Assumptions

In the Preferred Scenario, the Albuquerque Drinking Water Project is assumed to come on line as planned in 2006. The amount currently contracted to users within the Middle Rio Grande is approximately 70,400 af. Contracted amounts into the region are currently allocated as follows: Albuquerque 48,200, Bernalillo, 400, Belen 500, Los Lunas 400, and MRGCD 20,900 afpy. Physical conditions and permitting may affect the annual amount actually delivered.

9.3.2 Urgent Shortfall Reality

The initial scheduling of actions in the scenario may leave us with a Rio Grande Compact shortfall for ten to twenty years. Consequently, we would need to accelerate the implementation of our water planning actions. We would need to eliminate any projected short-term deficits in our compliance with the Rio Grande Compact until the plan's actions have had time to take effect. All users, municipal and rural, should share in the substantial contributions to the effort. The state and the region should work openly and cooperatively to address this issue. Specific urgent actions should be identified, studied, evaluated and implemented that are focused on increasing river flow to avoid defaulting on the Rio Grande Compact. These actions will have urban and rural economic impacts, but such impacts should be temporary. Unless there is a priority call, water right holders must be fairly compensated for any temporary loss of use rights when water is reallocated to meet compact delivery requirements.

9.3.3 Urban and Rural Conversation Activities

The Preferred Scenario features rigorous conservation efforts including the installation of low flow appliances (e.g. showerheads, faucets, toilets, and clothes washing machines) in 80 percent of existing properties, with low-flow appliances installed in all new properties. It also calls for converting 30 percent of existing landscaping to xeriscape and requiring xeriscaping for all new construction. This scenario also assumes that 25% of existing homes will collect water through rooftop rain harvesting and that all new homes will have rooftop rain harvesting systems. Additionally, 5 percent of existing homes will convert to on-site gray water re-use, and gray water re-use will be standard in all new homes. There will be a 5% reduction in landscaped acreage in commercial properties and growth rate of water use for future parks and golf courses would be reduced by 80% from the current growth rate (A-18, A-21, A-22, A-56, A-24, A-27, A-44, A-61).

Governments in the region should develop, adopt and implement sustainable water resource management plans coordinated with the Water Resources Board, and the Water Providers Council, and the State Engineer that could include:

- reduce water consumption;
- minimize impact on water resources;
- encourage conservation-oriented economic development;
- ensure adequate water supplies for any proposed development, and consider the carrying capacity and location of development.
- integrate with other major plans in the region

9.3.4 Water Resource Planning and Management

The Preferred Scenario includes a variety of initiatives that will need to be undertaken and implemented at various governmental levels from local through federal (A-58). These initiatives include:

- Identify, quantify, and adjudicate all water rights and all wet water quantities in the water planning region within 25 years, via negotiation (A-71).
- Seek additional legislation in order to extend the regional capacity for leasing and other forms of water banking. An education component is necessary in order to make leasing and banking generally acceptable and understood. This educational component should include clear definitions and/or principles detailing what is intended. As part of this scenario, water banking would be implemented within the region to maximize beneficial use and to permit the water right to stay with the owner while the water is leased for a period of time (A-67).
- Address groundwater/surface water interactions more explicitly in the statutes for administering water rights and reconcile conflicts in the law (conjunctive management) (A-144).
- Establish a state-based dedicated recurring revenue stream for water projects, planning and conservation (A-59). Augment with federal money such as a national infrastructure program and revenue stream for water planning and conservation.
- Request OSE/ISC to propose an equitable distribution of evaporative losses of Rio Grande water among regions on the river and among compact states (A-51). Spring 2004 information from the ISC indicates that the compact has already apportioned the waters of the basin; evaporative losses are considered neither an asset nor a liability. Therefore, this does not seem to be a viable option.
- Encourage active water resource administration by the OSE/ISC, including native, imported, surface, ground, and reused waters, to encourage that only the necessary water be drawn (A-143).
- Establish and integrate a regional Geographical Information System (GIS) database of publicly accessible information on water resources and photo imagery covering the water planning region (A-73).
- Implement local and regional watershed management plans through all land and water agencies in the area to increase water yield, to prevent erosion, to protect and improve forest health and to protect recharge zones (A-66).

- Encourage local jurisdictions to integrate the land use, transportation, economic development, and water components of each of their comprehensive plans; and to integrate their comprehensive plans with the Regional Water Plan (A-52, A-30, A-28).
- Establish erosion prevention measures and use soil and vegetation management techniques to reduce runoff and increase infiltration throughout the watershed, including forested mountains and uplands (A-33).
- Create, enhance and expand local government storm water management plans and programs on a region-wide basis to minimize erosion, control runoff, enhance infiltration and recharge, and prevent pollution of surface and ground water (A-34).
- Establish region-wide educational programs, including school curricula and projects, to encourage full awareness of the full range of water issues among the citizenry, and voluntary conservation of water (A-56).
- Ensure that water planning continues through open, inclusive and deliberative processes that provide for in-depth consideration of policy issues by diverse stakeholders to enable participants to come to informed recommendations (A-53).
- Establish regular and continuous monitoring of the plan and update as necessary the provisions of this plan.
- Establish performance measures to gauge the ability of local governments to implement this plan and regularly report back to the public.

9.3.5 Water Monitoring and Measurement

The Preferred Scenario also states that all uses of water in the MRG Region should be measured. Although controversial, this scenario calls for metering all water supply wells, including domestic wells, and all surface water flows through irrigation systems, throughout the water-planning region (A-7, A-8, A-73).

9.3.6 Agriculture

The scenario includes lining 150 of the 750 miles of MRGCD irrigation conveyances, chosen after consideration of the extent of leakage, impact on recharge to the underground reservoir, preservation of riparian use, impact on water quality, impact on wells, and impact on habitat. It also includes, when feasible, laser leveling irrigated fields, lining on-farm irrigation canals, and developing drip irrigation on irrigated acres under cultivation (A-10, A-7, A-9). Funding for acequia conservation programs is encouraged (A-60).

Provide education for farmers, ranchers, newcomers, and delivery system operators on available support programs and means of operating efficient water conveyance systems in New Mexico.

Neither total crop acreage nor crop-type distribution is altered in the Preferred Scenario (A-11). But, with no policy changes, there is likely to be a 25-30% reduction in irrigated acreage by 2050 (MRGCOG 2001).

The scenario would permit emergency leasing of agricultural water to meet Rio Grande Compact obligations and environmental needs and would develop protective mechanisms to support the overall value of agricultural lands, including:

- benefits to ecosystem health
- potential in terms of recharge, compact delivery, food security and economics
- cultural and historic value
- contribution to the quality of regional airshed and viewshed
- agricultural economy (A-60)

9.3.7 Water Quality

Maintain sufficient surface-water quality and ground-water quality in order to ensure access to safe drinking water and provide for varied non-drinking uses (agricultural, environmental, recreational, cultural, etc.). Water quality in the region can be maintained in two ways: 1) reduce contaminant impacts on water supplies, and 2) enhance naturally occurring water quality. The following actions are designed to address water quality:

- Ensure compliance with federal, tribal, state and local standards for water quality pertaining to surface waters, drinking water, storm water, and wastewater (A-50).
- Identify, protect and monitor areas vulnerable to contamination (A-47).
- Enforce wellhead protection programs on all public water supply wells within local government jurisdictions (A-50).
- Replace conventional septic systems where needed with systems that provide better protection of groundwater quality by: 1) construction of new or expanded centralized wastewater treatment systems and 2) use of advanced technology for on-site wastewater treatment (A-26, A-47).
- Preserve the highest quality waters in the region for drinking purposes (A-15).
- Join with efforts to mitigate point source pollution impacting the region.
- Establish programs to address non-point source pollution in the region.
- Improve water quality monitoring, testing and treatment for ground and surface waters throughout the region (A-47).

9.3.8 Bosque and Other Riparian Habitats

Another high priority in the Preferred Scenario is ensuring the health of the river and bosque. The scenario includes removal of exotic vegetation from all 17,000 acres of bosque within the levees and replanting with native plants (A-1).

In addition, the scenario calls for continued studies on evapotranspiration so that the findings can be applied to vegetation management programs and encourage the region to develop the economic potential of non-native species removal, harvesting, and output of products by local industries. (A-40, A-2)

Additionally, this scenario calls for creating constructed wetlands for groundwater recharge, water harvesting, habitat improvement, and hydrological management of the Rio Grande. (Wetlands may be best utilized following standard water treatment to further enhance water quality.) (A-36)

To further develop and support the river and its riparian environment, the scenario includes designating in-stream flow as a beneficial use (A-63).

Restoration of riparian areas outside the levees should also be considered (A-33, A-2).

9.3.9 Water Storage to Reduce Evaporative Losses

The scenario assumes that the City of Albuquerque storage space in Abiquiu Reservoir may be leased to allow others to store water in the available storage space under agreement with Albuquerque. Such storage could be a lower-evaporation alternative to storage in Elephant Butte, and it could provide storage space for an environmental conservation pool. The scenario calls for initiating artificial recharge capabilities in the region starting in 2010 (A-46).

It also calls for efforts to maximize and explore other options for upstream storage, and in so doing maintain the pool at Elephant Butte Reservoir as close to, but no lower than, the Compact threshold of 400,000af. The Preferred Scenario provides general support for project initiatives through which the region would seek to store as much water upstream as possible to the extent that it may be approved by regulatory authorities and consistent with avoiding significant harm to the environment. These initiatives would require congressional authorization (A-45, A-38).

9.3.10 Desalination

The Preferred Scenario includes several technological approaches to assist in meeting water resource management requirements. The scenario provides for treating saline and brackish water for potable or non-potable use in the region. Desalination is used in various parts of the world as well as in the United States to obtain fresh water. In addition to the Tularosa basin and the Estancia basin, there are reliable reports of large reserves of brackish to highly saline ground water in the Middle Rio Grande Basin as well as in areas surrounding the basin outside the MRG Region.

Although costs for initial infrastructure, pipelines, energy use and brine disposal are presently substantial, cost reduction resulting from continuing technological advances can be expected. In view of reports of large reserves of brackish or saline water in the Middle Rio Grande Basin and neighboring areas, sufficient brackish or saline water to achieve a maximum supply of 22,500 acre-feet per year of desalinated water may be readily available. Accordingly, while considering the need for and expectation of scientific advances in the desalination process and the expectation that the price of water will increase over time sufficient to cause desalination to become economical, there is sufficient reason for the scenario to propose the desalination and transportation of water.

Recognizing the very large uncertainties, we estimate a 22,500 afpy may be available within 30 years for the Middle Rio Grande Region, which may have to be revised as knowledge grows. We feel reasonably certain that desalination will provide some water to the region within the next 20 years. We recommend that technical and feasibility studies be funded and proceed as soon as possible. Should less supply materialize, we recognize water balancing must come from others sources.

9.3.11 Transfer of Water

Under the Preferred Scenario, it is assumed that exotic phreatophyte species could be removed from all 17,500 acres of bosque in Socorro and Sierra counties and be revegetated with native species. The scenario also assumes that surface water rights will continue to be purchased from agricultural use in those counties, reducing agricultural acreage (A-69).

9.4 Assessment of the Preferred Scenario

9.4.1 Evaluation of the Preferred Scenario

The aim of the Preferred Scenario was to utilize the candidate alternative actions to meet the mission and goals of the plan.

The evaluation as to whether goals were met was deferred until the recommendations resulting from the Preferred Scenario were defined selected, as discussed in Chapter 10. The support of the goals by the various recommendations, and hence by the scenario, appears as Table 10-1.

The evaluation of the scenario’s effectiveness in meeting the mission – balance water use with renewable supply - is considered by estimating the water implications of the chosen alternative actions over time. Two figures of merit were the primary considerations – the projected decline or lack thereof in the aquifer storage and the projected ability to meet demands for water within the region without compromising the state’s ability to meet its Rio Grande Compact obligations. Illustrations are presented below in Sections 9.4.2 and 9.4.3.

Recognizing the limitations on modeling and uncertainties in predicting future events, we have developed two examples of model results. Section 9.4.2 presents the Preferred Scenario essentially as written. Several of the plan objectives identified there may prove very difficult to achieve in reality. As a sensitivity check on the example results, these objective values were adjusted to potentially more achievable targets in a second example as reported in Section 9.4.3.

A table relating the statement/number of each chosen alternative action in the Preferred Scenario, the water implication of the action as interpreted for the scenario, cost implication of the action as interpreted, and a description of side effects of the action as interpreted will be developed during updates of the plan during 2004.

9.4.2 Illustration of the Preferred Scenario Implications

An illustration of the implications of the Preferred Scenario is provided below using Version 3.2.2 of the MRG model, but it is, indeed, only an illustration. No formal evaluation of the Preferred Scenario has been prepared because final agreement on the Preferred Scenario presented in Section 9.3.2 did not explicitly rely upon the MRG model. All of the previous scenario modeling results were available to participants in the joint Water Assembly and Water Resources Board workshops which produced the Preferred Scenario, but discussion, compromise and eventual agreement focused directly and exclusively on the textual description of the draft Preferred Scenario, rather than numerical analysis of its implications. Participants in the workshops were left to rely upon or not rely upon the previous numerical model output, at their individual discretion.

In part, this final step in the negotiation of a Preferred Scenario simply reflected the ad hoc evolution of the workshop discussions as participants sought ways of compromising differing points of view into wording which all could accept. In part, this final step reflected a concern among at least some participants in the workshops that the model itself should not constrain the final selection of a Preferred Scenario. A few words of explanation of this latter concern may be helpful.

Computer models of water systems relevant to the MRG Region exist in various forms pertinent to the purpose for which they were constructed. The U.S. Geological Survey has constructed a highly detailed model of the aquifer in order to gauge the effect of past and future pumping. The Office of the State Engineer now utilizes another version of this model in reaching its decisions regarding ground-water permitting. The New Mexico Interstate Stream Commission and the U.S. Army Corps of Engineers contracted with S.S. Papadopulos & Associates to construct a probabilistic model of the water supply available to the Middle Rio Grande to assist those agencies and the regional water planning effort in understanding the effect of different policies or practices on the water budget. Finally, the Bureau of Reclamation is constructing the Upper Rio Grande Water Operations Model (URGWOM) to assist it in actual management decisions in the Upper Rio Grande.

In this modeling context, considerable sensitivity surrounds the validation of any particular model relative to the purposes to which it is applied, and this is the case with the MRG model. There was broad consensus that the MRG model was very valuable in educating both the public and the planners themselves on the nature of the regional water situation and the actions which could be taken to fulfill the mission, goals and objectives of the plan. However, that consensus did not extend to vesting the model with final measurement authority as to the likely results of a Preferred Scenario. Some planners placed great stock in the actual values predicted by the model; others did not.

It is unlikely that these differences in judgment could have been resolved within the time period available to complete the plan, nor was it necessary to achieve that resolution. The plan is not intended to be a forecast of the water future of the MRG Region. Rather, it is a guide to actions which need to be taken to make that future as propitious as possible for the region. The model has been a valuable instrument in achieving the plan, but the final decisions are properly left to the planners and the public generally rather than the model per se.

This perspective should also guide interpretation of the illustrated results of the Preferred Scenario below. Namely, the illustration is put forth purely as one possible embodiment of the agreed upon scenario rather than as a set of specific quantified actions to which planners have collectively assented. For some planners the model settings listed in Table 9-6 may be close to what they would like to see actually occur. For others, these settings may not be viewed as desirable, achievable or even acceptable.

Table 9-6 contains the computer model settings based upon the Preferred Scenario. In the model, all actions are deemed to occur within 15 years. Please note that while the Preferred Scenario does not always contain numbers, the computer model requires such to operate. For example, the laser leveling of fields when feasible, as suggested in Section 9.3.6 was modeled by laser leveling 22,000 acres. The assumed (not recommended) reduction in agriculture of 25-30% mentioned in Section 9.3.6 was modeled by reducing alfalfa and pasture acreage proportionally. A further note to consider when reducing agricultural lands is that if all reductions occur on non-Pueblo lands, then the reduction is far greater than 25-30%. For more information on the model, calculations, values and settings, see Cooperative Water Resources Modeling in the Rio Grande Basin (Passell, et al 2003).

In establishing getting the settings of Table 9-6, the model required some settings which did not explicitly appear in the Preferred Scenario. The following values were assumed.

• Reduce Irrigated Acreage of Yards in New Homes	40%
• Desired Farm Acreage to Laser Level	22,000 ac
• Desired Farm Acreage to Line/Pipe Delivery Canals	7,500 ac
• Desired Drip Irrigation Acreage	2,500 ac
• Transfer from Socorro & Sierra Crop Acreage	7,500 ac
• Cost to Retire an Acre of Farm Land	$20,000
• Treatment time horizon	15 years
• Interest rate	6%
• Payback time horizon	30 years

The assumptions by the evaluators for the Preferred Scenario and below for Sensitivity Check Scenario are for purposes of example only. They may not represent the thoughts of the Water Assembly or of the Water Resources Board. The assumptions used here will be evaluated during the implementation of the plan and revised if needed.

The results of running the Sandia model, Version 3.2.2, with the Preferred Scenario illustrative settings are reported in Figure 9-3. With these settings, the model projects a significant cumulative shortfall in Compact deliveries (up to almost 450,000 acre feet) before the effects of the water-saving measures are achieved, but by 2050 a surplus of about 750,000 acre-feet is produced. Aquifer depletions are also arrested followed by accumulating recharge until stabilizing toward the end of the planning period.

9.4.3 Second Illustration, Sensitivity Check Scenario

When the evaluators ran the model as associated with the Preferred Scenario for the first illustration (with settings as in Table 9-6) they noted that the settings for a number of the "preferred" attributes might be more likely achievable considering political and cultural issues. Accordingly, the evaluators modified several of the settings to see their effect on the results for cumulative aquifer depletion and for Rio Grande Compact cumulative balance. They called the result the "Sensitivity Check Scenario". The complete set of Sensitivity Check Scenario settings are in Table 9-7. Most settings were left unchanged from the Preferred Scenario. Selected settings were modified as follows:

• Convert Existing Residential Property to Low Flow Appliances	from 80% to 15%
• Convert Existing Homes to On-Site Greywater Use	from 5% to 20%
• Convert Existing Commercial Property to Low Flow Appliances	from 80% to 15%
• Reduce Growth in Water Use by Parks and Golf Courses	from 80% to 20%
• Desalination	from 22,500 af/y to 7,500 afpy
• Years Drought Will Last	from 10 to 25
• Drought Intensity	from 11% to 17%
• Transfer from Socorro & Sierra Crop Acreage	from 7,500 ac to 0 ac
• Agricultural Acreage Reduction	from 25%-30% to no change

The evaluators' reasoning in choosing the changes for the sensitivity check scenario were as follows:

The change from 80% to 15% in conversion to low flow appliances to achieve better realism (residential and commercial) is based upon previous experience in low-flow programs. To date the City of

Table 9-6 Slider Bar Settings for Illustration of Preferred Scenario (Source: The Middle Rio Grande Water Assembly)

	Setting		Setting
Residential		**Ag, continued**	
Convert Existing Residential Property to Low Flow Appliances	80%	Alfalfa	17,000 ac
Low Flow Appliances in New Homes	yes	Corn	no change
Convert Existing Homes to Xeriscaping	30%	Sorghum	no change
Xeriscaping of New Homes	yes	Wheat	no change
Reduce Irrigated Acreage of Yards in New Homes	40%	Oats	no change
Reduction in Consumption by Xeriscape	40%	Fruit	no change
Price Elasticity of Demand	-.15	Nursery	no change
Average Price of Water	no chg	Melons	no change
Convert Existing Acreage to Rooftop Harvesting	25%	Pasture	13,000 ac
Rooftop Harvesting for New Construction	yes	Peppers	no change
Convert Existing Homes to On-Site Graywater Use	5%	Misc. Vegetables	no change
On-Site Graywater Use for New Construction	yes	Total Crop Area	37,500 ac
		Total Crop Consumption	85K af/y
Non-Residential			
Convert Existing Commercial Property to Low Flow Appliances	80%	**Reservoirs**	
Low Flow Appliances in New Construction	yes	Abiquiu Shared Pool Authorization	yes
Convert Existing Commercial Property to Xeriscaping	30%	Abiquiu Reauthorization	no
Xeriscaping of New Construction	yes	Maximize Upstream Storage	yes
Reduce Landscaping for New Commercial Property	5%	Minimum Reservoir Volume	400,000 af
Apply City of Albuquerque Water Re Use Plan	yes	New Northern Reservoir	no
Reduce Growth in Water Use by Parks and Golf Courses	80%	Artificial Recharge	yes
		Year New Res. or Recharge Project is Complete	2010
San Juan / Chama Diversion Project			
Use San Juan Chama Water?	yes	**Desalination**	
San Juan Chama Supply	70,400 af/y	Desired quantity of desalinated water	22,500 af/y
Date for San Juan Chama Supply Change	2006	Water source	MRG
		Year desalinated water is available	2020
Bosque Restored			
Bernalillo Acreage	all	**Drought**	
Sandoval Acreage	all	Year Drought Begins	2002
Valencia Acreage	all	Years Drought Will Last	10
		Drought Intensity	11%
Population compared to BBER Prediction			
Bernalillo (see Chapter 7)	100%	**Transfers**	
Sandoval (see Chapter 7)	100%	Treated Socorro & Sierra Bosque Acreage	17,500 ac
Valencia (see Chapter 7)	100%	Transfer from Socorro & Sierra Crop Acreage	7,500 ac
Self-supplied (see Chapter 7)	100%	Cost to Retire an Acre of Farm Land	$20,000

	Setting		Setting
Agriculture		**Global Settings**	
Length of Conveyance Channel to Line & Cover	0	Treatment time horizon	15 years
Length of Conveyance Channel to Line	150 mi	Interest rate	6%
		Payback time horizon	30 years
Desired Farm Acreage to Laser Level	22,000a		
Desired Farm Acreage to Line/Pipe Delivery Canals	7,500 a		
Desired Drip Irrigation Acreage	2,500 a		

Albuquerque has had slightly greater than a 10% success rate in low-flow toilets, and less in the other recommended low-flow appliances. In 2003, Gary Woodard of the research faculty of University of Arizona informally indicated that a 10% conversion of existing residences to low-flow appliances–toilets, sinks, showers and washing machines–is considered successful.

The increase from 5% to 20% in greywater conversion to achieve better realism is based upon a symmetry with the projected low flow appliance programs in the plan.

The reduction in future growth rate of water use by parks and golf courses to 20% of the historical growth rate was based upon non-formal recommendations.

The level of drought was incremented from 11% by 6% to show a reduction comparable to the 1950s drought superimposed upon the very long-term tree ring average precipitation for the area. The duration of 25 years was based upon the reports on Pacific Decadal Oscillation (Liles 2003).

The quantity of desalinated water available within the region was reduced from 22,500 afpy to 7,500 afpy because of the various concerns about the risk of mining of brackish water in the region having the side effect of impacting fresh water supplies.

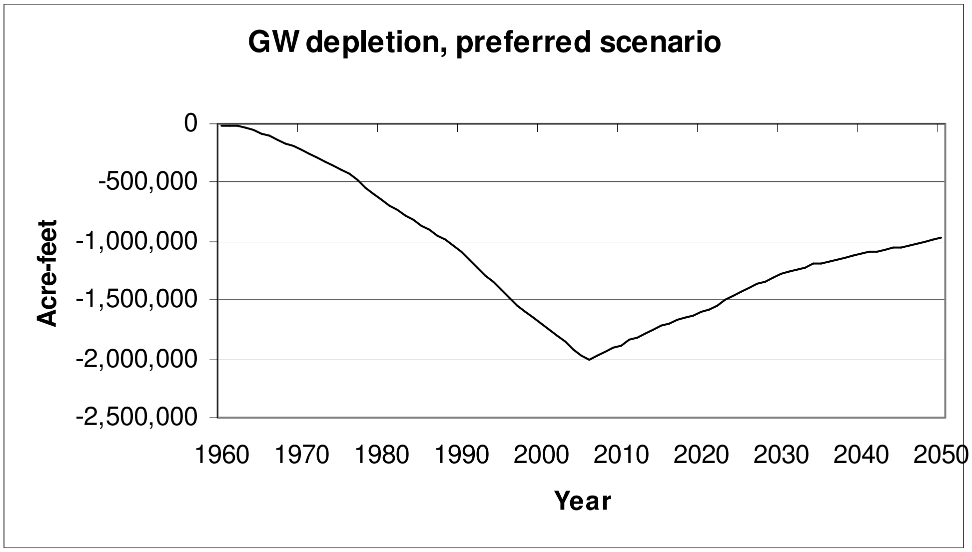
The quantity crop acreage to be transferred from the Socorro-Sierra Region was reduced from 7,500 acres to 0 acres in recognition of the Socorro County Commission directive precluding export of water.

Reduction in crop acreage was reduced to zero because the agricultural acreage in the region was reported by D.B. Stephens and Associates to have remained substantially constant in the region over that past decade, mostly because of increases in Pueblo irrigation.

As a part of the sensitivity analysis, to see how much effect the various increments had, the evaluators tabulated the modeled values for cumulative Rio Grande Compact Balance at 2050 and the cumulative Aquifer Depletion at 2050 as each of the incremental changes was applied. The results appear in Table 9-8.

The results of running the MRG model, Version 3.2.2, with the adjusted Sensitivity Check Scenario illustrative settings are reported in Figure 9-4. With these settings, the model projects a more significant decline in Rio Grande Compact deliveries (up to about 700,000 acre-feet) before the effects of the water-saving measures are achieved, but by 2050 a deficit of only about 50,000 acre-feet is produced. Aquifer depletions are also arrested followed by accumulating recharge until stabilizing, perhaps with a slight downtrend, toward the end of the planning period.

Figure 9-3 Results of Sandia Model Preferred Scenario Illustration (Source: The Middle Rio Grande Water Assembly with assistance from Sandia National Laboratories)



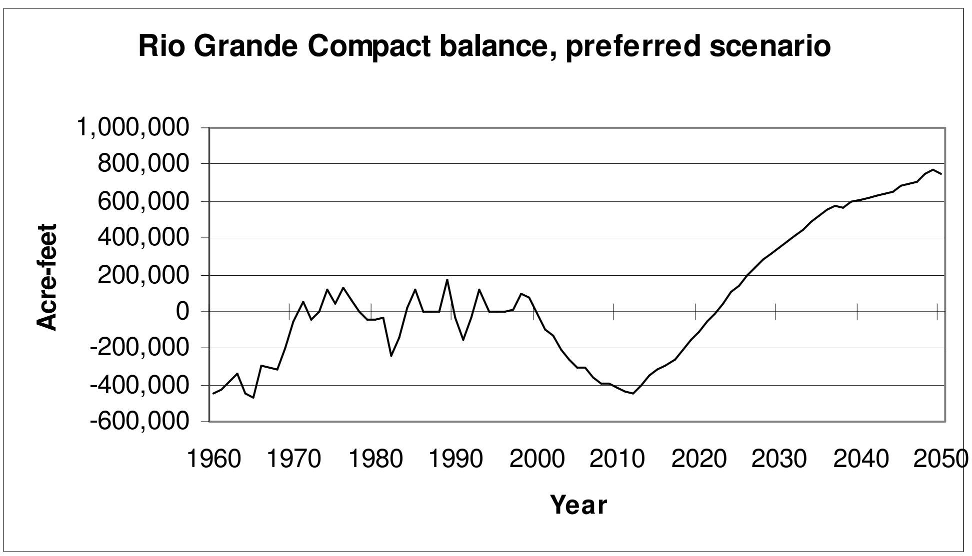


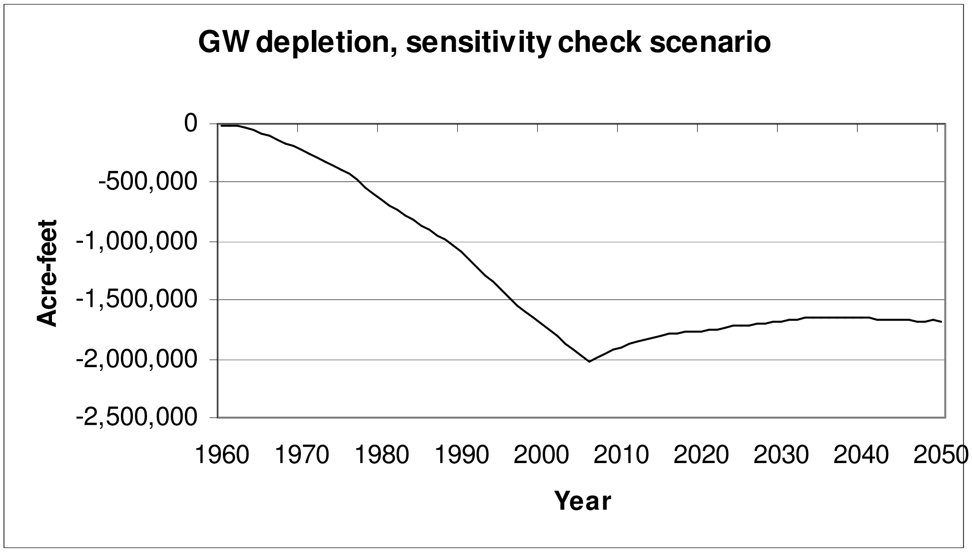
Table 9-7 Slider Bar Settings for Illustration of Sensitivity Check Scenario (Source: The Middle Rio Grande Water Assembly)

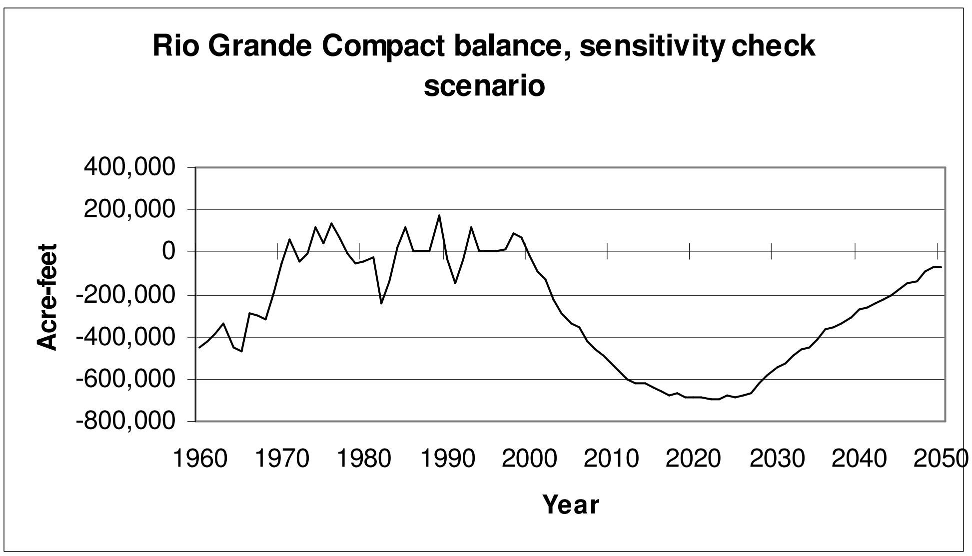
	Setting		Setting
Residential		**Ag, continued**	
Convert Existing Residential Property to Low Flow Appliances	15%	Alfalfa	no change
Low Flow Appliances in New Homes	yes	Corn	no change
Convert Existing Homes to Xeriscaping	30%	Sorghum	no change
Xeriscaping of New Homes	yes	Wheat	no change
Reduce Irrigated Acreage of Yards in New Homes	40%	Oats	no change
Reduction in Consumption by Xeriscape	40%	Fruit	no change
Price Elasticity of Demand	-.15	Nursery	no change
Average Price of Water	no chg	Melons	no change
Convert Existing Acreage to Rooftop Harvesting	25%	Pasture	no change
Rooftop Harvesting for New Construction	Yes	Peppers	no change
Convert Existing Homes to On-Site Graywater Use	20%	Misc. Vegetables	no change
On-Site Graywater Use for New Construction	Yes	Total Crop Area	50,000
		Total Crop Consumption	85K af/y
Non-Residential			
Convert Existing Commercial Property to Low Flow Appliances	15%	**Reservoirs**	
Low Flow Appliances in New Construction	Yes	Abiquiu Shared Pool Authorization	yes
Convert Existing Commercial Property to Xeriscaping	30%	Abiquiu Reauthorization	no
Xeriscaping of New Construction	Yes	Maximize Upstream Storage	yes
Reduce Landscaping for New Commercial Property	5%	Minimum Reservoir Volume	400,000 af
Apply City of Albuquerque Water Re Use Plan	Yes	New Northern Reservoir	no
Reduce Growth in Water Use by Parks and Golf Courses	20%	Artificial Recharge	yes
		Year New Res. or Recharge Project is Complete	2010
San Juan / Chama Diversion Project			
Use San Juan Chama Water?	yes	**Desalination**	
San Juan Chama Supply	70,400 af/y	Desired quantity of desalinated water	7,500 af/y
Date for San Juan Chama Supply Change	2006	Water source	MRG
		Year desalinated water is available	2020
Bosque Restored			
Bernalillo Acreage	all	**Drought**	
Sandoval Acreage	all	Year Drought Begins	2002
Valencia Acreage	all	Years Drought Will Last	25
		Drought Intensity	17%
Population compared to BBER Prediction			
Bernalillo (see Chapter 7)	100%	**Transfers**	
Sandoval (see Chapter 7)	100%	Treated Socorro & Sierra Bosque Acreage	17,500 ac
Valencia (see Chapter 7)	100%	Transfer from Socorro & Sierra Crop Acreage	0 ac
Self-supplied (see Chapter 7)	100%	Cost to Retire an Acre of Farm Land	$20,000
Agriculture		**Global Settings**	
Length of Conveyance Channel to Line & Cover	0	Treatment time horizon	15 years
Length of Conveyance Channel to Line	150 mi	Interest rate	6%
		Payback time horizon	30 years
Desired Farm Acreage to Laser Level	22,000a		
Desired Farm Acreage to Line/Pipe Delivery Canals	7,500 a		
Desired Drip Irrigation Acreage	2,500 a		

Table 9-8 Incremental Effects of Sensitivity Analysis Changes to Slider Settings (Source: The Middle Rio Grande Water Assembly with assistance from Sandia National Laboratories)

	Cumulative Rio Grande Compact Balance at 2050 (acre-feet)	**Cumulative Aquifer Depletion at 2050 (acre-feet)**
No Action Model (default)	-960,000	3,140,000
Preferred Scenario (baseline)	+754,000	670,000
Convert Existing Residential Property to Low Flow Appliances from 80% to 15%	+771,000	1,146,000
Convert Existing Homes to On-Site Graywater Use from 5% to 20%	+766,000	1,113,000
Convert Existing Commercial Property to Low Flow Appliances from 80% to 15%	+776,000	1,190,000
Reduce Growth in Water Use by Parks and Golf Courses from 80% to 20%	+766,000	1,256,000
Desalination from 22,500 afpy to 7,500 afpy	+701,000	1,546,000
Years Drought Will Last from 10 to 25	+692,000	1,580,000
Drought Intensity from 11% to 17%	+669,000	1,608,000
Transfer from Socorro & Sierra Crop Acreage from 7,500 ac to 0 ac	+491,000	1,647,000
Crop Acreage Reduction from 25%-30% to Zero	-70,000	1,681,000
Sensitivity Check Scenario (aggregate of all changes from baseline)	-70,000	1,681,000

Figure 9-4 Results of Sandia Model Sensitivity Check Scenario Illustration (Source: The Middle Rio Grande Water Assembly with assistance from Sandia National Laboratories)





Chapter 9 References

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