

Lower Rio Grande Valley Basin Study

Plan of Study

**State of Texas
Great Plains Region**



List of Acronyms and Abbreviations

AFR	Alternatives Formulation Report
BCSD	Bias Corrected Spatially Downscaled Surface
CNA	Mexico National Water Commission (or CONAGUA)
ET	Evapotranspiration
GAM	Groundwater Availability Model
GPRO	USBR Great Plains Regional Office
IBWC	International Boundary and Water Commission
MOA	Memorandum of Agreement
MR&I	Manufacturing, Residential, and Industrial
OTAO	Reclamation's Oklahoma Texas Area Office
PAR	Preliminary Assessment Report
POS	Plan of Study
QA	Quality Assurance
QC	Quality Control
Reclamation	U.S. Bureau of Reclamation
Region M	Texas Region M Planning Group
RGRWA	Rio Grande Regional Water Authority
SCR	Screening Criteria Report
Study	Lower Rio Grande Basin Study
TCEQ	Texas Commission on Environmental Quality
TWDB	Texas Water Development Board
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VIC	Variable Infiltration Capacity
WAM	Water Availability Model
WRAP	Water Rights Analysis Package

Introduction

There is an urgent need to address a current and projected water supply deficit within the Lower Rio Grande Basin of Texas, which is one of the fastest growing and most economically depressed areas in the U.S. The Bureau of Reclamation (Reclamation) and the Rio Grande Regional Water Authority (RGRWA) and its 53 member entities, in collaboration with the Texas Region M Planning Group (Region M), Texas Water Development Board, Texas Commission on Environmental Quality (TCEQ), and International Boundary and Water Commission, are conducting a Basin Study (Study) to evaluate the impacts of climate variability and change on water supply imbalances within an eight county region along the U.S./Mexico border in south Texas. In July, 2011, this Study was selected under Reclamation’s Basin Study Program. The estimated total cost of the Study is \$412,798 with a cost-share of 48.4 percent by Reclamation and 51.6 percent by RGRWA (the non-Federal Cost-Share Partners). The Study will be conducted over a period of two years, beginning in October 2011.

This Plan of Study contains: the Study’s purpose and objectives; a description of the Study management structure; a description of the major phases of the Study and a breakdown of the major tasks in each phase; and a plan for public involvement throughout the Study.

Study Location

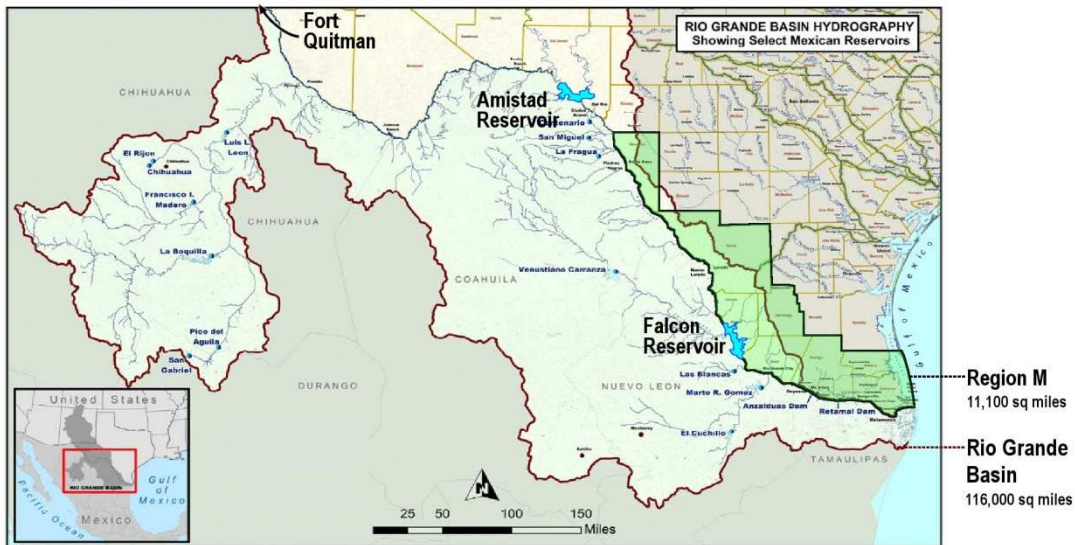


Figure 1: Lower Rio Grande Basin (adapted from IBWC)

Purpose and Objectives

The purpose of the study is to evaluate the impacts of climate variability and change on water supply imbalances within the 2070 planning horizon for the Lower Rio Grande Basin as shown in Figure 1. This includes drainage of the Rio Grande River below Ft. Quitman, Texas and includes a significant area in the Republic of Mexico . The area of the United States for the Study will include an eight county region along the U.S./Mexico border in south Texas (Cameron, Willacy, Hidalgo, Starr, Zapata, Jim Hogg, Webb and Maverick Counties). The information gathered will build upon existing, well recognized data/models to perform a systems reliability analysis and formulate a range of alternatives to meet short, mid, and long-term planning objectives, particularly during times of drought. Of notable interest are regional supply options identified in the Region M portion of the State Water Plan, including seawater and brackish groundwater desalination, importation of fresh groundwater from sources outside the study area, and may include other options yet to be identified

This basin study will:

- Perform hydrologic projections of future water supply and demand in the face of the changing climate.
- Evaluate how existing water and power infrastructure will perform in the face of changing water realities.
- Formulate a range of alternative regional water management options to meet planning objectives.
- Evaluate and screen alternatives based on several factors including cost/benefits, public acceptance, and various political, institutional, regulatory, and environmental constraints.
- Recommend a preferred alternative plan to meet planning objectives.
- Recommend next steps and the associated responsible party and whether a feasibility study is envisioned.

Study Management

Management of the Study will be conducted by the RGRWA and Reclamation's Oklahoma Texas Area Office (OTAO)

Study Managers: Reclamation's study manager is Jeffrey Gerber, Environmental Protection Specialist. The RGRWA's study manager is Marcie Oviedo, Director of Planning for the Lower Rio Grande Valley Development Council.

Project Team: The Project Team will provide expertise and knowledge related to meeting the Study's scope and objectives. The Team will complete the tasks related to the Study and be responsible for ongoing quality assurance. Members include, but are not limited to:

Rio Grande Regional Water Authority

- Ken Jones, Executive Director
- Marcie Oviedo, Director of Planning for the Lower Rio Grande Valley Development Council
- Contractor

Reclamation

- Jeff Gerber, Environmental Protection Specialist
- Thomas Michalewicz, Special Projects Director
- Collins Balcombe, Supervisory Program Coordinator
- Subhrendu Gangopadhyay, Hydraulic Engineer
- Andrew Tiffenbach, Mechanical Engineer

Administrative Record: The study managers are responsible for maintaining the administrative record of all electronic and paper documents that substantively relate to completion of this Study. Copies of the administrative record will be provided to both Reclamation and RGRWA upon completion of the Study.

Quality Assurance/Quality Control (QA/QC)

QA/QC Team: The QA/QC Team will provide policy guidance, independent oversight, and peer review over technical aspects of the Study. In-progress reviews will be conducted by Reclamation project team members through telephone and email communications no less frequently than every two weeks, and one week in advance of each deliverable listed below. Reclamation's Team Members will have the added responsibility of ensuring that the Study adheres to Reclamation policy; directives and standards; and guidelines with respect to planning; engineering design and cost estimating; hydrology; economics; environmental impacts; or any other technical aspects of the Study.

Quality Control. Data used in the climate and hydrology modeling have already been subjected to and satisfied Reclamation's Peer Review of Scientific Information and Assessments Directives and Standards during its investigation of West-Wide Climate Risk Assessments: Bias Corrected Spatially Downscaled

Surface (BCSD) Water Projections, which utilized the BCSD climate projections and Variable Infiltration Capacity hydrologic models.

Quality Assurance. The application of the data for the Basin Study in modeling future supply conditions will be conducted by experienced hydrologist Dr. Subhrendu Gangopadhyay, PhD, P.E., of Reclamation's Water Resources Planning and Operations Support Group. Quality assurance of Dr. Gangopadhyay's work will be performed by Delbert M. Smith, Manager of Reclamation's Water Resources Planning and Operations Support Group. The QA/QC Team will be represented by various technical and nontechnical disciplines. Members include, but are not limited to:

Rio Grande Regional Water Authority

- Marcie Oviedo, Director of Planning for the Lower Rio Grande Valley Development Council

Reclamation

- Kip Gjerde, Regional Planning Officer
- Del Smith, Manager of Reclamation's Water Resources Planning and Operations Support Group
- Nancy Parker, Hydraulic Engineer
- Matt Warren, Supervisory Engineer
- Jeff Gerber, Environmental Protection Specialist
- Bob Jurenka, Plant Structures Engineer
- Gary Snyder, Structural Engineer
- Linda Bowles, Conveyance Engineer
- Gerald Zander, Cost Estimator
- Steve Piper, Economist

QA/QC Process: In addition to providing ongoing guidance on policy decisions, the QA/QC Team will provide review and comments at key milestones as well as of all deliverables outlined above. Deliverable reviews will target only those team members that have relevant expertise in a particular area.

Study Tasks, Deliverables, and Schedule

Task 1: Study kick-off: Reclamation and RGRWA

1.1 Hold kick-off meetings

- 1.1.1 Hold Reclamation meetings between OTA/O, GPRO, and TSC to define scope of work, team members, schedule, and roles/responsibilities

- 1.1.2 Hold meeting between Reclamation and RGRWA in Austin, TX to discuss draft Memorandum of Agreement (MOA) and POS
- 1.2 Execute MOA and complete Final POS
- 1.3 Execute third party contract between RGRWA and its consultant
- 1.4 Hold meeting between Reclamation, RGRWA, and RGRWA's contractor
- 1.5 Meet with the International Boundary Water Commission (IBWC) to discuss scope of work
- 1.6 Meet with TWDB to discuss scope of work
- 1.7 Coordinate with Reclamation's Upper Colorado Region on previous/ongoing activities within the Upper Colorado Region that are within the Study area.

Task 2: Determine future water needs in 2070 based on climate variability projections: Reclamation Lead

- 2.1 Develop hydrologic projections of water supply and demand based on latest climate science data for the study area: Reclamation¹
 - 2.1.1 Develop daily Variable Infiltration Capacity (VIC) forcings for climate projections, 1950-2099
 - 2.1.2 Run VIC hydrology model to develop gridded monthly runoff time-series
 - 2.1.3 Develop basin contribution areas for Texas Commission on Environmental Quality (TCEQ) control locations
 - 2.1.4 Set up the VIC hydraulic routing model - flow fraction, flow direction and station location files for TCEQ control points
 - 2.1.5 Run the hydraulic model for climate projections to develop monthly routed flow
 - 2.1.6 Conduct hydroclimate data analysis for the Study area - changes in precipitation, temperature, snowpack, runoff volumes and timing
 - 2.1.7 Develop monthly historic change factor-corrected streamflow time-series for incorporation into the Rio Grande Water Rights Analysis Package (WRAP/Water Availability Model
- 2.2 Meet with TCEQ to discuss WAM: **Reclamation and RGRWA**
- 2.3 Run the WAM using streamflow projections developed from Task 2.1.7 above: **RGRWA**
- 2.4 Fresh and brackish groundwater availability analysis (i.e., updating the Groundwater Availability Model (GAM):**RGRWA**
- 2.5 Projections of Future Water Demands for 2070 planning horizon: **Reclamation and RGRWA**

¹ Subtasks for items 2.1 through 2.5 to be developed with RGRWA's Contractor.

- 2.5.1 Review of Region M plan
- 2.5.2 Review of IBWC (or similar) plan

Task 3: Analyze how existing water supply infrastructure will perform relative to future needs: Reclamation and RGRWA

- 3.1 Baseline System Reliability Analysis: **Reclamation and RGRWA**
 - 3.1.1 Identify reliability metrics, for example, the fraction of months during which the supply target is met.
 - 3.1.2 Develop historical yield-reliability curves for the Rio Grande in the Region M area.
- 3.2 Projections of Future System Reliability: **Reclamation**
 - 3.2.1 Estimation of changes in reservoir evaporation due to climate change
 - 3.2.2 Evapo-Transpiration (ET) sensitivity analysis not including adjustment of irrigation demands, including analysis of sensitivity of ET to precipitation and temperature changes, and developing monthly ET adjustment factors
 - 3.2.3 Adjustment of irrigation demands; **RGRWA Lead**
 - 3.2.4 WAM simulations to estimate changes in reservoir yields: **RGRWA Lead**
 - 3.2.5 Apply risk metrics from 3.1.1 with WAM simulation results of task 3.3.4. Analysis similar to task 3.1.2 but with projected inflows and demands: **Reclamation Lead**

Task 4: Define planning objectives: Reclamation and RGRWA

- 4.1 Provide justification of planning objectives **RGRWA Lead**
 - Note: Consideration will be given to meeting needs of large and small communities and addressing environmental factors, etc.
- 4.2 Describe alternatives that are eliminated that do not meet planning objectives: **RGRWA Lead**

Task 5: Formulate a range of water supply alternatives to meet planning objectives: Reclamation and RGRWA, RGRWA Lead

- Note: The alternatives formulated in this task will be limited only to those that meet the planning objective(s)
- 5.1 Hold a stakeholder meeting to discuss issues associated with potential alternatives : **RGRWA Lead**
- 5.2 Describe the No Action (i.e., Future Without Action) conditions in the study area: **RGRWA Lead**
- 5.3 Formulate non-structural alternatives, if applicable. Potential options include but are not limited to demand-and supply-side opportunities such as: **RGRWA Lead**

- Water Conservation and efficiency
 - Operational changes (to include Mexico)
- 5.4 Formulate structural alternatives, if applicable. Potential options include but are not limited to: **RGRWA Lead**
- Seawater desalination
 - Brackish groundwater desalination
 - Importation of fresh groundwater
 - Wastewater reuse
- 5.5 Prepare draft and final Alternatives Formulation Report (AFR): **Reclamation Lead**
- The AFR provides a conceptual executive summary of all alternatives that have the potential to meet identified planning objectives
- 5.5.1 Submit Preliminary Draft AFR to QA/QC Team
- 5.5.2 Address comments and prepare Revised AFR
- 5.5.3 Submit Revised AFR to QA/QC Team for additional review
- 5.5.4 Address comments, if applicable
- 5.5.5 Prepare Final AFR

Task 6: Develop criteria to screen alternatives: Reclamation and RGRWA: RGRWA Lead

- 6.1 Identify criteria considered important to deciding whether to select and alternative for implementation. Potential criteria include, but are not limited to : **RGRWA Lead**
- Costs
 - Environmental impacts
 - Legal, regulatory, and institutional factors
 - Acceptability
- 6.2 Identify metrics to measure each criterion (i.e., scaled 1 to 5) : **RGRWA Lead**
- 6.3 Develop weighting factors for each criterion based on relative importance : **RGRWA Lead**
- 6.4 Develop a final matrix of criteria and weighting factors: **RGRWA Lead**
- 6.5 Prepare draft and final Screening Criteria Report (SCR): **Reclamation Lead**
- 6.5.1 Submit Preliminary Draft SCR to QA/QC Team
- 6.5.2 Address comments and prepare Revised SCR
- 6.5.3 Submit Revised AFR to QA/QC Team for additional review
- 6.5.4 Address comments, if applicable
- 6.5.5 Prepare Final SCR

Task 7: Evaluate and compare water supply alternatives – reconnaissance level assessment: Reclamation and RGRWA

- 7.1 Evaluate each alternative based on criteria established under Task 5.3:
RGRWA Lead
 - 7.1.1 Document results for criteria established under Task 5.3 in 1-2 page summary reports for each alternative
 - 7.1.1.1 Confer with appropriate entities with regulatory jurisdiction as necessary, including IBWC, TCEQ, USFWS, etc.
- 7.2 Conduct screening analysis : **RGRWA Lead**
 - 7.2.1 Incorporate results from Task 6.1 into screening matrix developed under Task 5.3
 - 7.2.2 Recommend preferred alternative(s) for an appraisal-level evaluation
 - Note: The objective is to recommend only one alternative for further design, so this step may be repeated and refined as necessary until one option is selected.
- 7.3 Prepare draft and final Preliminary Assessment Report (PAR):
Reclamation Lead
 - 7.3.1 Submit Preliminary Draft PAR to QA/QC Team
 - 7.3.2 Address comments and prepare Revised PAR
 - 7.3.3 Submit Revised PAR to QA/QC Team for additional review
 - 7.3.4 Address comments, if applicable
 - 7.3.5 Prepare Final PAR

Task 8: Evaluate and compare water supply alternatives – appraisal level assessment: Reclamation and RGRWA

- 8.1 Evaluate each alternative based on criteria established under Task 5.3:
Reclamation Lead
 - 8.1.1 Document metrics for criteria established under Task 5.3 in a report(s) for each alternative.
 - Note: if only one alternative is recommended under Task 6.2.2, then a screening analysis at this level will not be necessary.
 - Engineering design must meet Reclamation’s policy and standards for developing appraisal-level cost estimates.
 - 8.1.2 Reclamation must review and approve design and cost estimates prepared by RGRWA pursuant to the Reclamation Service Agreement provided in Enclosure 1.
- 8.2 Conduct screening analysis, if applicable **Reclamation Lead**
 - 8.2.1 Incorporate results from Task 7.1 into screening matrix developed under Task 5.3, if applicable
- 8.3 Develop model of financial capability, including rate structures on preferred alternative, including: **RGRWA Lead**

8.3.1 **RGRWA** will provide the draft model

1. The total cost of providing treated water on a joint basis including all direct and indirect costs.
2. Projected cost of the treated water to each participant.
3. The service level provided to each participant, including the development of an objective, quantifiable basis for calculating the annual cost of service for each participant.
4. If participants will provide existing facilities, equipment or material to the regionalized facility, include the costs of these “in-kind” contributions.
5. A ten-year forecast of the expected annual cost of providing treated water from the brackish water treatment facility.
6. A comparison of each participant’s individual cost of providing the same level of treated water under an alternative, more conventional means to the anticipated cost of a regionalized brackish water facility.
7. Prepare an assessment of the financial impact on alternative supplies on local irrigation districts providing water to municipalities.

8.3.2 **Reclamation** will review and provide comments on the financial model pursuant to the Reclamation Service Agreement provided in Enclosure 1.

8.4 Recommend preferred alternative for feasibility-level design:
Reclamation

Task 9: Prepare draft and final Basin Study Report

- 9.1 **RGRWA** will compile reports developed under previous tasks into a Preliminary Draft Basin Study Report according to the outline provided in Enclosure 2.
- 9.2 **Reclamation** will submit Preliminary Draft Basin Study Report to QA/QC Team for review and comment
- 9.3 **Reclamation and RGRWA** will address comments and prepare Revised Draft Basin Study Report
- 9.4 **Reclamation** will submit Revised Draft Basin Study Report to QA/QC Team for additional review
- 9.5 **Reclamation and RGRWA** will address comments, if applicable
- 9.6 **Reclamation** will submit Final Basin Study Report to GPRO and Policy and Administration for approval
- 9.7 **Reclamation** will distribute Final Basin Study Report to RGRWA

Deliverables

1. **Task 1.** Signed MOA and Final Plan of Study

2. **Task 2.** Technical Memorandum that includes the historic change factor-corrected monthly stream flow time-series for the Rio Grande WRAP, WAM, and GAM.
3. **Task 3.** Baseline System Reliability and Projections of Future System Reliability Technical Memorandum combined with Task 2 - includes reservoir yield, agricultural demands, WAM simulations.
4. **Task 4.** Technical Memorandum describing planning objectives, preliminary screening criteria, and alternatives eliminated from further consideration.
5. **Task 5.** Draft and Final Alternatives Formulation Report (AFR)
6. **Task 6.** Draft and Final Screening Criteria Report
7. **Task 7.** Draft and final Preliminary Assessment Report (PAR)
8. **Task 8.** Technical Memorandum to include Draft and Final Financial model and resulting preferred alternative for feasibility-level design
9. **Task 9.** Draft and Final Basin Study Report

Tasks	Estimated Deliverable				
	Completion Date	Budget Reclamation	Budget RGRWA		
Task 1	10/31/11	\$24,336	\$24,657		
Task 2	3/31/12	\$45,601	\$23,213		
Task 3	6/30/12	\$30,334	\$39,115		
Task 4	7/31/12	\$16,982	\$39,115		
Task 5	10/31/12	\$16,982	\$25,567		
Task 6	11/15/12	\$16,982	\$25,567		
Task 7	12/15/12	\$13,104	\$12,007		
Task 8	1/31/13	\$13,104	\$12,007		
Task 9	2/28/13	\$21,523	\$12,602		
Total		\$198,948	\$213,850		\$412,798

Roles and Responsibilities

Study Partner Meetings

Reclamation and RGRWA will work closely Five meetings are currently envisioned as follows:

1. *Targeted for October 2011* - Meeting with RGRWA and RGRWA's contractor to discuss the Study objectives, structure, schedule, and meet with key stakeholders including but not limited to IBWC and TPWD (Task 1);

2. *Targeted for January 2012* - Meeting to discuss the assessment of current and future water supply, and assessment of current and future water demand(Task 2);
3. *Targeted for June 2012* - Meeting to discuss the results of Task 2 and the proposed approach for Task 3 (analysis of the current and future system reliability);
4. *Targeted for August 2012* - Meeting to discuss the results of Task 3 and the proposed approach for Task 5 (formulation of a range of alternative water management options) and Task 6 (screening criteria); and
5. *Targeted for February 2013* - Meeting to discuss Findings for Final Draft Study Report.

Public Involvement

Public involvement will primarily occur through Partner and stakeholder representation at a key meeting to be held at the alternatives formulation Task 4.1. Stakeholders will be reminded at meetings that they are expected to represent all of their relevant member interests. In addition, the Study will be a permanent agenda items at meetings of the RGRWA, which will often include attendance by many of the stakeholders from the U.S. and Mexico. Individual meetings will be held on a case by case basis as needed to solicit input, expertise, and data requests as needed.

This Study will have numerous stakeholders, including but not limited to:

- Texas Water Development Board
- Region M Planning Group
- Rio Grande Watermaster
- Texas Commission on Environmental Quality
- Texas Parks and Wildlife Department
- International Boundary Water Commission
- U.S. Department of Agriculture: Rural Development Administration
- U.S. Geological Survey
- Environmental Protection Agency
- U.S. Fish and Wildlife Service
- Texas Water Resources Institute
- Many of the above entities will be present at bimonthly RGRWA board meetings, where the Basin Study will be a standing agenda item.

Public involvement also will be made through the internet, where a link on the RGRWA website will be maintained to provide up-to-date information on the basin study. The following will be provided on the web link:

- Summary and background information
- A link to the original proposal for funding
- A link to the final MOA and POS
- Updates/news releases on completed milestones
- Points of contact

Public comments on final draft report

- RGRWA and Reclamation press releases will solicit public comment by providing a link to the document on the RGRWA website.

ENCLOSURE 1

Draft Basin Study Report Outline

ENCLOSURE 1

Draft Basin Study Report Outline

Summary

Findings

The “Summary” provides the gist of the entire report, with “Findings” sketching in the background necessary to understand the “Recommendations” that follow. Sections that need to be summarized in the findings are:

1. Water Supplies and Demands
2. Planning Objectives
3. Constraints
4. Reclamation Involvement Required for Objectives to be Met
5. Consequences of Taking no Federal Action
6. Brief Description of Plans

Recommendations

Recommendations follow from the findings and cannot, of course, be contradicted by them (there has to be a water shortage in the basin that Reclamation can do something to solve as the most obvious instance). The recommendations include:

1. Statement of whether or not the study should continue to feasibility stage
2. Alternative(s) most likely to be feasible (table?)
3. Estimates of costs/benefits and environmental effects of most likely alternatives
4. Statement about schedule, duration , and cost of feasibility study (if recommended)
5. Statement of the ability of local and state government and organizations to fund study, evidenced by letter of intent by non-Federal sponsor stating willingness to pursue feasibility and to share in costs of study and project implementation
6. Other recommendations deemed appropriate

(See § 1.0 in *Basin Study Framework*.)

Map

Map of the entire basin, so an 8½ x 14 fold-out will probably be needed to show the detail.

Table of Contents

Chapter 1: Introduction

Purpose of Study

The purpose is whether or not to recommend a more detailed feasibility study of the basin.

In this section you also establish:

1. Planning Objectives
2. Constraints
3. Authority—Secure Water Act (PL111-11)

Setting

This section draws up the region that would be affected by the plans in this basin report, including:

1. Project Location
2. Social Characteristics
 - a. Social and Economic Background
 - b. Major Industries
 - c. Recreation
3. Environmental Characteristics
 - a. Climate
 - b. Water Resources
 - c. Land Resources
 - d. Plants and Wildlife
 - e. Historical and Archeological Resources
4. Present Water and Related Land Development
 - a. Irrigation
 - b. MR&I
 - c. Flood Control

Public Involvement

This section assures the public and other interested parties that they were invited to help with production of the report—we didn't do it by ourselves. Include:

1. Public Meetings
2. Other Public/Stakeholder Involvement (refer to Chapter 7).

What to Expect in this Report

Let's the readers know what to expect in the other chapters of the report.

Chapter 2: Regional Water Supplies and Demands

(See § 4.4.5 in *Basin Study Framework*.)

Methods and Process (existing information as much as possible)

This first section explains to the reader how you came up with your information, so you'll need:

1. Assumptions (Period of Analysis, Climate Change, Population Growth, Energy Development, Changes in Land and Water Use, and the rest)
2. Data Used (Census, USGS Stream Gauges, and the rest.)
3. Models Used.

Present Water Supplies

Describe the present water supplies in the basin.

1. Historic Flows in Rio Grande River
2. Inflow and Accretion Data from Gauges or Models (if available)
3. Runoff from Precipitation, Topography, Temperature, and the rest
4. Snowpack Levels, Soil Moisture, other Physical Measurements.

Future Water Supplies to (2050 or whatever future date)

Describe the future water supplies.

1. Projected Flows in Rio Grande River
2. Projected Runoff to from Precipitation, Temperature, Projected Snowpack, Soil Moisture, other Physical Measurements.

Present Water Demands

Describe the present water demands.

1. Present Agricultural Water Demands
2. Present MR&I Water Demands
3. Other Present-day Water Demands.

Future Water Demands to (2050?)

Describe the future water demands.

1. Projected Agricultural Water Demands
2. Projected MR&I Water Demands
3. Other Future Water Demands
4. Projected Water Supply Deficit.

Summary Table of Water Supplies and Demands (as required by Secure Water Act § 9503(b)(2))

1. Projections of Changes due to Climate Change
2. Projections of Changes and Timing and Volume of Runoff due to Climate Change
3. Projections of Groundwater Recharge and Discharge due to Climate Change
4. Projections of Increases in Water Demands from Rising temperatures and/or Reservoir Evaporation due to Climate Change.

Chapter 3: Regional/Basin Water Facilities and Operations

Methods and Process (existing information as much as possible)

This section, a parallel to the same section in Chapter 2, explains to the reader how you came up with your information.

1. Assumptions (Period of Analysis, Climate Change, Population Growth, Energy Development, Changes in Land and Water Use, and the rest)
2. Data Used (ID Records, City Records, Tribal records, and the rest.)
3. Models Used (River Basin Operations Simulator that includes all Pertinent River Characteristics, and the rest.)

Present Reliability of Facilities and Operations

An assessment of present problems.

1. Measurement of Present System Reliability (Water Shortages over ___-year Period?)
 - a. Agriculture
 - b. MR&I
 - c. Other
2. Specific Problems with System Reliability (with Quantified/Qualified Support).
 - a. Agriculture
 - b. MR&I
 - c. Other

Future Reliability of Facilities and Operations (as required by SWA§ 9503(b)(3))

Basin Study Framework to include:

1. Projections of Change on Reclamation's Ability to Deliver Water
2. Projections of Change on Hydroelectric Power Generation
3. Projections of Change on Recreation at Reclamation Facilities
4. Projections of Change on Fish and Wildlife Habitat
5. Projections of Change on Threatened and Endangered Species or Candidate Species (ESA)
6. Projections of Change on Water Quality Concerns
7. Projections of Change on Flow and Water Dependent Ecological Resiliency
8. Projections of Change on Flood Control Management.

Chapter 4: Plans to Meet Future Water Supply Demands

Formulation of Plans to Meet Planning Objectives

Describe how the “Planning Objectives” set out in “Purpose of Study” in Chapter 1 guided formulation of the plans to meet water supply shortages.

Non Structural Measures

The following are things listed in the *Basin Study Framework* that could be incorporated into any plan to meet future water shortages. The first things should be part of any plan and the others should be brought up if only to be dismissed later on. These things are:

1. Water Conservation and Efficiency
2. Operational Changes
3. Inter-basin Transfers Using Existing Facilities
4. Water Banking
5. Combined Surface/Groundwater Use
6. Drought Contingency Use
7. Legal and Institutional Changes (Water Rights).

Structural Measures (list the most likely first)

These things are also listed in the *Basin Study Framework*. Again, they should be considered and dismissed, if not incorporated into a plan. They are:

1. Upgrades, Rehabilitation, or Replacement of Existing Facilities
2. Development of New Facilities (including Conveyance or Storage)
3. Water Recycling or Reuse Facilities
4. Desalination (Brackish Water) Facilities
5. Development of an Inter-Tie between Two Water Distribution Systems
6. Facilities Needed to Implement Non Structural Changes.

Plans

This section is where you combine measures from the non-structural and structural sections into plans that would meet the water shortages of the future. Describe these plans here. One other plan, the *Future-Without-the-Project Condition*, must also be included. The Future-Without is the most reasonable prediction of what would happen in the basin if no Reclamation actions were taken. Since it provides the basis by which the other plans are assessed, a clearly defined Future-Without-the-Project Condition is essential in evaluation, comparison, and selection of the best plan.

Chapter 5: Evaluation and Comparison of Plans

Evaluation

Evaluate the plans described in Chapter 4 on the basis of costs, effects, and plan measurements in this section.

1. Costs
 - a. Construction
 - b. Operations and Maintenance
2. Social and Economic Effects
3. Environmental Effects
 - a. Climate
 - b. Water Resources
 - c. Land Resources
 - d. Plants and Wildlife
 - e. Historical and Archeological Resources
4. Plan Measurements
 - a. Acceptability—Plan Accepted by Local, State Interests?
 - b. Effectiveness—Plan Achieves Plan Objectives?
 - c. Efficiency—Plan Has Best Benefit:Cost Ratio or is the Most Cost Efficient/Lowest Cost?
 - d. Completeness—Plan includes Provisions to realize All Plan Objectives?
 - e. Adaptive management—Plan can be Adapted to fit Changed Conditions in the Project Area?

Comparison

Fold-out Table with plans rated by same information as in “Evaluation” Section.

1. Costs
2. Social and Environmental Effects
3. Environmental Effects
4. Plan Measurements

Chapter 6: Findings and Recommendations

The conclusions of the basin study.

Best Plan

The “Best Plan” could be one of the plans formulated for this study or in could be made up of parts of plans combined into a new plan. The section should include:

1. Water Conservation (Should be Part of Any Plan)
2. Other Aspects of the Plan
3. Costs
4. Other

Recommendations

The recommendations of the basin study.

1. Continue to Feasibility?

2. Other Recommendations Deemed Appropriate, including identifying partnerships with USFWS and agricultural interests for intermarketing of resulting net water rights.
3. Risks and Uncertainties.

Chapter 7: Coordination and Consultation

Here we detail the coordination and consultation done during the course of the study (touched on in Chapter 1 in “Public Involvement”).

Coordination

Who did we work with regularly the study?

1. With Irrigation Districts
2. With Cities and towns
3. Other.

Consultation and Review

Who was invited to review the study (or parts of it)?

1. Mexico
2. U.S. Fish and Wildlife Service
3. TWDB
4. Peer Review
5. Other.

References Cited

Supporting Information