CHAPTER 4: ALTERNATIVES FORMULATION REPORT

I. Objective

Previous chapters of this study report have discussed:

- Hydrologic projections of future water supply and demand in the face of the changing climate
- Development of a planning objective and planning criteria to guide the evaluation of options
- Evaluation of how existing water and power infrastructure will perform in the face of changing water realities
- Formulation of a range of alternative regional water management options to meet the planning objective

The planning objective was established to set the goals for the recommended strategy:

> *Alleviate projected water supply imbalances in the study area by developing one or more alternatives in Cameron, Willacy, and Hidalgo Counties that will (1) provide a minimum of 86,438 acre-feet of water year round by 2060; (2) protect existing water rights; (3) be compatible with regulations, policies, and environmental law; and (4) contain actions that are within the reasonable control of study sponsors.*

The following WMSs were recommended in the previous chapter for further evaluation:

- Seawater desalination
- Fresh groundwater development
- Brackish groundwater desalination
- Non-potable reuse

The goal of alternatives formulation is to determine which among the four recommended WMSs best meet the planning objective and should be studied in more detail, including but not limited to, site selection, preliminary engineering and cost estimates, and financial capability. This determination will be made by characterizing each of the four WMSs in more detail as it relates to established screening criteria.

II. Limitations of the Characterization Process

The characterization of the WMS was based on the information available for each of the four WMSs in the Region M Plan. Because of the scope of the study, the characterization is limited and intended only as a starting point for the evaluation of the WMS. The limitations of the characterization process are as follows:

- **WMSs evaluated:** The study is limited by scope and budget to investigate those strategies that specifically address potential water deficits related to climate change that have been identified by the study. One of the key constraints is that the selected WMS must reduce dependency on the Rio Grande. The growing need to develop alternative water sources within control of the study partners was expressed by RGRWA and confirmed by the study analysis. *Nevertheless, the most robust solution to the expected shortages in the study area will include the continued development of the range of strategies recommended by Region M, many of which would increase the efficiency of the use of Rio Grande supplies.*

- **Regional analysis:** Some of the strategies could be implemented in a wide range of locations, and the specifics of the location will affect everything from the scale of production to the permits required.

- **Potential for subjectivity:** The screening criteria used in the characterization process were relatively prescriptive; however, there was still some room for subjectivity when selecting the appropriate ratings for each evaluated option.

- **Uncertainty:** The characterization was performed based on limited and high-level analyses. Therefore, knowledge of items such as costs, permit requirements, and long-term feasibility are still highly uncertain.

III. Water Management Strategies Evaluation

In the analysis below, one WMS, brackish groundwater desalination (BGD), which best meets the goals of the study within the study budget, is recommended for further study.

One of the primary outcomes of this study is a recommendation regarding which alternative(s) may be viable for further study in a Reclamation-sponsored SECURE (Science and Engineering to Comprehensively Understand and Responsibly Enhance) Feasibility Study as authorized under P.L. 111-11

(i.e., SECURE Water Act). SECURE feasibility studies represent the final planning phase of Reclamation's WaterSMART Basin Study Program and entail more detailed investigations, design, and cost estimates.

A. Seawater Desalination

Brownsville Public Utilities Board (BPUB) and Laguna Madre Water District have already confirmed the feasibility of seawater desalination along the Texas Gulf Coast through detailed investigations and pilot testing, and design and cost estimates of proposed facilities have already been produced. Other counties within the study area, including Hidalgo County, did not include seawater desalination as a WMS in the most recent 2010 Region M Water Plan, perhaps due to their relative farther distance from the Gulf Coast, and instead have proposed less costly options such as water reuse and BGD.

B. Fresh Groundwater Development

Fresh groundwater is an important resource that should be considered in any water purveyor's portfolio of water supply options in the study area. As stated in the Task 4 Technical Memorandum, the 2010 Region M Plan found that about 20% of the 822 groundwater wells in the study area yield fresh groundwater (<1,000 mg/L TDS). Therefore, of the 176,355 ac-ft/yr of managed available groundwater (sustainable yield) designated by the study area's Groundwater Management District, about 35,271 acre-feet are expected to be freshwater.[40] This amount is reduced to 12,094 ac-ft/yr when totaling the estimated fresh groundwater available in the three counties specified in the planning objective (Cameron, Hidalgo, and Willacy) as shown in table 4-1.

Table 4-1: Fresh groundwater yield by county

County	Cameron	Hidalgo	Jim Hogg	Maverick	Starr	Webb	Willacy	Zapata
Yield (ac-ft/yr)	2,947	9,147	65	0	4,188	7,918	0	0

Due to the limited number of production wells in the study area, the exact location of the 12,094 ac-ft/yr of fresh groundwater remains unknown. According to the 2010 Region M Plan, TDS trends in groundwater do not exist at the

[40] 2011 Region M Plan, Chapter 4, Section 4.5.7.1 Strategy Description.

regional level as indicated by the highly variable TDS levels across wells in the area. This highlights the need for site-specific exploration activities to determine the best locations for fresh groundwater development.

Another factor to consider is the rising use of fresh groundwater associated with oil and gas exploration activities (i.e., hydraulic fracturing) in the study area. Although the 2010 Region M Plan estimated fresh groundwater use for oil and gas activities to total only 4,200 ac-ft/yr, current efforts to revise the Region M Plan site have greatly increased that estimate by more than double[41] (table 4-2).

Table 4-2: Adjusted DRAFT mining projections (total water demand, ac-ft/yr)

Region	County	2020	2030	2040	2050	2060	2070
M	Cameron	65	68	47	31	15	7
M	Hidalgo	2,445	3,203	3,888	4,592	5,385	6,339
M	Jim Hogg	93	97	72	53	34	22
M	Maverick	1,988	2,737	2,933	2,302	1,674	1,217
M	Starr	571	697	775	858	961	1,091
M	Webb	3,862	3,008	2,257	1,537	690	502
M	Willacy	49	51	38	28	18	12
M	Zapata	85	89	66	49	31	20
M	**TOTAL**	9,158	9,950	10,076	9,450	8,808	9,210

Efforts to quantify use for fracking are complicated by the fact that water use for oil and gas development is exempt from Texas groundwater regulation.[42]

C. Comparison of Brackish Groundwater Desalination and Non-potable Reuse

Brackish groundwater desalination and non-potable reuse appear to be more viable in terms of meeting the planning objectives and thus are described in more detail in table 4-3. Given the multiple locations identified in the Region M Plan for both of these WMSs, and in order to maximize economies of scale, they are conceptualized as *regional* in nature. In the case of brackish groundwater

[41] Draft Region M Mining Demands Technical Memorandum, February 20, 2013, Black & Veatch Corp.

[42] Under Texas Water Code §36.117, production or injection wells drilled for oil and gas are exempted from regulation.

Table 4-3: Alternatives evaluation matrix

Evaluation Criteria		Alternative Concept			
Criterion	**Description**	**Regional Brackish Groundwater Desalination**	**Score (1 to 5)***	**Regional Water Reuse**	**Score (1 to 5)***
Effectiveness	**Extent to which an alternative reliably meets the planning objective**				
Water quantity	*Extent to which alternative can provide up to 86,000 acre-feet per year of water in Cameron, Willacy or Hidalgo Counties*	Dependent on availability in selected locations. Approximately 280,000 ac-ft of available brackish groundwater in the Three-County area.	5	Assuming that 35% of the DMI usage is recoverable return flow, 75,700 AcFt could potentially be available for treatment and reuse in the 3-county target area. Treated water TDS may be too high for some uses.	3
Water reliability	*Extent to which quantity reduces dependency on the Rio Grande, is drought proof, secure for the planning horizon, and not subject to reduction/loss*	Independent of the Rio Grande River; considered a "new supply" that is drought proof and not subject to reduction/loss, assuming water rights are secured	5	Because most raw M&I water supply emanates from the Rio Grande River, wastewater effluent also indirectly depends on the Rio Grande River, and is therefore subject to potential loss and lack of reliability.	3
Constructability	*Challenges associated with construction*	Locating ideal area for wellfield, potential challenges in delivery/distribution from that location, disposal of concentrate, but it is a proven technology in use in the area.	4	Depends on the adaptability of existing wastewater treatment plants, extent of treatment required, and identification of suitable users and the delivery to those users. High TDS levels in wastewater effluent emanating from raw water withdrawn from the Rio Grande is expected to require advanced water treatment prior to reuse.	4
Servicability	*Challenges associated with operations and serviceability*	Issues associated with disposal of concentrate, RO maintenance, membrane fouling, etc, as well as energy requirements, may present operations and serviceability challenges	3	Operations and serviceability challenges limited to the extent of treatment and appurtenant infrastructure required.	4
			4.25		***3.5***
Acceptability	**The workability and viability of an alternative with respect to how compatible it is with authorities, regulations, policies, and environmental law**				
Protects existing water rights	*Extent to which satisfaction of existing water rights assigned to WUGs are not harmed.*	No impacts expected on existing surface water rights; little competition for brackish groundwater.	5	Not aware of surface water rights in the Arroyo Colorado which would be affected by reduced return flows.	5
Impacts on instream flows	*Extent to which flows of the Rio Grande or Arroyo Colorado Rivers would impacted*	No impact expected on the Rio Grande; Impacts could be beneficial to the Arroyo Colorado depending on brine disposal methodology and saline requirements of the river	5	No impact expected on the Rio Grande; Reduction in instream flows in the Arroyo Colorado expected due to reduced return flows	4
Impacts on water quality	*Extent to which water quality of the Rio Grande or Arroyo Colorado Rivers, as well as bay/estuaries would be impacted*	Brine could be disposed of via the Arroyo Colorado, and impacts on the river remain unknown, with potential to benefit the salinity of the costal estuaries.	4	Likely to benefit the Arroyo Colorado by decreasing nutrient loading, which has been identified as an issue in the river.	5
Impacts on fish & wildlife	*Extent of potential impacts on fish and wildlife habitat, sensitive areas, or T&E species*	Direct impacts include construction of facilities, wellfields, and distribution pipelines. Operational impacts associated with brine disposal unknown.	4	TDS accumulation in irrigated soils anticipated, with potential to affect ecology. Impacts of reduced instream flows of the Arroyo Colorado due to reduced return flows unknown.	4
Stakeholder acceptance	*Extent to which study stakeholders view an alternative as favorable*	TBD	5	TBD	5
			4.6		***4.6***
Completeness	**Extent to which an alternative accounts for all necessary investments or other actions to be implemented**				
Control	*Extent to which implementation potential is within the reasonable control of study sponsors*	Expected to be within the reasonable control of study sponsors.	4	Expected to be within the reasonable control of study sponsors.	4
Coordination	*Extent to which multi-organizational coordination would be needed for construction and operation*	Coordination with TCEQ expected for pilot testing and brine disposal.	3	Coordination with TCEQ expected for application permits; coordination with end users expected in terms of identifying users and applications; coordination with irrigation districts if using canals for conveyance,	2
Risk	*The degree of engineering uncertainty and associated risk, as well as additional investigations that are needed to reduce risk*	Moderate degree of engineering uncertainty associated with source quantity and location, piloting, and brine disposal. Additional investigations required.	3	Moderate degree of engineering uncertainty associated with source quantity and location, as well as with conveyance. Additional investigations required.on advanced water treatment needs where applicable. Some regulatory uncertainty remains in terms of emerging contaminants identified on EPA's CCL3 List	3
Permitting	*Extent to which facilities would require permits or clearances which entail risk that could affect the timely or successful completion of the project*	Timing of implementation through permitting associated with piloting, production wells, and bring disposal.	3	Timing of implementation through permitting associated with use and application of reclaimed water.	4
			3.25		***3.25***
		TOTAL SCORE	***12.1***	TOTAL SCORE	***11.35***

* 1 = Least favorable, 3 = moderate, and 5 = most favorable.

desalination, wells in different locations could feed into a large centralized plant, located with minimized distance from the water recipients, with consideration for either pipeline or canal conveyance, or a combination of both. Co-location with, or modification of existing raw water treatment plants, should also be considered.

In the case of non-potable reuse, existing treatment plants could be modified as necessary to meet the needs of potential customers, and utilize joint transportation facilities, as well. However, as described in table 4-3, it is contemplated that high salinity of treated effluent may result in making transport via irrigation canals an untenable solution.

In either WMS, the ability to utilize existing infrastructure and interconnections could increase cost effectiveness. The criteria in the evaluation matrix are based on the planning criteria described in chapter 3.

IV. Conclusion and Next Steps

Based on the ranking of criteria in table 4-3, BGD appears to be the strategy best suited for a more detailed investigation in this study.

The next chapter will establish criteria for the evaluation of one or more BGD facilities in the study area, including the addition of cost of service, which represents the overall efficiency criterion in the aforementioned P&Gs.