San Antonio Water System

Title XVI Feasibility Report
Brackish Groundwater Desalination Program

for the
Bureau of Reclamation

May 2011

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List of Abbreviations

acft	Acre-feet
acft/yr	Acre-feet/year
ASR	Aquifer Storage and Recovery
BGD	Brackish Groundwater Desalination
BOR	Bureau of Reclamation
BSR	Bulverde Sneckner Ranch
CIP	Clean In Place
CMAR	Construction Manager at Risk
DFC	Desired Future Conditions
EA	Environmental Assessment
EAA	Edwards Aquifer Authority
EARIP	Edwards Aquifer Recovery Implementation Program
EDR	Electrodialysis Reversal
EUWCD	Evergreen Underground Water Conservation District
GCD	Groundwater Conservation District
GAM	Groundwater Availability Model
GMA	Groundwater Management Area
GPCD	Gallons per Capita per Day
GPM	Gallons per Minute
mgd	Million Gallons per Day
mg/L	Miligrams per Liter
NEPA	National Environmental Policy Act
NF	Nano-filtration
RO	Reverse Osmosis
RRC	Railroad Commission of Texas
SAWS	San Antonio Water System
SCADA	Supervisory Control and Data Acquisition
TCEQ	Texas Commission on Environmental Quality
TDS	Total Dissolved Solids
THC	Texas Historical Commission
TPWD	Texas Parks and Wildlife Department
TWDB	Texas Water Development Board
USDW	Underground Source of Drinking Water
UIC	Underground Injection Control
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
VSEP	Vibratory Shear Enhanced Processing
WIF	Water Infrastructure Funding
WMP	Water Management Plan

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1.0 Introduction

1.1 Non-Federal Sponsor

The non-federal sponsor of the program is San Antonio Water System (SAWS). The Brackish Groundwater Desalination Program (BGD) is one water resource option contained in SAWS' *2009 Water Management Plan Update* (WMP) (see Appendix A). SAWS' WMP is a multi-faceted plan that has identified the requirements and the supply options that will assist in meeting water demand for SAWS service area through the 2060 timeframe. The WMP considers future population projections, continuous improvement in water conservation, and a portfolio of potential water supply projects to meet demand. All planning takes into consideration the impact of a repeat of the 1950's drought of record. In addition, projects outlined in the WMP are in concert with the regional water planning effort (South-Central Texas Water Planning Group-Region L) established by Senate Bill 1 (Texas 1997 Legislative Session) and the State Water Plan.

Feasibility work on the BGD Program began in 2006 and continued through 2008. R.W. Beck, Inc., in association with LBG-Guyton Associates, and Mickley & Associates compiled the initial BGD Feasibility Study in 2008, titled "*Brackish Groundwater Desalination Feasibility Assessment Report*" (see Appendix B). Other pertinent information relating to water management strategies, population projections, and supply gaps were derived from the WMP.

1.2 Description of SAWS and Proposed Desalination Program

San Antonio Water System serves approximately 1.3 million people in the urbanized part of Bexar County. SAWS has approximately 356,000 water and 399,000 wastewater connections throughout the service area. SAWS service area is illustrated in Figure 1-1. The greater part of SAWS' current water supply is derived from the Edwards Aquifer. The Edwards Aquifer (including catchment area) covers approximately 8,000 square miles and includes all or part of 13 counties in south-central Texas. In the San Antonio region, the Edwards limestone attains a thickness of approximately 450 to 500 feet. SAWS has a total of 92 Edwards production wells supplying its customers with an average daily pumpage of 136.50 million gallons per day (418 acre-feet).

The remainder of SAWS water supplies are composed from various surface, groundwater, and recycled water sources. The only surface water program is the Western Canyon Program. The source water is from Canyon Lake, which SAWS purchases from the Guadalupe-Blanco River Authority (GBRA). In the Oliver Ranch/Bulverde Sneckner Ranch (BSR) program, groundwater is produced from the Trinity aquifer which is located in north central Bexar County. In the Local Carrizo program, groundwater is produced from the Carrizo aquifer from wells located in southeast Bexar County. SAWS is also able to recover stored water from the Twin Oaks Aquifer Storage and Recovery (ASR) facility. Furthermore SAWS maintains the nation's largest recycled water delivery system which supplies customer with non-potable water for industrial and irrigation uses.

SAWS continues to evaluate the feasibility of developing additional firm water supplies. These supplies are invaluable in that they will meet demand over the next 50 years and provide the mechanism for diversification. Diversification is essential in order to meet Federal and State requirements to manage withdrawals from the Edwards Aquifer. The WMP provides an overview of potential water supply projects that will assist SAWS in meeting future water demands and the goal of diversification. The BGD Program is one of the projects identified to meet future water requirements. Another measure outlined in the WMP is conservation. Conservation is considered an additional water supply and has the ability to defer facility expansions and new projects. SAWS' current water conservation program serves 50% more people with the same amount of water used in the mid -1980's.

The overall BGD Program will consist of several project phases that may produce up to 25 million gallons per day (mgd) when fully built out. The BGD Program will be developed in phases over a period of approximately 15 years. The first phase of the program is anticipated to be completed by the end of 2016 and will consist of approximately 13 brackish water production wells, a well field collection system, a reverse osmosis (RO) treatment plant, a concentrate transmission pipeline, approximately three concentrate injection wells, and the associated electrical / Supervisory Control and Data Acquisition (SCADA) systems.

The BGD Program will be located within the lower San Antonio and Atascosa Rivers' watersheds in southern Bexar County on property owned by SAWS. Within the project area, land use is predominately agricultural. Many domestic and irrigation wells in this area rely heavily on the freshwater from the Carrizo and Queen City aquifers. The majority of the BGD production well field will be located on the Carrizo outcrop. The plant facilities will be located on the Reclaw outcrop. In this area, soils typically range from sand to a sandy loam. Brackish groundwater will be withdrawn from the lower portion of the Wilcox member of the Carrizo-Wilcox Formation (Figure 1-2).

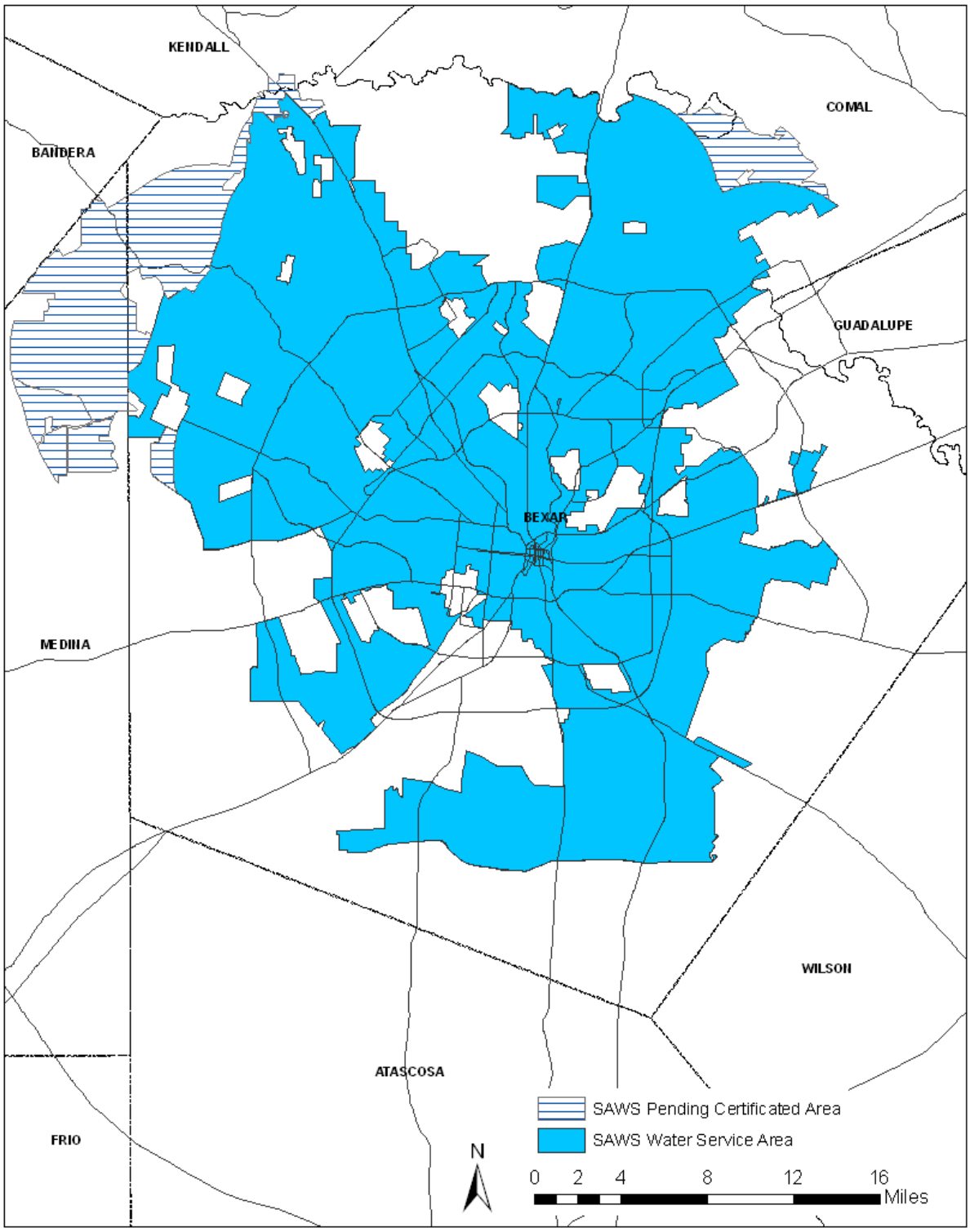


Figure 1-1: SAWS 2010 Water and Pending Certificated Areas

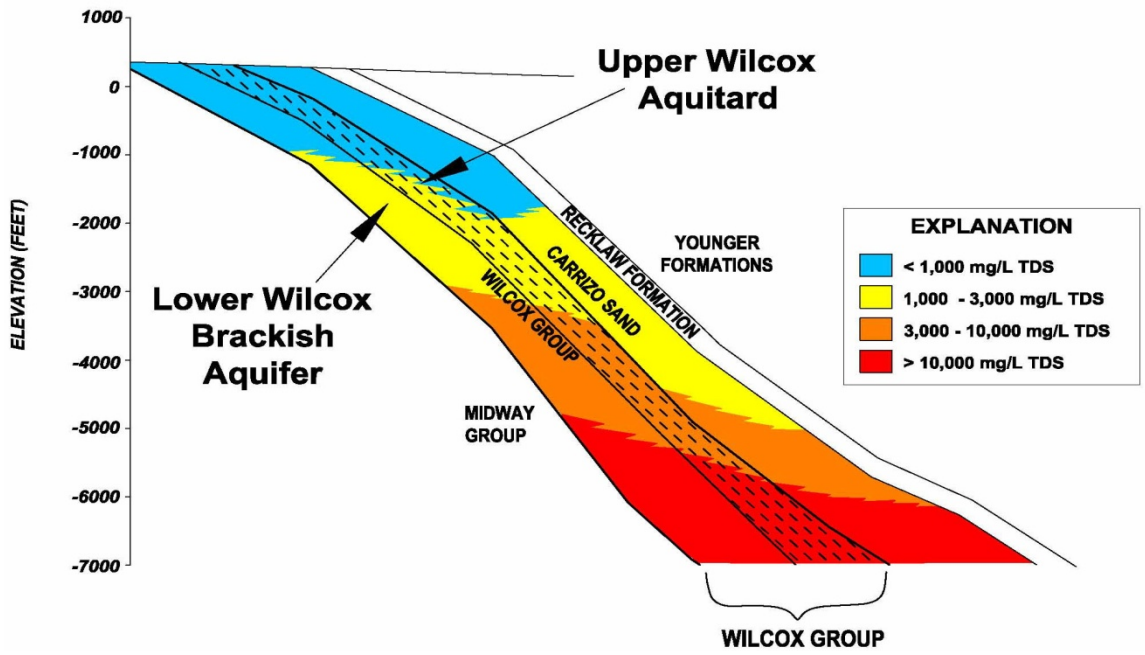


Figure 1-2: Cross-Section of the Carrizo-Wilcox Aquifer from Beck (2008)

1.3 Description of Site Specific Study Area

The proposed BGD Program will be located in Southern Bexar County. The Program will consist of three separate construction phases. Completion of the first phase will be in 2016, the second phase in 2021, and the third phase in 2026. Figure 1-3 shows the anticipated location of the production wells, collection pipeline, desal plant, and concentrate disposal wells for all three phases in Bexar County. This project will treat brackish groundwater that ranges in quality from 1,300 – 1,500 milligrams/liter (mg/L) total dissolved solids (TDS). Brackish groundwater will be withdrawn from the lower Wilcox aquifer and treated by a new reverse osmosis (RO) treatment facility located on SAWS owned property. Integration of water produced at this facility into SAWS distribution system will be accomplished by construction of a new transmission pipeline to the northwest side of San Antonio terminating at the Anderson Pump Station (Figure 1-4). The integration line will be used to transport water from the BGD program, as well as, the local Carrizo project, and ASR. Design and construction of the integration line is independent of the BGD program and should not be considered part of the Title XVI Project.

The project study area is located on the outcrops of the Carrizo and Reclaw Formation. Geologic formations in this area include the Sparta, Weches, Queen City, Reclaw, Carrizo, and Wilcox formations. These formations dip gently to the southeast toward the Gulf of Mexico at a rate of approximately 100 – 150 feet per mile. Based on R.W. Beck's feasibility report it has been determined that there is sufficient brackish water resources with appropriate water quality to

support a treatment plant operation for greater than 50 years. The proposed desalination facility will be located on SAWS' Twin Oaks ASR Facility property, thus maximizing the use of SAWS' existing land. This location is ideal due to its close proximity to the future brackish production well fields and the concentrate injection wells.

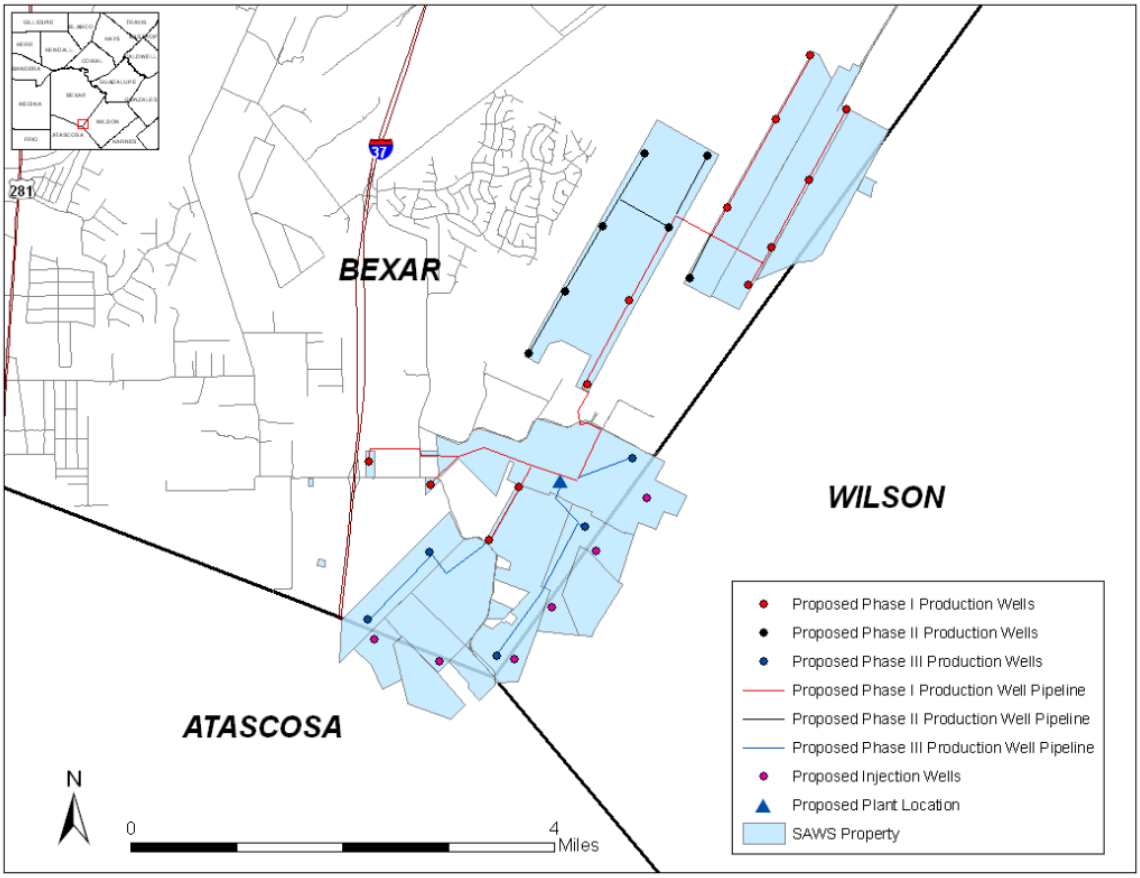


Figure 1-3: BGD Program and Component Location - All Phases

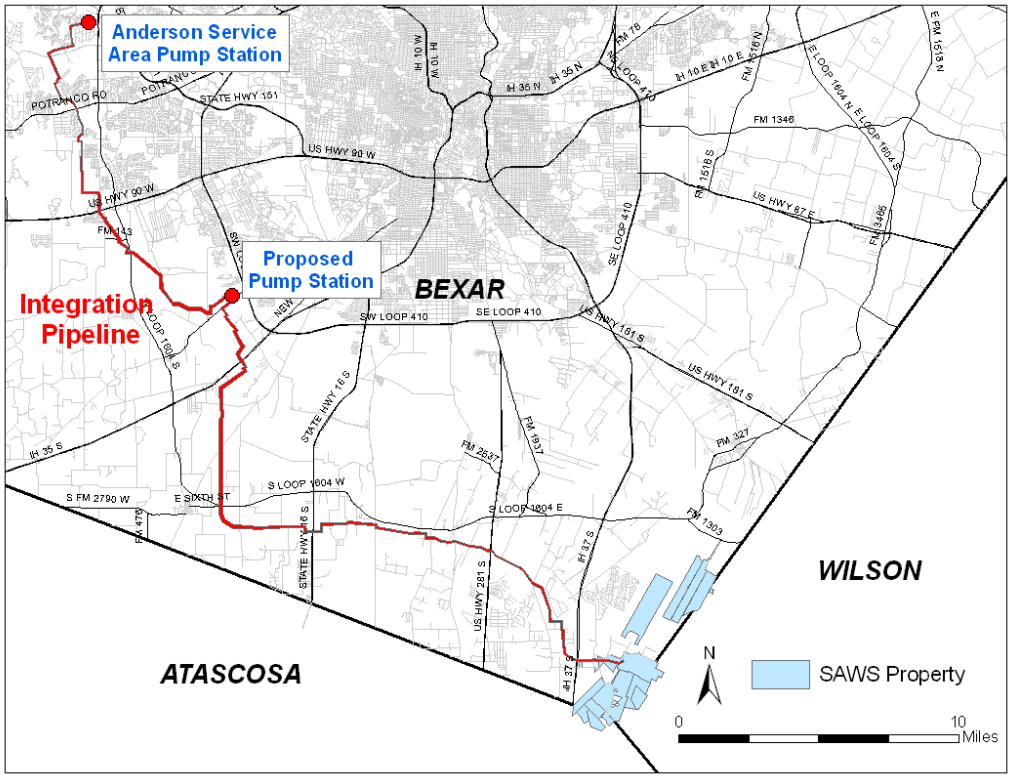


Figure 1-4: Brackish Groundwater System Integration Line

2.0 Problem and Needs

2.1 Need for a BGD Project

In south central Texas, sustainable water supplies are limited. Limited supply coupled with an increasing urban population has forced Texas to take a more long-term view of water supply planning. Over the past decade the San Antonio/Bexar County region has experienced a growth rate of approximately two percent per year. The current estimate of SAWS service population in year 2060 is approximately 2.156 million. In the San Antonio region, the primary source of potable water is the Edwards Aquifer. This source is the cornerstone of SAWS water resources. In the early 1990's, litigation was brought against the City of San Antonio and others by the Sierra Club citing violations of the Endangered Species Act. The litigation resulted in the Edwards Aquifer being legislatively limited and subject to drought cutbacks.

During development of the WMP, one of the goals was to increase diversification of SAWS' water supply. The WMP was developed based on: (1) changes in the Edwards Aquifer Enabling Legislation, (2) changes in population, (3) recent technical work on the water supply options, (4) evaluation of the economics of each project, (5) the regulatory landscape, and (6) drought of record planning. The WMP fully assessed future supply gaps during the 50-year planning horizon and a repeat of the drought of record considering SAWS available supplies at three different points during the planning horizon. Supply was determined during simulated drought of record periods by quantifying the percentage of SAWS Edwards' supply that would be available if a drought of record similar to that of the 1950's occurred. Current drought triggers established by the 2007 Texas Legislature were taken into consideration. In addition, after 2012, the Edwards Aquifer regional pumping "floor" used for planning purposes was assumed to be 320,000 acre-feet. The pumping "floor" of 320,000 acre-feet was derived from the passage of Senate Bill 3 during the 2007 Texas Legislature. Based on the WMP there are multiple periods where new projects will be required to meet the future water demand considering a repeat of the drought of record, current water supplies, and the possibility of drought restrictions on the Edwards. SAWS current water supplies include: permitted Edwards Aquifer water rights, groundwater from the Carrizo aquifer (south Bexar County), the groundwater from the Trinity aquifer (Oliver Ranch/BSR program), surface water from the Western Canyon project (Canyon Lake), and stored Edwards water from SAWS ASR project. The Oliver Ranch/BSR and Western Canyon projects are limited due to the contract term. This could potentially limit long-term production unless extensions are agreed upon.

SAWS' Edwards Aquifer water supply may be further impacted by the final results of the Edwards Aquifer Recovery Implementation Program (EARIP). The EARIP is a collaborative, multi-stakeholder, consensus-based process designed by the U.S. Fish and Wildlife Department to protect federally-listed threatened and endangered species reliant on spring flow from the Edwards Aquifer while balancing the permitted groundwater rights of human users. The EARIP is led by a Steering Committee of 26 members comprised of representatives from regulatory agencies, municipal water purveyors, groundwater districts, irrigation farmers, recreational interests, industrial users, environmental interests, and downstream water-rights holders. The

goal of the EARIP is to effectively manage the Edwards Aquifer to meet all of the different stakeholder concerns while simultaneously protecting spring flow for endangered species during severe droughts.

By state law, a federally-approved plan to manage the Edwards Aquifer must be agreed to by the end of 2012. Failure to reach this goal could lead to costly and contentious litigation. Development and completion of the BGD Program further demonstrates to the EARIP stakeholders that the region's largest Edwards Aquifer permit-holder (SAWS) is actively working to successfully diversify its water supplies in order to address future population growth and flow requirements of the species under federal mandates.

2.2 Current and Projected Water Supplies

The current permitted and projected future water supplies for SAWS are listed in Table 2-1. A large component not listed in Table 2-1 is SAWS' Recycled Water Program. This program supplies recycled wastewater for non-potable uses such as irrigation, industrial use, and maintenance of flow within the San Antonio River. The Recycled Water program eliminates the need for pumping, approximately, 85,000 acft/yr of potable resources from the Edwards Aquifer.

Table 2-1: Current and Future Water Supplies

SAWS Water Supply (acft/year)		
***Source**	**Current Permitted Supplies**	**Future Supplies**
Edwards Aquifer	261,000	
Oliver Ranch/BSR	3,500	
Local Carrizo	6,400	
Western Canyon	8,210	
Aquifer Storage and Recovery (ASR)**	83,000	
Regional Carrizo		*15,000*
Brackish Groundwater Desalination		*26,000*
Ocean Desalination		*120,000*
Total	**362,110**	**161,000**

*Table updated as of 8/2010

**ASR is not considered a firm yield source

Italicized information represents future water supplies only.

The Edwards Aquifer is the cornerstone of San Antonio's water supply, but it was recognized by SAWS, the local elected political leadership, water resource planners, and the citizens of San Antonio, that SAWS' water supply must become more diversified in the future. As early as the mid-1990's, SAWS Board of Trustees began to outline a vision for greater diversification of SAWS' water supply portfolio. Figure 2-1 shows the amount of diversification in SAWS current water resource supplies.

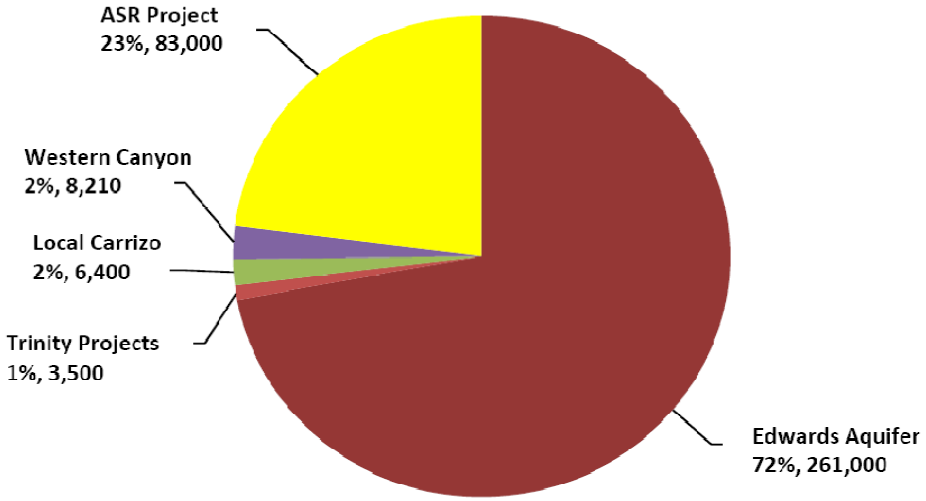


Figure 2-1: Diversification in SAWS Current Water Supply Portfolio (2010)

2.3 Current and Projected Water Demands

The Texas Water Development Board (TWDB) population projections form the basis for the population planning in the WMP. TWDB incorporates U.S. Census 2000 survey data and data from the Texas State Data Center for the individual county population estimates. SAWS further refines the population data to more accurately reflect the latest models and information regarding local growth in Bexar County.

Approximately every three to five years, SAWS' water resource program is re-evaluated. This evaluation is a detailed review of each active water supply, SAWS conservation programs and measures, per capita consumption trends, population projections, and potential future water supply projects. Each time SAWS updates the water management plan, water demands are projected 50 years into the future. The current WMP projects SAWS water needs to the year 2060. Consumption is measured by gallons per capita per day (GPCD). Table 2-2 illustrates SAWS' service area population and the anticipated water demand at three different levels of per capita consumption through year 2060. These three levels are normal, high, and low demands. Normal demand (116 GPCD) refers to average demands during hydrologically favorable periods with no restrictions on Edwards Aquifer supplies or on usage. High demand (126 GPCD) indicates increased use of outdoor watering during dry periods prior to drought trigger cutbacks mandated by city ordinance. Low demand (106 GPCD) may occur either in very wet years with little or no supplemental landscape watering, or during extreme drought periods when outdoor watering has been severely curtailed or eliminated. For a more detailed description of the current and projected water demands, refer to SAWS 2009 WMP.

Table 2-2: Population and GPCD 50-Year Projections

Year	Population Projection	GPCD High (acft/yr)	GPCD Med (acft/yr)	GPCD Low (acft/yr)
2010	1,333,500	207,925	186,266	171,777
2020	1,474,400	208,094	191,579	175,063
2030	1,639,400	231,382	213,018	194,655
2040	1,815,200	256,194	235,861	215,528
2050	1,985,500	280,230	257,989	235,749
2060	2,155,800	304,266	280,118	255,969

SAWS has taken a conservative approach to water supply planning because of the potential for drought restrictions and legislative changes impacting our primary water supply (Edwards permanent water rights and Edwards leased water rights). In addition, the challenges and length of time required to develop other water supplies is significant and by no means certain. To forecast the timing and need for additional water supply, SAWS assumed a "worst case" where no additional Edwards' leases were renewed and no additional water supply projects (including Regional Carrizo and the BGD Program) were brought on line. This was coupled with a simulation of a repeat of the "drought of record" and the depletion of all water stored in SAWS ASR site. In general, during the seventh or eighth year of a repeat of the drought of record SAWS enters a water deficit. Table 2-3 provides SAWS most recent projection of water deficits that could be expected in the worst year of a drought of record for the years 2030, 2040, 2050, and 2060. The water supply amounts were calculated by summing all of SAWS available water supplies for a given year. SAWS available water supply (in a worst case situation) assumes that there is reduced Edwards pumping because of specific stages of drought restriction, current Edwards groundwater leases are not renewed, and there is no pumping of the Trinity Aquifer during the worst years of the drought.

SAWS water demand during a drought of record (10 year period) is calculated as the midpoint between the high and medium demand for years 1-4 and 9, and the midpoint between the medium and low demand for years 5-8 (worst years of the drought). Selection of the midpoint of the aforementioned demand projections is based on stringent mandatory restrictions expected during a drought of record. A portable document file (pdf) of the spreadsheets used to calculate the water deficit/supply can be found in Appendix C. Figure 2-2 illustrates that a deficit could occur in year 2020 assuming a drought of record begins in 2013. Similar projections of potential water deficits were made for the planning horizon through 2060, as shown in Table 2-3, indicating the need for additional water supplies.

Table 2-3: Projected Potential Water Deficits

Year	Deficit (acft)
2030	62,099
2040	88,707
2050	109,882
2060	131,056

Due to the uncertainties in the EARIP process, outlined in Section 2.1, and the anticipated future water demands in San Antonio, it is vital that the BGD Program be built.

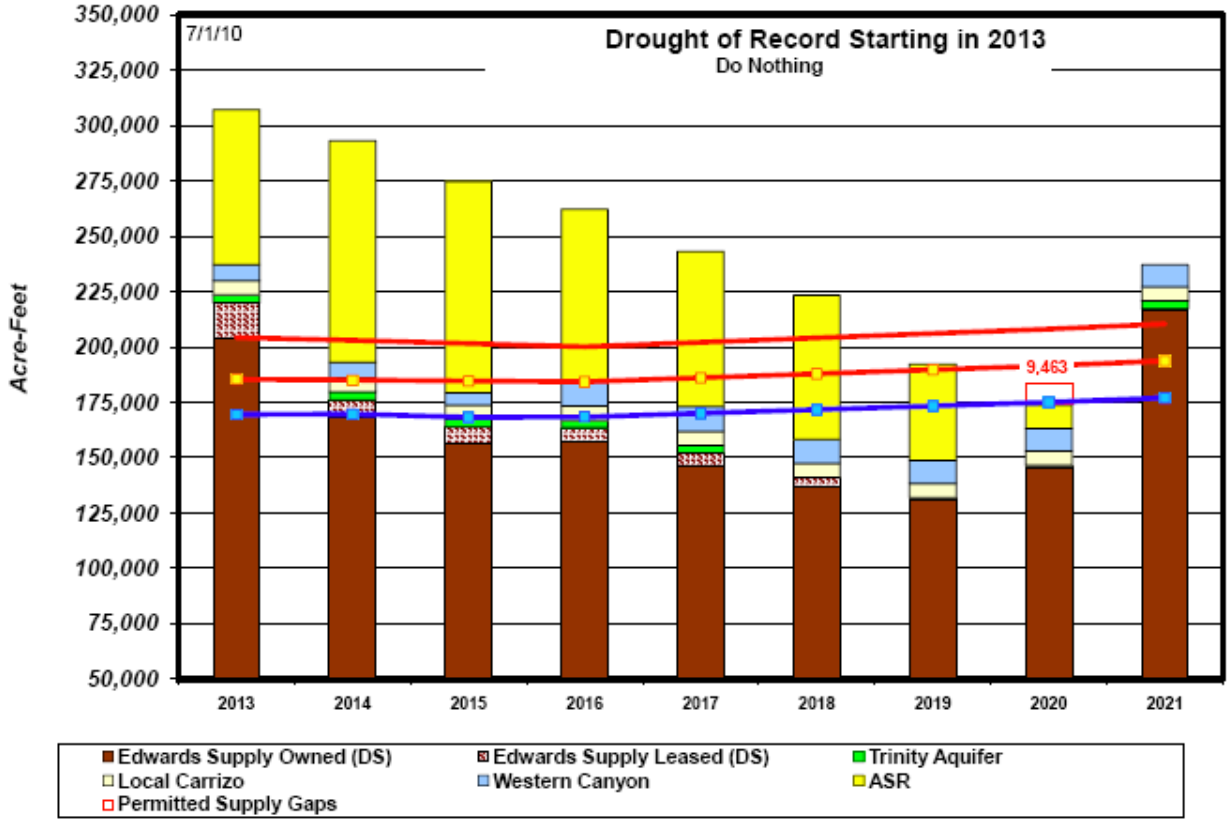


Figure 2-2: Drought of Record Beginning 2013

2.4 Water Quality Concerns

SAWS must meet all primary and secondary water quality standards for all public water supply projects. One of SAWS' greatest concerns with any new water resource project is the integration of the new supply into the existing distribution system. The impact of a new water resource's unique water chemistry and the effects on the existing distribution system is a topic that must be thoroughly evaluated. The age and pipeline material in SAWS distribution system varies throughout San Antonio.

A thin scale layer coating the inside of the distribution pipelines has formed over time due to the high calcium carbonate content of the water. Changes to the water quality could disturb this scale layer, causing it to slough off into the pipe and creating unappealing aesthetic characteristics in the drinking water. In order to avoid significant water quality and aesthetic fluctuations, water from each new supply is treated to be chemically compatible with the Edwards' water. Drinking water produced from the RO treatment plant will require post treatment prior to entering the distribution system. SAWS has conducted pipe loop testing to outline the chemical adjustments to insure compatibility.

2.5 Description of Current and Projected Wastewater and Disposal Options

This section is not applicable to SAWS' BGD program because the source water for the project is groundwater not wastewater.

3.0 Water Reclamation and Reuse Opportunities

3.1 Use of the Desalinated Water

Planning and feasibility work has been undertaken to determine the amount of potable water that can be produced and integrated into SAWS distribution system. The BGD Program will produce approximately 10 mgd of potable water following construction of the first phase of the project. Subsequent phases will increase production to a total of approximately 25 mgd. Due to steady growth of the water service area and ever-increasing limits on pumping from the Edwards Aquifer, SAWS desires to integrate the potable desalinated brackish water from the proposed BGD facility site in southeast Bexar County into the northwest portion of the distribution system at Anderson Pump Station. The area served by Anderson Pump Station is populated with residential, commercial, and industrial users (Sea World and Microsoft). The industrial users are sensitive to fluctuations in water quality from their water source. Therefore, SAWS has defined a Finished Water quality for the BGD Program that closely resembles the quality of the Edwards Aquifer water source and meets United States Environmental Protection Agency (USEPA) Primary and Secondary Drinking Water Standards.

For a more detailed description of the uses of the desalinated water please refer to R.W. Beck's Feasibility 2008 report, Volume 1, Section 3.3 "Connection to Distribution System Evaluation."

3.2 Water Market Available for Desalinated Water

The purpose of the BGD Program is to treat brackish groundwater to USEPA Primary and Secondary Drinking Water Standards, in order to diversify SAWS existing water supply. The treated potable water will be used to meet future demands of SAWS residential, commercial and industrial users on the northwest side of San Antonio.

A brief market assessment analysis was completed based on the population growth and future demand in San Antonio. The northwest area of the city is expected to experience the highest increase in growth and demand. For a more detailed description of the water market available for the desalinated water please refer to R.W. Beck's Feasibility 2008 report, Volume 1, Section 3.3, "Connection to Distribution System Evaluation." In addition, SAWS' 2009 WMP addresses increased water demand based on population growth.

3.3 Considerations that may Prevent Implementing the BGD Project

The BGD Program is consistent with state and federal water resource initiatives. Producing brackish groundwater will reduce competition for new freshwater resources in the south-central Texas region and will lower dependency on the Edwards Aquifer. With all projects, there are limiting factors that could hinder or potentially prevent implementation. The following factors could impact development of the BGD Program:

- **Development of Restrictive Desired Future Conditions (DFC)** - The state water planning process has established Groundwater Management Areas (GMA) throughout Texas. The purpose of a GMA is to regulate groundwater on a resource basis rather than a political basis. Each GMA is responsible for groundwater resource planning across the state for areas both controlled by a groundwater districts and outside the boundaries of any district. The southern portion of Bexar County is managed by GMA 13, even though no groundwater district is present. The GMA's have been tasked to establish a DFC for each groundwater resource for 50 years into the future. Currently, the DFC established by GMA 13 will not impact the BGD Program. However, state law requires the GMA to review the DFC every five years. Although no major change in the DFC is expected in the future, a more restrictive DFC could limit the BGD Program.

  To eliminate or reduce the impact of DFC's, SAWS participates in the GMA public meetings (required as part of the GMA process) to establish a consensus among all aquifer users. In addition, SAWS has provided technical information to GMA 13 to support the development of DFC's with the most recent data and analysis. Further, SAWS has provided groundwater modeling results and information regarding surface water/groundwater interaction.

- **Concentrate Disposal** - Another limiting factor is the disposal of the concentrate from the desalination process. An economic means of concentrate disposal must be identified and tested for the BGD Program to move forward. SAWS is conducting research to finalize concentrate disposal for the BGD Program. Preliminary research indicates that deep well injection into the Edwards Formation on SAWS property in Wilson County appears to have merit. Design and permitting of the test injection well is underway. It is anticipated that drilling of the test injection well, to determine the efficacy of deep well injection of concentrate, will begin in mid-2011.

Finally it is important to note that it is not anticipated that public acceptance will be an issue in developing the proposed Title XVI Project. This is due to the following reasons:

- The production wells are located in Bexar County
- Drought restrictions are common for the Edwards Aquifer, therefore the public understands the need for continued development of new water resources and diversification
- SAWS has provided project related information to the public in south Bexar, Atascosa, and Wilson County through SAWS website, written literature, and newspaper articles

3.4 Regulatory Agencies Over Project Area

The primary regulating agency with authority over the BGD Program is the Texas Commission on Environmental Quality (TCEQ). The TCEQ has established rules and regulations that address the design of the well field, collection system, reverse osmosis treatment plant, and concentrate injection system. In addition, the TCEQ regulations define the requirements for operational

reporting once the project is on-line. The majority of permits for development and construction of the BGD program will be obtained from the TCEQ.

Presently, other than TCEQ, there are no other regulatory agencies with jurisdiction over southern Bexar County.

3.5 Water to be Desalinated

R.W. Beck evaluated the brackish groundwater resources of the Wilcox and Edwards Aquifers in the vicinity of San Antonio. Brackish or saline groundwater can be found in most of the aquifers of Texas. Based on Beck's evaluation, SAWS has elected to develop brackish groundwater from the Wilcox Formation through a phased approach in southern Bexar County.

The Wilcox Formation is a muddy sandstone, composed of fluvial/deltaic sediments. Thickness ranges from a few hundred feet in the outcrop to approximately 2,000 feet, in the deep subsurface south and east of San Antonio. The Wilcox is overlain by the Carrizo Sandstone, a highly prolific aquifer in the area, and underlain by the Cretaceous Midway Formation, a thick shale. The Wilcox is divided into an Upper Wilcox and the lower Wilcox (Figure 1-2). In southern Bexar County, the Upper Wilcox is predominantly composed of shale with interbedded discontinuous sands. The thickness of the Upper Wilcox ranges from 200 feet to 350 feet. The lower Wilcox (SAWS production zone) is dominated by fine-grained sands and may be as thick as 1,000 feet.

Fresh groundwater (with TDS less than 1,000 mg/L) occurs in the up-dip and outcrop portions of the Wilcox. Several domestic, municipal and irrigation wells produce groundwater from this section. These wells, however, are generally less than 800 feet deep and have not tapped the total thickness, or the brackish section of the Wilcox. Farther down-dip, the Wilcox aquifer thickens and the water quality becomes increasingly saline. In some of the deeper sections of the Wilcox aquifer, in Wilson and Atascosa Counties, the salinity of the water is 10,000 mg/L TDS or greater. The potential productivity of sands in the brackish portion of the aquifer is considered to be similar to the sands in the fresh-water section. The BGD Program will target brackish groundwater located in the lower Wilcox. For a more detailed description of the water to be desalinated, refer to R.W. Beck's Feasibility 2008 report, Volume I, Section 2.1 "Site Selection."

3.6 Source Water Facility Location

The treatment facilities associated with the BGD Program will be located on SAWS' Twin Oaks ASR Facility site in south Bexar County. The proposed location is illustrated in Figure 3-1. It is anticipated that a formal facility siting study will be conducted to refine the location on the Twin Oaks ASR Facility property. It is anticipated that the plant facilities will require approximately 15 to 20 acres of the 3,200 acre property. Production well fields will be located on properties purchased by SAWS in Bexar County approximately three to four miles from the proposed treatment plant facility. Concentrate injection wells will be located on Twin Oaks ASR Facility

property extending into Wilson County approximately two to three miles from the proposed treatment plant.

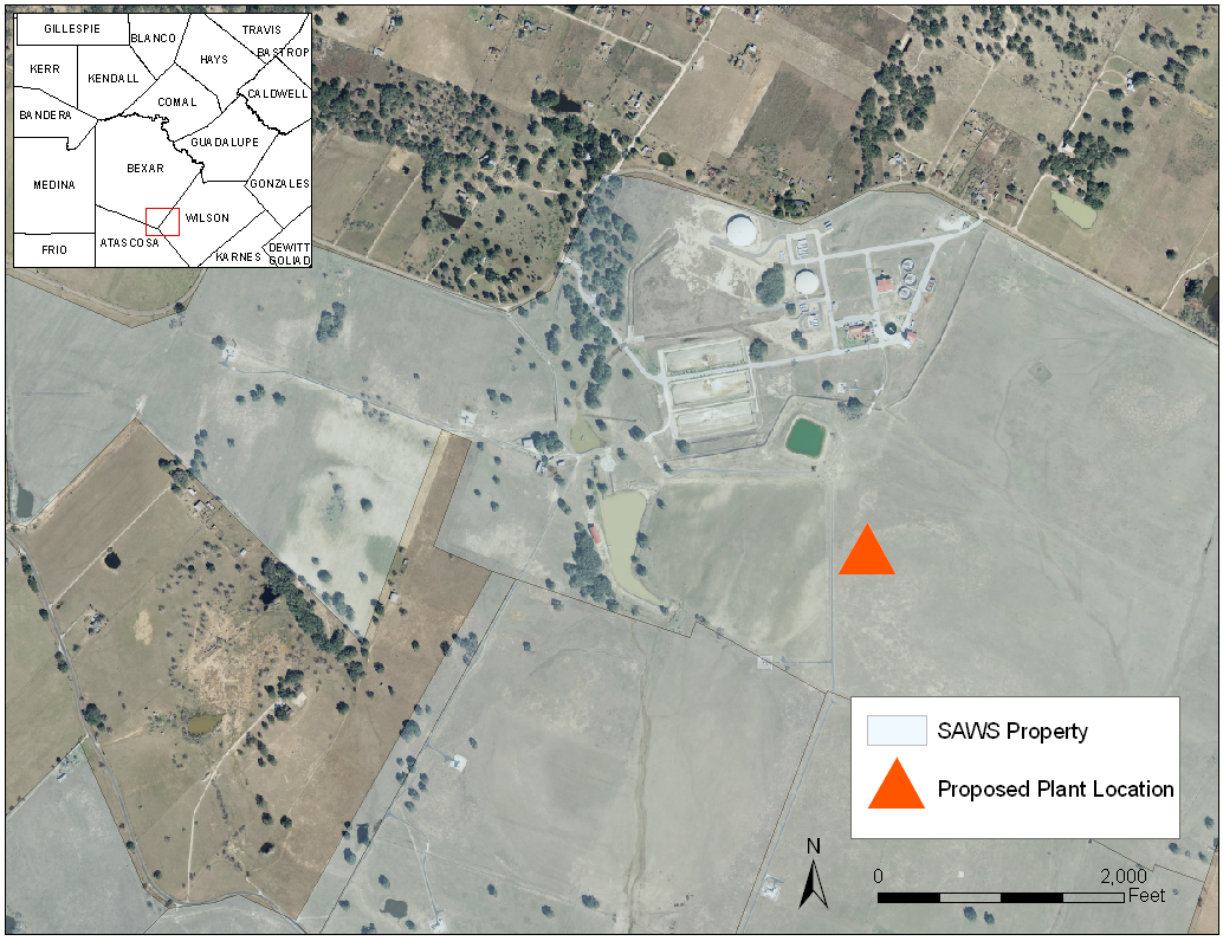


Figure 3-1: BGD Proposed RO Treatment Plant Location

For a more detailed description of the desalination facility refer to R.W. Beck's Feasibility 2008 report, Volume 1, Sections 3.4.3 and 3.6, "RO Process Configuration" and "Treatment Plant Location."

3.7 Description of Current Desalination Taking Place

Currently, SAWS has no other desalination treatment technology in use.

3.8 Technologies Available for Brackish Desalination

Treatment of brackish and saline water is divided into two major categories: (1) thermal (distillation) and (2) membrane technologies. Distillation is commonly used for high salinity waters and requires large quantities of energy. It is not commonly used for inland desalination

because the technology has low water recovery rates. The most common membrane technologies used for brackish desalination are RO, electrodialysis reversal (EDR), and nano-filtration (NF). NF is effective for the removal of calcium, magnesium, and sulfate, but is not efficient in removing common salts such as sodium chloride. Based on SAWS research, RO and EDR are the treatment technologies most applicable to SAWS brackish desalination program. SAWS has selected RO as the preferred treatment process. RO is the most common treatment process used in the Texas desalination operations. The rationale supporting SAWS selection of this treatment technology was based on the following considerations:

- **Market Competition** – There are multiple RO equipment suppliers, but only one primary EDR equipment supplier.

- **Advances in Technology** – Due to a higher level of market competition, there have been significant scientific advances in RO equipment technology.

- **Lower Relative Cost** – The 20-year life cycle cost for an RO facility is expected to be approximately 20 percent less than that for an EDR facility due to lower power consumption and membrane replacement costs.

- **Pathogen and Emerging Contaminants Removal** – With RO treatment, the membrane acts as a barrier to pathogens and emerging contaminants. With EDR treatment, pathogens and emerging contaminants have to be addressed during post-treatment.

- **"Hot Spot" Concerns with EDR** – Recommended maintenance for EDR includes identifying "hot spots" weekly. With the improvements in RO technology, the level of maintenance required for EDR is actually higher due to "hot spot" maintenance. If a "hot spot" is not addressed, a fire may result.

4.0 Description of Alternatives

4.1 Non-Federal Funded Project

SAWS will continue to pursue the BGD Program even in the absence of federal funding. The BGD Program was included in SAWS 2009 WMP as an integral part of SAWS future water supply because it addresses SAWS goal of increased supply diversification and reduction in the use of the Edwards Aquifer. In addition, the program supports the goal of the South Central Regional Planning Group (Region L) of using brackish groundwater as a management strategy to meet future water needs for the region. The estimated capital costs to SAWS, for all three phases if federal funding were not received, would be approximately $247.82 million. Section 9 of this report outlines SAWS financial condition. SAWS would remain financially capable of developing this Program without Federal funding.

4.2 Summary of Project Objectives

All projects outlined in SAWS' 2009 WMP have similar objectives of providing SAWS ratepayers with a clean sustainable water supply and meeting water demand for the next 50 years. Furthermore, these projects strive to increase SAWS' water resource diversification. If these projects fail to materialize, the alternative solution is the acquisition of permanent and/or leasing of additional Edwards's aquifer water rights. The objective of this Title XVI project would be to assist in alleviating future stress on the Edwards Aquifer and endangered species (as required by Federal and State Laws), as well as, developing a new unused drought proof source of water that is independent of other large consumers.

4.3 Other Water Supply Alternatives

SAWS outlined a diverse set of projects to meet water supply goals for the City of San Antonio through year 2060 in the 2009 WMP. Projects are classified based on SAWS needs during the short-range, mid-range, and long range planning horizons.

- **Short-Range Program (through 2014)**
  - Maintain the current Edwards Aquifer Inventory of Leases
  - Acquire additional Edwards Aquifer Permits
  - Phase I of BGD
  - ASR
  - Ocean Desalination – initial reconnaissance and feasibility work
  - Integration Pipeline – required for delivery of brackish water
  - Other Water Supplies – Competitive Sealed Proposals
  - Regional Carrizo

- **Mid-Range Program (2015-2034)**
  - Maintain the current Edwards Aquifer Inventory of Leases
  - Additional Edwards Permits or Expanded Brackish Desalination

- Recharge Enhancement
- ASR
- Recharge and Recirculation

- **Long Range Program (2035-2060)**
  - Additional ASR
  - Ocean Desalination
  - Other Water Supplies

These projects are needed in conjunction with the proposed Title XVI Project to satisfy future demand and are not considered as alternatives to the BGD Program.

The only viable alternative to the proposed Title XVI Project is the purchasing and/or leasing of additional Edwards groundwater rights. Additional Edwards water acquisitions could supplement the 26,000 acft/yr of water that would be expected from the full build out of the BGD Program. SAWS existing infrastructure is set up to take advantage of the Edwards alternative. Essentially, little if any new infrastructure would be required to incorporate the use of additional Edwards Aquifer water rights. Purchase of additional Edwards' water rights is the least costly water supply alternative when coupled with storage in SAWS' ASR project. Although permanent acquisition of additional Edwards' water rights is significantly less expensive when compared to the BGD Program, it is not the preferred option due to regulatory uncertainties, local diversification policies, drought management plans, and potential impact to the federally protected endangered species associated with the Edwards Aquifer.

Table 4-1 outlines the costs expected to be incurred for the leasing or purchasing of 26,000 acft/yr of water from the alternative option. These costs include the cost for leasing or purchasing Edwards' water, the Edwards Aquifer Authority (EAA) fee, maintenance, chemicals, energy, and debt services. The lifecycle costs for purchasing and leasing Edwards' groundwater can be found in Table 4-2. These costs were based on a 30-year cycle.

Table 4-1: Alternative Project: Edwards Acquisition Costs

Description	Lease ($ per acft)	Purchase ($ per acft)
Water	$145.00	$102.00
EAA Fee	$37.00	$37.00
Maintenance (pump stations, SCADA)	$7.00	$7.00
Chemicals	$2.00	$2.00
Energy	$40.00	$40.00
Debt Service (5% at 30 years, well drilling, replacement costs)	$95.00	$95.00
Total	**$326.00**	**$283.00**
Total 26,000 acft	**$8,476,000.00**	**$7,358,000.00**

Table 4-2: Edwards Aquifer Acquisitions Life-Cycle Costs

Edwards Aquifer Groundwater Acquisitions (Purchase)

	Purchasing 11,800 acft	Purchasing 8,800 acft	Purchasing 5,400 acft	Total 26,000 acft
Life Cycle Cost	**$78,817,327**	**$58,779,024**	**$36,068,946**	**$173,665,297**
Initial Capital Cost	$79,142,364	$59,021,424	$36,217,692	$174,381,480
Present Worth of 30-year EAA Production Fee	$6,711,612	$5,005,270	$3,071,416	$14,788,298
Present Worth of 30-year Maintenance Cost	$1,632,554	$1,217,498	$747,101	$3,597,154
Present Worth of 30-year Energy Cost	$7,255,797	$5,411,103	$3,320,449	$15,987,349
*Residual Value over 30 years	$15,925,000	$11,876,271	$7,287,712	$35,088,984

Edwards Aquifer Groundwater Acquisitions (Lease)

	Leasing 11,800 acft	Leasing 8,800 acft	Leasing 5,400 acft	Total 26,000 acft
Life Cycle Cost	**$57,503,424**	**$42,883,909**	**$26,315,126**	**$126,702,459**
Initial Capital Cost	$17,192,364	$12,821,424	$7,867,692	$37,881,480
Present Worth of 30-year EAA Production Fee	$6,711,612	$5,005,270	$3,071,416	$14,788,298
Present Worth of 30-year Groundwater Lease	$26,302,264	$19,615,248	$12,036,629	$57,954,140
Present Worth of 30-year Maintenance Cost	$1,632,554	$1,217,498	$747,101	$3,597,154
Present Worth of 30-year Energy Cost	$7,255,797	$5,411,103	$3,320,449	$15,987,349
*Residual Value over 30 years	$1,591,167	$1,186,633	$728,161	$3,505,962

Residual Value: Book Value((Age/Life)-1) - Land and/or Purchased Water Rights

Purchased Water Rights and Land show no depreciation in this cost cycle analysis

Assumes 50 year life span of the facility for all components

Assumes that all costs are incurred at the same time in t_0: the initial year

Assumes a 5% discount rate

4.4 Description of Proposed Title XVI Project

To support development of the BGD Program, a significant body of technical work has been completed to assure SAWS that this water supply project will be viable for 50 – 75 years into the future. SAWS has completed the following activities related to development of the project:

- Feasibility Study (R.W. Beck, Inc. 2008);
- Injection Well Research (Jeff Stone, 2008);
- Membrane Pilot Testing (Carollo Engineers 2010);

- Pipe Loop Testing (HDR Engineering, Inc. (2010);
- Concentrate Pipe Loop Testing (Carollo Engineers, 2010); and
- Feasibility of the Saline Edwards for Concentrate Disposal (LGB-Guyton, 2010).

Collectively, these studies support implementation of the project. The initial phase of the BGD Program will produce approximately 10 mgd. With all phases of the program, a total of approximately 25 mgd can be produced. Figure 1-3 illustrates the major components of all three phases.

To implement the initial phase of the BGD Program, SAWS will drill 13 production wells into the lower Wilcox Formation. It is anticipated that Phase II will require approximately 8 production wells and Phase III will require four production wells. Property has been acquired to accommodate all production wells for Phase I, and approximately 71% of Phase II. It is anticipated that land for the remainder of Phases II and III production wellfields will be acquired and located in the vicinity of the project site. Wells will range in depth from approximately 1,100 to 1,800 feet. Based on the pump testing conducted during the feasibility period, it is anticipated that these wells will produce at a rate of approximately 800 to 1,000 gallons per minute (gpm) and water quality will range between 1,300 - 1,500 mg/L total dissolved solids.

A collection system will be designed to convey raw water for the production wells to the treatment plant. Collection system piping ranges in size and will be configured for the build out of all three phases of the program. SAWS is in the process of acquiring an easement between the two northern production well field properties. In addition, SAWS will purchase an additional land tract that will provide direct access to the well field.

The reverse osmosis treatment plant building will be built to accommodate all future phases of the program. It is anticipated that Phase I of the program will require seven membrane trains. Phases II and III will require four and three membrane trains respectively. Additional plant components will include the associated pre-treatment facilities, cartridge filter system, pumps, clean in place (CIP) equipment, and solids handling equipment.

The disposal system will include a transmission pipeline, pre-injection facilities at each injection well, and the injection wells. Phase I of the program anticipates the need for 3 injection wells. Based on SAWS current knowledge, additional injection wells will be required for both Phases II and III. Experience gained from the use of the Phase I injection wells will assist SAWS in finalizing the injection well requirements for the future phases of the program.

Table 4-3 outlines the production wells, well field collection system piping, RO treatment plant, and disposal system associated with the cost projections for the program contained in Appendix D.

Table 4-3: BGD Program Construction Components

Estimated Values	Brackish Project Components		
Production Wells	Phase I	Phase II	Phase III
Number of Wells	13	8	4
Collection Pipe to Plant			
8"	20,170 ft	-	-
12"	12,460 ft	7,329 ft	4,099 ft
16"	6,124 ft	8,898 ft	6,400 ft
18"	16,896 ft	3,969 ft	-
20"	-	2,518 ft	-
24"	10,930 ft	-	3,851 ft
27"	-	-	3,493 ft
Desal Plant			
RO Membrane Trains	7	4	3
Concentrate Disposal Pipe			
8"	10,000 ft	*TBD	*TBD
14"	8,229 ft	*TBD	*TBD
Concentrate Injection Wells			
Number of Wells	3	2	1

*Amount required will be based on the productivity of phase I wells

SAWS has selected RO as the treatment process. RO treatment is considered an "Innovative Treatment Process" by the TCEQ. In order to use RO as the treatment process, SAWS was required to complete pilot testing and formally submit the results of this testing to TCEQ for approval. SAWS conducted pilot testing of the RO membranes between March 2008 – June 2010. A recovery rate of 90% was achieved along with a 99.7 % salt rejection. SAWS received approval on the membrane pilot testing from TCEQ on November 30, 2010. Based on the pilot testing, SAWS will configure the treatment plant for a single pass, three stage RO process.

Permeate pipe loop testing was completed to establish the post treatment water chemistry adjustments required prior to introduction treated water into SAWS distribution system. In addition, pipe loop testing established the maximum quantity of raw water that can bypass the plant and be blended with the permeate. SAWS anticipates the pilot testing of additional RO membranes (different manufactures) during 2011. Additional detailed information may be found in R.W. Beck's Feasibility 2008 report in Section 3.4.3 RO Process Configuration. The plant building will be configured to accommodate all phases of the program.

Deep well injection is SAWS preferred method of concentrate disposal. SAWS will design and construct a concentrate pipeline from the RO treatment plant to the concentrate injection wells. It is anticipated that an 18-inch line will be required for full build out of the BGD Program.

Approximately three Class I injection wells will be needed to dispose of approximately 1-1.5 mgd of concentrate for the first phase of the program. SAWS completed concentrate pipe loop testing to determine the effects of concentrate water quality on three different types of pipe material at differing velocities. The study concluded that the pipe material with the smoothest interior and the highest velocity should be used for planning. A further conclusion of the study was that SAWS should consider the possibility of installation of dual concentrate disposal lines for the purpose of redundancy.

Associated with the BGD program, will be the design and construction of the electrical system, SCADA system, administrative building, laboratory, chemical storage buildings, service roads at the treatment plant and well field, as well as on-site yard piping to convey finished water to the distribution point at SAWS ASR facility. The integration pipeline to convey water from south Bexar County to northwest San Antonio will be completed as a separate SAWS project and is not included in the project described herein.

SAWS will engage a Program Manager to oversee a team of engineers for all design disciplines associated with the program, as well as, provide construction management services.

SAWS has spent considerable time investigating the form of procurement that is most advantageous for this type of project. It has been determined that the procurement method for this project will be completed through a Construction Manager at Risk (CMAR) recently authorized in the 2007 Texas Legislature. Prior to using this form of procurement, a formal finding must be made by the SAWS Board of Trustees. SAWS Board of Trustees approved the use of CMAR on April 6, 2010.

The CMAR form of procurement provides a number of advantages to SAWS:

- Allows “best value” selection of construction bids;
- Establishes a guaranteed maximum price which is the maximum cost of the construction of the program;
- Allows for more collaboration between the construction contractor, design engineer, and owner; and
- The TCEQ is familiar with permitting using this form of procurement.

The CMAR coupled with a Program Manager will provide an integrated approach to project completion.

Development of subsequent phases will occur at approximately five year increments and result in a full build out capacity of approximately 25 mgd. The majority of the required infrastructure for the BGD Program will be constructed during Phase I. Major activities associated with subsequent phases will involve the acquisition of additional well field property, addition of RO treatment equipment for the plant, production well field expansion, and construction of additional injection wells. Table 4-4 provides a description of the BGD phases by the estimated

completion date, major construction components, and the amount of water in acre feet that will be supplied by each phase.

Table 4-4: Title XVI BGD Program Components and Phases

Phase	Estimated Completion Date	Major Construction Components	Supply (acft/yr)
I	2016	• Land • Electrical/SCADA • Treatment Plant • Production Well Field • Injection Well Field • Pipeline Conveyance System	11,800
II	2021	• Additional Properties • Expanded Electrical/SCADA • Expanded Treatment Plant • Additional Production Wells • Additional Injection Wells • Expanded Pipeline Conveyance System	8,800
III	2026	• Additional Properties • Expanded Electrical/SCADA • Expanded Treatment Plant • Additional Production Wells • Additional Injection Wells • Expanded Pipeline Conveyance System	5,400

Table 4-5 presents an estimate of capital and operating and maintenance costs by program phase. Additional injection well costs were extrapolated by SAWS from the existing HDR cost estimates for phases II and III of the Program. For more detailed project costs, including the unit costs, and the approach refer to Appendix D. To aid in water supply project cost comparison, costs are presented by acre-foot and by 1,000 gallons. Program costs were updated in October 2010 and reflect the current economic situation and latest configuration of the BGD Program. The lifecycle costs of the BGD Program can be found in Table 4-6 and were based on a 30-year cycle.

Table 4-5: Title XVI BGD Program Cost Estimates

ITEM	ESTIMATED COSTS			
	PHASE I	PHASE II	PHASE III	TOTAL COSTS
Pattillo, Nelson, ASR Brackish Wells (13)	$16,645,000			$16,645,000
Phase 1 Collection system to Plant	$4,265,000			$4,265,000
ASR/Jasik/Nelson/Plant Electrical Infrastructure	$785,000			$785,000
Phase 2 Brackish Wells (7)		$10,572,000		$10,572,000
Phase 2 Collection system		$2,122,000		$2,122,000
Phase 2 Electrical Infrastructure Improvements		$350,000		$350,000
Phase 3 Brackish Wells (5)			$5,994,000	$5,994,000
Phase 3 Collection system			$626,000	$626,000
Phase 3 Electrical Infrastructure Improvements			$250,000	$250,000
Carrizo Monitoring Wells (25 total)	$1,035,000	$585,000	$315,000	$1,935,000
Finished Water PS and Transmission to Storage	$1,676,000	$888,000	$740,000	$3,304,000
Instrumentation and Controls	$765,000	$335,000	$243,000	$1,343,000
Treatment Plant Site Work (at ASR)	$1,800,000			$1,800,000
Treatment Plant Equipment (25 MGD RO System)	$15,700,000	$10,400,000	$7,200,000	$33,300,000
Lime and CO2 Treatment System (25 MGD)	$1,900,000	$1,300,000	$800,000	$4,000,000
Treatment Plant Building	$3,800,000			$3,800,000
Solids Removal Pretreatment	$5,000,000	$3,900,000	$2,400,000	$11,300,000
Finished Water Storage Tank (7 MG)	$3,600,000			$3,600,000
Concentrate Transmission Main to Injection Site	$923,000	$615,333	$307,667	$1,846,000
Concentrate Pump Stations	$2,399,000	$728,000	$772,000	$3,899,000
Concentrate Injection Wells	$9,000,000	$6,000,000	$3,000,000	$18,000,000
Concentrate Storage at WTP and Injection Site	$1,760,000	$1,173,333	$586,667	$3,520,000
Injection Wells Electrical Infrastructure	$150,000	$100,000	$50,000	$300,000

ITEM	ESTIMATED COSTS			
	PHASE I	PHASE II	PHASE III	TOTAL COSTS
Contingency (20% of Construction)	$14,241,000	$7,814,000	$4,657,000	$26,712,000
Construction Total	***$85,444,000***	***$46,882,667***	***$27,941,333***	***$138,573,000***
Other				
Pre Construction Testing and Studies	$19,717,000			$19,717,000
Design & Program Management (18%)	$15,380,000	$8,439,000	$5,029,000	$28,848,000
Land Acquisition (Well Fields)	$7,678,000	$2,245,000	$264,000	$10,187,000
Land for Injection Wells ($4,850/acre)	$0			$0
Easements	$21,000	$41,000	$40,000	$102,000
Permitting	$1,500,000	$122,000	$84,000	$1,706,000
Bond Issuance	$500,000	$520,000	$310,000	$1,330,000
Interest During Construction (3 yr const: 5%, 30 yr bond)	$19,163,000	$8,527,000	$4,927,000	$32,617,000
Interest Earned on Unused Principal (3%)	($4,089,000)	($1,820,000)	($1,051,000)	($6,960,000)
Total Capital Cost	**$145,314,000**	**$64,956,667**	**$37,544,333**	**$247,815,000**
Annual Costs				
Debt Service (5.0%; 30 years)	$9,453,000	$4,226,000	$2,442,000	$16,121,000
Pipeline, Wells, Pump Station O&M	$448,000	$185,000	$139,000	$772,000
Treatment Plant O&M	$3,300,000	$1,100,000	$800,000	$5,200,000
Lime and CO2 O&M	$800,000	$550,000	$360,000	$1,710,000
Treatment Plant Energy	$890,000	$688,000	$425,000	$2,003,000
Well Field and Injection Wells Energy	$841,000	$397,000	$245,000	$1,483,000
Total Annual Cost	**$15,732,000**	**$7,146,000**	**$4,411,000**	**$27,289,000**
Yield Acre-Feet	**11,800**	**8,800**	**5,400**	**26,000**
ANNUAL COST PER ACRE-FOOT	**$1,333.22**	**$812.05**	**$816.85**	**$1,049.58**
ANNUAL COST PER 1,000 GALLONS	**$4.09**	**$2.49**	**$2.51**	**$3.22**

Table 4-6: Title XVI BGD Program Life-Cycle Cost Estimates
Brackish Groundwater Desalination Program

	Brackish (P-1) 11,800 acft	Brackish (P-2) 8,800 acft	Brackish (P-3) 5,400 acft	Total 26,000 acft
Life Cycle Cost	**$226,612,151**	**$103,312,978**	**$64,276,841**	**$394,201,970**
Initial Capital Cost	$145,314,000	$64,956,667	$37,544,333	$247,815,000
Present Worth of 30-year Maintenance Cost	$69,913,907	$28,208,448	$19,968,814	$118,091,169
Present Worth of 30-year Energy Cost	$26,609,713	$16,679,109	$10,299,542	$53,588,364
*Residual Value over 30 years	$15,225,469	$6,531,246	$3,535,848	$25,292,563

Residual Value: Book Value((Age/Life)-1) - Land and/or Purchased Water Rights

Purchased Water Rights and Land show no depreciation in this cost cycle analysis

Assumes 50 year life span of the facility for all components

Assumes that all costs are incurred at the same time in t_0: the initial year

Assumes a 5% discount rate

4.5 Disposal Water Quality Requirements

SAWS has chosen deep well injection as its preferred method of concentrate disposal. The salinity of the concentrate and the receiving formation is anticipated to be greater than 10,000 mg/L. As a result, Class I Underground Injection Control (UIC) wells will be required for disposal. SAWS will be required to complete all of the requirements for permit supporting data and file an application titled "Permit Application to Dispose of Waste in a Class I Injection Well." This application will be evaluated and approved before the issuance of an injection permit by TCEQ. The evaluation criteria include:

- examination of the regional hydrogeology;
- identification of major geologic structures and aquifers;
- determination of the confining zone thickness;
- determination of the injection zones;
- migration of injected water in the receiving body;
- determination of the lowest Underground Source of Drinking Water (USDW);
- location of continuous confining zones;
- determination of injection pressures; and
- a chemical analysis of the concentrate to be injected.

TCEQ will determine if an injection well permit can be issued based on: (1) the above mentioned criteria, (2) no detrimental impact will occur to the receiving formation or any United States Drinking Water (USDW) formation in the vicinity, and (3) there will be no harmful effects on any oil/gas reserve (Texas Railroad Commission letter). Further, TCEQ will also review and

approve design plans for the pre-injection units associated with the disposal system and approve an operating permit.

4.6 Alternative Measures/Technologies Available for Water Reclamation

Treatment of brackish and saline water is divided into two major categories: (1) thermal (distillation) and (2) membrane technologies. Distillation is commonly used for high salinity waters and requires large quantities of energy. It is not commonly used for inland desalination because the technology has low water recovery rates. The most common membrane technologies used for brackish desalination are RO, EDR and NF. NF is effective for the removal of calcium, magnesium, and sulfate, but is not efficient in removing common salts such as sodium chloride. Based on SAWS research, RO and EDR are the treatment technologies most applicable to SAWS brackish desalination program. SAWS has decided to utilize the RO process. The rationale supporting SAWS selection of this treatment technology can be found in section 3.8 of this report.

SAWS has investigated two methods of reclaiming additional water from the concentrate disposal stream. Zero liquid discharge was considered and Vibratory Shear Enhanced Procession (VSEP) was field tested. Zero liquid discharge was investigated as a method to eliminate the need for injection wells. In contrast, VSEP was considered to primarily assist SAWS in reducing the volume of concentrate requiring injection and to enhance permeate recovery.

Zero liquid discharge is a relatively new technology that has been used in some industrial applications. Specifically, the system was the GE/Ionics/RRC that uses a seeded slurry mechanical vapor compression evaporator. At the time of SAWS feasibility investigation, there were no systems of this type used on a commercial basis for a municipal desalination plant. The primary reason that this type of system was not field tested was because of its high electrical demand. This type of system was not considered cost competitive.

SAWS field tested the VSEP system developed by New Logic Technology, Inc. This type of system is a volume reduction technology that has been successfully used in other industries. It uses a flat sheet membrane technology that is vibrated at a frequency of 50 Hz to induce a shear force that will prevent the settling of larger particles (other impurities, salts) on the membrane surface while allowing additional water to be recovered. SAWS was primarily interested in the potential for concentrate volume reduction and increased permeate recovery. Field testing did not support the proposed concentrate volume reduction nor the increase in permeate recovery. It is likely that this type of technology is sensitive to site-specific water chemistry. The overall VSEP capital and O&M costs to support a 25 mgd reverse osmosis treatment plant were significantly more expensive than the drilling of injection wells. In addition, the fact that injection wells would still be required to support the VSEP process coupled with a higher salinity concentrate could possibly make TCEQ permitting of the injection wells more difficult.

5.0 Economic Analysis

5.1 Financial Conditions in the Project Area

San Antonio's economy saw unprecedented growth in the 1990's and continues to grow. Major employers in the city are associated with the services, manufacturing, and government employment sectors. The service sector is the largest and fastest growing sector of the economy, largely because of increased demand for health care and business services and San Antonio's sound tourism industry. The large concentration of government workers is due mainly to the location of four military bases in the area.

As a result of this continued growth, SAWS commitment to diversification over the past 15 years has resulted in demonstrable diversified sources of water. The Edwards Aquifer, Oliver Ranch/BSR, Local Carrizo, Western Canyon, ASR, and the Recycled Water projects have all contributed to a diverse portfolio of water resource projects. This success has not occurred without a cost to SAWS and the ratepayer community. Approximately $600 million has been expended to supplement water supply and meet water demands in innovative ways. Diversification remains a key component of consideration of SAWS when protecting its rate-payers against future Edwards Aquifer permit reductions during critical period stages.

As previously discussed in Section 2.3 of this report, SAWS has determined a need for the Title XVI project to assist in alleviation of future water supply deficits that could occur during a drought of record. TWDB's *2011 South Texas Regional Water Plan*, provided a detailed evaluation of the economic conditions that would result in the south Texas region if future water supply needs were not met (Appendix E). This report shows the effect on the monetary value of domestic water shortages, lost income and jobs from reduced commercial business activity, lost state and local taxes, and lost utility revenue for local cities and counties. In San Antonio alone it is estimated that a water deficit in 2020 could result in the loss of 15,208 jobs and $683.59 million dollars from commercial business activity. Although the analysis does not outline the exact economic impact of not producing the 26,000 acft/yr from the BGD Program, it provides a general summary of the effect that a water supply deficit would have on the City of San Antonio. It is imperative that SAWS continue to develop new drought proof water supply projects such as the recommended Title XVI Project in order to retain, support current business, and attract future businesses. Further, it is important that the business community clearly see that SAWS is taking the necessary steps to provide alternative drought proof supplies, continuing diversification, and reducing demand on the Edwards Aquifer. A strong commitment from the City of San Antonio to provide water, power, and infrastructure will help stimulate economic growth.

If the Title XVI Project was not implemented, SAWS would need to move forward with the alternative project which is the acquisition and leasing of additional Edwards's groundwater, previously discussed in Section 4.3 of this report. Acquisition of the alternative supply (Edwards leases/acquisitions) is vulnerable to drought restrictions, legislative uncertainties, and endangered species related issues. Further reliance on this resource would not instill confidence in the business community or regional stakeholders in the EARIP process that SAWS committed

to diversification and prepartion for the future. This could result in diminished business and economic growth in San Antonio.

5.2 Cost Comparison of Alternatives

Since the completion of SAWS 2005 Water Resource Plan, significant changes occurred that have impacted water resource planning. As a result, SAWS put together a task force to develop the 2009 WMP which includes various water resource projects designed to augment our current water supply. An important goal of the Task Force was to correctly compare relative costs of the proposed projects. The Task Force evaluated various cost methodologies and financial assumptions used by the TWDB and professional organizations for standardization and appropriateness given current economic and interest rate conditions. The Annualized Cost Methodology was used as the basis for developing the cost per acre foot. This methodology is currently recommended by TWDB for the regional water planning process and calculates the current year annual capital and O&M costs throughout the debt payoff period. Project cost estimates were prepared based on the recommended standards of the TWDB and modified to reflect current financial market conditions.

Table 5-1 illustrates the cost comparisons between the BGD Program and the Edwards Aquifer water right leases and purchases. Although leasing and purchasing Edwards' groundwater is less costly than the BGD Program, the BGD Program remains favorable because it alleviates SAWS reliance on the Edwards and its uncertainty to provide adequate water supplies to meet demands of the future.

Table 5-1: Alternative Project and Title XVI Program Comparison

Project	Component	Cost/AF
Edwards Water	Leasing Edwards Groundwater	**$326**
	Purchasing Edwards Groundwater	**$283**
Title XVI Program	Brackish (Phase I)	**$1,333**
	Brackish (Phase II)	**$812**
	Brackish (Phase III)	**$817**
	Brackish (All Phases)	**$1,050**

5.3 Other Benefits Considered

The primary benefit associated with the implementation of the BGD Program is that it provides an additional water source for SAWS that will be needed to meet future demand. Additional benefits of the BGD program include:

- reduction of water demand on the Edwards Aquifer;

- provides the potential for additional spring flow to support federally approved endangered species initiatives outlined within the EARIP process; and
- provides a dual benefit of development of a new unused water resource and while reducing dependence on a water resource that contains species under the protection of the Federal Endangered Species Act.

5.4 Benefits of Proposed Projects

The BGD Program will assist SAWS in sustaining growth through reduction of peak demands from the Edwards Aquifer during the summer. Inevitably, the project will assist San Antonio's long-term water supply demands and provide the support necessary to accommodate forthcoming economic opportunities.

Benefits of the BGD Program include:

1. Flexibility in facility size;
2. Minimal reliance on extended delivery systems;
3. Additional opportunity for local control of water supplies;
4. Reduced SAWS dependence on other inland water sources;
5. Very high quality potable water;
6. A reliable water source even in times of drought;
7. Increased supply from non-traditional sources;
8. Proof of concept and development of data for future development of Wilcox brackish resources in the region;
9. No known sources of contamination of the water source;
10. Reduces competition for limited freshwater sources; and
11. Continuing technology advancements for South Texas region.

6.0 Selection of the Proposed Title XVI Project

6.1 Reduction, Postponement, or Elimination of Expansion or Development of New Water Supplies

SAWS does not anticipate that the proposed Title XVI Project will eliminate or postpone the development of future water supplies outside of the Edwards Aquifer. These new supplies outlined in the SAWS 2009 WMP will still be needed in conjunction with the Title XVI Project to meet SAWS goals of diversification and future water supply demand. The BGD Program will assist in reducing the need for expansion and further development of the Edwards Aquifer. Furthermore, the BGD Program will assist SAWS in preparing for any Edwards pumping restrictions that may result from the EARIP process or other reductions. For more detail on the EARIP process refer to Section 2.1 of this report.

6.2 Reduction or Elimination of Existing Diversions from Surface Waters or Withdrawal from Aquifers

The proposed Title XVI project will produce 25 mgd or 26,000 acft/yr at final build out. This will help SAWS reach mid-term water supply goals without acquiring future Edwards' groundwater permits. Furthermore, in the short-term the proposed project will reduce pumping from the Edwards Aquifer and prepare SAWS for any impacts that may be realized from the EARIP. The goal of the EARIP is to manage the Edwards Aquifer by maintaining adequate spring flows needed for the health of several endangered species during severe droughts while simultaneously providing water for regional groundwater users. For more detailed information on the EARIP refer to Section 2.1 of this report.

SAWS has an opportunity to make great strides in the region by developing non-Edwards supplies. This Title XVI project is one example of how this can be accomplished. Although Edwards groundwater is cheaper to produce than brackish groundwater, SAWS realizes the importance of moving forward with more expensive water to reduce pumping on the Edwards and diversify existing supplies.

6.3 Reduction of Demand on Existing Federal Water Supply Facilities

This project would not reduce the demand on existing Federal water supply facilities.

6.4 Reduction, Postponement, or Elimination of New or Expanded Wastewater Facilities

This section is not related to the Title XVI Project since SAWS is developing a program to treat brackish groundwater for potable consumption and no wastewater effluent will result from the program. SAWS currently has sufficient wastewater treatment capacity to absorb the wastewater generated from the addition of 25 mgd of potable water from the BGD Program. SAWS wastewater treatment plant, Dos Rios, is rated at 125 mgd, but currently the daily average is approximately 75 mgd. Further, SAWS has already begun expansion of the Dos Rios

wastewater treatment plant to 217 mgd. The completion of the expansion will be within the next 10 years.

7.0 Environmental Assessment

A full NEPA environmental investigation has not been initiated for this project. This will occur following the selection of the Program Manager in late 2011. An Environmental Assessment (EA) has been completed for the property of the first eight production wells for Phase I (Appendix F). Additional EA's will be completed for the remainder of the project area in order to receive the TWDB Water Infrastructure Funding (WIF). Based on the results of the initial EA associated with the production wells, it is not anticipated that adverse environmental impacts will be identified that will affect implementation of the BGD Program. Furthermore, referenced in Appendix G, are letters from the Texas Historical Commission (THC) and the U.S. Fish and Wildlife Service (USFWS) stating No Action required for the first eight production wells for the BGD Program.

All phases of the project are anticipated to have no finding of significant impact.

7.1 Potential Significant Impacts on Endangered or Threatened Species, Natural Resources, Cultural Resources, Public Health or Safety, and Regulated Waters of the United States

SAWS has received an EA for the first eight production wells. Below are the findings of those sites. SAWS anticipates, in the future, receiving 2 other environmental assessments on the other five production well locations and the injection well locations. Since the BGD Program's properties are located in close proximity and are currently being used for the existing ASR it is anticipated that the future EA's will show no significant impact.

Protected species that may be encountered within the project area include the Texas Horned Lizard (Phrynosoma cornutum) and the Harvester Ants (genus Pogonomyrmex). The Harvester Ant is protected in the project area because they are the primary food source for the Texas Horned Lizard. The State of Texas lists the status of the Texas Horned Lizard as threatened. The Federal government does not consider the Texas Horned Lizard a threatened or endangered species. Rare species that may be encountered within the project area include the Elmendorf's Onion (Allium elmendorfii) and the Sandhill Woolywhite (Hymenopappus carrizoanus). These two rare species are not protected by law, but Texas Parks and Wildlife Department (TPWD) considers them to be at risk for endangerment.

SAWS has received a letter from the THC confirming that there will be no significant impact to any archeological sites. It is not anticipated that public health and safety will be affected by this project. Furthermore, there are no regulated waters in the vicinity of the project area.

Oil and gas production near the project site is primarily limited to the Poth and the Austin Chalk Formations. Based on preliminary investigations, it is not anticipated that Class I injection wells will pose a threat to the production of these oil and gas wells. As part of the Class I permitting process, SAWS will be required to furnish evidence to the RRC that the injection of concentrate

will not detrimentally impact an existing oil/gas formation. This information will be available late spring/early summer of 2011.

7.2 Potential Significant Environmental Effects of the Project

Currently SAWS does not anticipate any significant environmental effects from the BGD Program.

7.3 Status of Required Federal, State, Tribal, and/or Local Environmental Compliance Measures

The BGD Program will receive WIF from the TWDB, in the form of low interest loans to support development of the project. To be eligible for such funding involves the completion of Environmental Assessments for the entire project area. SAWS has completed the first Environmental Assessment for the first eight brackish production wells.

7.4 Other Information to Assist with NEPA Compliance

There is no other information at this time that would assist assessing the measures that may be necessary to comply with NEPA.

7.5 Title XVI Project's Affect on Water Supply and Water Quality

LBG-Guyton Associates completed an evaluation of water level declines related to production of brackish groundwater from the Wilcox Aquifer in the southern part of Bexar County. Modeling simulations were completed using the TWDB Southern Queen-City Sparta Carrizo-Wilcox Groundwater Availability Model (GAM). The modeling indicated that the Wilcox aquifer can support all phases of the BGD program for greater than 50 years. Water level decline in the Wilcox Formation is estimated to be approximately 350 – 400 feet at the end of 50 years of production. In addition, the modeling indicates that production from the Wilcox Formation will have almost no impact (4-8 feet of water level decline over 50 years) to water levels in the overlying Carrizo Formation. Production from the BGD program is anticipated to begin at the end of year 2016. Phases II and III will be completed in years 2021 and 2026 respectively. Water level monitoring and hydrologic modeling in both the Carrizo and Wilcox Formations will be conducted to confirm previous water supply and quality predictions once the first phase of the project is in operation. It is not anticipated that the BGD Program will affect the water quality of the area or existing freshwater aquifers.

7.6 Public involvement in the Feasibility Study

SAWS has provided project related information to the public in south Bexar County, Atascosa County and Wilson County through SAWS website, written literature, newspaper articles, and through scientific meetings for the general public and elected officials. In addition, SAWS has

provided information, project status updates, and scientific information to the manager of the Evergreen Underground Water Conservation District (EUWCD) and elected officials.

SAWS does not anticipate that there will be any public acceptance issues for the project. This is largely based on SAWS decision to develop all phases of the program within Bexar County. Previously, the majority of criticism came from residents in Atascosa and Wilson counties when production well fields were projected for placement in those counties. Furthermore, because drought restrictions are common for the Edwards Aquifer in Bexar County, the residents understand the importance for the development of new water resources and the need for continued diversification.

7.7 Potential Effects the Project may have on Historic Properties

In order to coordinate the review of cultural and historical resources, SAWS completed a desktop review of published records and a pedestrian survey of the area associated with the first eight brackish production wells. This information was provided to the THC for review. The THC reviewed the historical/cultural information and indicated that the project may proceed (Appendix G). It is anticipated that coordination with the THC will be required as SAWS completes the EA's associated with other portions of the BGD program. No other historical sites are expected to be located on any other portions of SAWS' BGD Project area.

8.0 Legal and Institutional Requirements

8.1 Water Rights Issues

The water source for this Title XVI project is groundwater. Groundwater is not subject to the same limitations as surface water. In Texas, areas not within groundwater conservation district (GCD) boundaries fall within the state's "Rule of Capture." The "Rule of Capture" provides that, absent malice or willful waste, landowners have the right to take all the water they can capture under their land. The well field property for Phase I is owned by SAWS and is not within a GCD.

8.2 Legal and Institutional Requirements

Public water systems in Texas must comply with all the applicable drinking water rules and regulations adopted and enforced through the TCEQ. As a public water treatment facility, the BGD treatment plant will adhere to all monitoring, recording and reporting of water quality data associated with treatment and disposal as stipulated by state federal regulations.

8.3 Multi-Jurisdictional or Interagency Agreements Required

The BGD Program will not require any Multi-Jurisdictional or Interagency Agreements.

8.4 Permitting Procedures Required for Implementation of Reuse

The BGD Program will incur various local, state and federal permitting obligations during construction and operations. With assistance from R.W. Beck, SAWS researched and developed the Permitting Plan from a 2004 TWDB guidance document for permitting desalination projects in Texas. The majority of the permits will be obtained from TCEQ. The Permitting Plan and ancillary information can be found in R.W. Beck's Feasibility 2008 report, Volume 1, Section 5 "Permitting" and in Appendix H of this report. The Permitting Plan lists permits that SAWS anticipates may be needed to complete the BGD Program. These include a list of local permits, TCEQ permits, and permits related for the wellfield, collection system, treatment plant, distribution system, and concentrate disposal. When the Permitting Plan was originally developed, it was thought that SAWS would complete a portion of phases II and III in Wilson and/or Atascosa County. This would have required additional permits from the Evergreen UWCD related to drilling, groundwater production, and transport of groundwater out of the district. Since SAWS is developing all three phases in Bexar County no additional permits from the Evergreen or other local conservation districts are required.

Some potential TCEQ permits, approvals, plans, and notifications that may be required for the Title XVI Project are as follows:

- Production Wells: Design Approval
- New Well Construction: Design Approval

- Commercial Hazardous Waste
- Notification of Hazardous or Industrial Waste
- Public Water System Plan
- On-site Sewer Facility Operating Permit
- Texas Pollutant Discharge Elimination System
- Storm Water Discharge (Construction and Industrial)
- Project Antiquities/Cultural Review
- Residual Solids Registration/landfill permit
- Petroleum Storage Tank Registration
- Discharge of Hydrostatic Test Water Permit
- Air Pollution Permit
- Pre-Injection Registration
- Storage or Process of Non-Hazardous Wastes
- 404 Permit
- UIC General Permit of Non-Hazardous Desalination Concentrate

Potable water treatment utilizing RO membrane technology falls under the "Innovative Treatment Technologies" portion of the TCEQ permitting structure. Pilot testing of the membranes is an essential step required to initiate permitting of the proposed RO facility. In 2010 pilot testing of the membranes which will be used during operation of the treatment process were completed and submitted to the TCEQ for review and approval.

8.5 Unresolved Issues Associated with Project Implementation

The only remaining issue is the drilling and confirmation that deep well injection will be a viable method of concentrate disposal. SAWS anticipates the completion of drilling and testing of a Class I test injection well by September 2011.

8.6 Current and Projected Wastewater Discharges Resulting from Project

The use of RO as the treatment method for the BGD Program will produce brine concentrate that will require proper disposal. The feasibility study assessed several disposal methods and it was determined that deep well injection was the best option for the project. Preliminary research indicates that the Edwards Formation in the project area appears to provide the best geology for deep well injection. SAWS will drill a test injection well to confirm that the Edwards Formation will provide the best long-term disposal option.

8.7 Rights to Wastewater Discharges Resulting from Project

Wastewater (concentrate) from the BGD Program will be injected into the Edwards Formation. This section of the report is not applicable to BGD Program.

9.0 Financial Capability of the Sponsor

9.1 Proposed Schedule

The anticipated schedule for Phase I of the BGD Program is shown on Figure 9-1 at the end of this section. Permitting, construction of Well Package I, and UIC Injection is scheduled to commence in 2011 along with commencement of design engineering of the well field collection system and pipeline, RO treatment plant, concentrate disposal system, and SCADA system. Construction of the latter will follow in 2013, with completion and acceptance testing occurring in 2016. Phases II and III of the project are currently planned for 2021 and 2026, respectively.

9.2 Willingness to Pay

SAWS understands that the maximum participation of the Bureau of Reclamation in project implementation costs is limited to 25% or $20 million of such costs whichever is less. SAWS is prepared to cover the 75% or more of the project implementation costs and will develop plans for operation, maintenance, and replacement of facilities in annual budgeting in the same manner as SAWS does for existing infrastructure. SAWS may, in the future, seek amended authorizations to increase the federal funding cap of $20 million to an amount that would fully fund 25% of all three phases of the Title XVI Project combined.

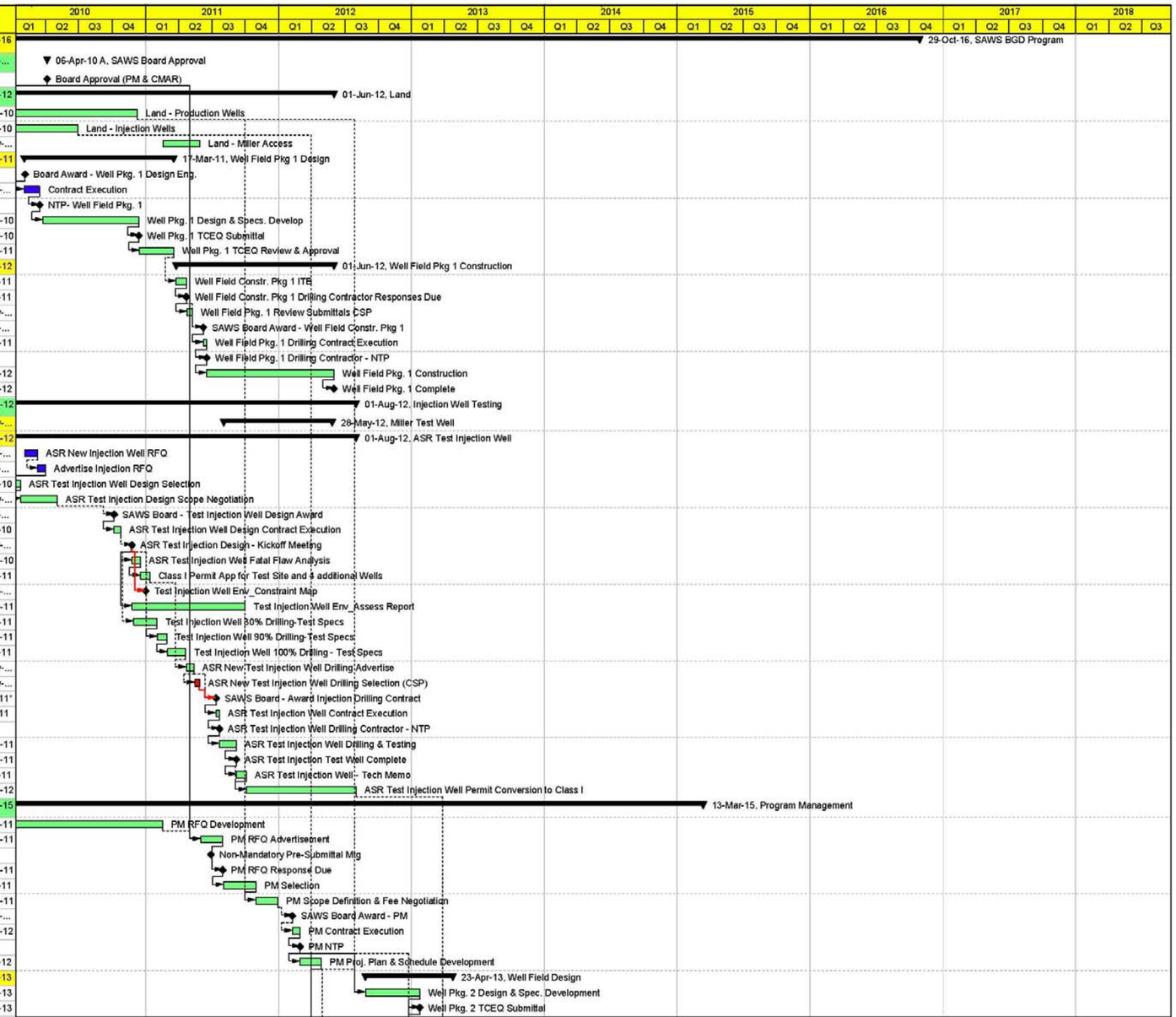
9.3 Funding Plan

All of the funds supporting construction of this project, including the non-Federal share of construction, will be funded by a combination of sources. These include future approved bond funds and utility revenues. Funding for operation, maintenance, replacement, and debt service will be from utility revenues. Appendix I shows the sources and uses of funding for the Capital and O&M costs, by year, for all phases. It is important to note that all cost information is an estimate and is subject to change. SAWS anticipates seeking a Federal cost-share for all phases of the BGD project by working with our Congressional delegation.

9.4 Funding Sources

All non-Federal funding for the project will be provided by SAWS. SAWS understands that their share will not be less than 75% of project costs and plans on funding that amount. SAWS will receive TWDB WIF low interest loans for certain components of the BGD Program.

Activity ID	Activity Name	Original Duration	Remaining Duration	Start	Finish
SAWS BGD Program		1780	1780	04-Jan-10 A	29-Oct-16
SAWS Board Approval		0	0	06-Apr-10 A	06-Apr-...
A1000	Board Approval (PM & CMAR)	0	0	06-Apr-10 A	
Land		629	629	04-Jan-10 A	01-Jun-12
LPW1000	Land - Production Wells	337	337	04-Jan-10	07-Dec-10
LPW1010	Land - Injection Wells	180	176	04-Jan-10 A	28-Jun-10
LPW1020	Land - Miller Access	100	100	19-Feb-11*	29-May-...
Well Field Pkg 1 Design		314	256	02-Feb-10 A	17-Mar-11
WF1000	Board Award - Well Pkg. 1 Design Eng.	0	0	02-Feb-10 A	
WF1010	Contract Execution	35	0	02-Feb-10 A	16-Mar-...
WF1020	NTP- Well Field Pkg. 1	0	0	16-Mar-10 A	
WF1030	Well Pkg. 1 Design & Specs. Develop	263	263	25-Mar-10*	13-Dec-10
WF1040	Well Pkg. 1 TCEQ Submittal	0	0		13-Dec-10
WF1050	Well Pkg. 1 TCEQ Review & Approval	93	93	14-Dec-10	17-Mar-11
Well Field Pkg 1 Construction		310	310	25-Mar-11	01-Jun-12
CWF1000	Well Field Constr. Pkg 1 ITB	30	30	25-Mar-11*	23-Apr-11
CWF1010	Well Field Constr. Pkg 1 Drilling Contractor Respons...	0	0		23-Apr-11
CWF1015	Well Field Pkg. 1 Review Submittals CSP	15	15	24-Apr-11	08-May-...
CWF1020	SAWS Board Award - Well Field Constr. Pkg 1	0	0		07-Jun-...
CWF1030	Well Field Pkg. 1 Drilling Contract Execution	10	10	07-Jun-11	17-Jun-11
CWF1040	Well Field Pkg. 1 Drilling Contractor - NTP	0	0	17-Jun-11	
CWF1050	Well Field Pkg. 1 Construction	350	350	17-Jun-11	01-Jun-12
CWF1060	Well Field Pkg. 1 Complete	0	0		01-Jun-12
Injection Well Testing		672	672	04-Jan-10 A	01-Aug-12
Miller Test Well		214	214	02-Aug-11	28-May-...
ASR Test Injection Well		672	672	04-Jan-10 A	01-Aug-12
A7000	ASR New Injection Well RFQ	28	0	02-Feb-10 A	10-Mar-...
A7010	Advertise Injection RFQ	21	0	10-Mar-10 A	01-Apr-...
A7020	ASR Test Injection Well Design Selection	19	19	04-Jan-10	22-Jan-10
A7030	ASR Test Injection Design Scope Negotiation	100	100	23-Jan-10	02-May-...
A7040	SAWS Board - Test Injection Well Design Award	0	0		05-Oct-...
A7050	ASR Test Injection Well Design Contract Execution	20	20	05-Oct-10	25-Oct-10
A7060	ASR Test Injection Design - Kickoff Meeting	0	0		23-Nov-...
A7070	ASR Test Injection Well Fatal Flaw Analysis	23	23	24-Nov-10*	16-Dec-10
A7080	Class I Permit App for Test Site and 4 additional Wells	25	25	17-Dec-10*	11-Jan-11
A7090	Test Injection Well Env_Constraint Map	0	0		31-Dec-...
A7095	Test Injection Well Env_Assess Report	310	310	24-Nov-10*	30-Sep-11
A7100	Test Injection Well 30% Drilling-Test Specs	63	63	29-Nov-10*	31-Jan-11
A7105	Test Injection Well 90% Drilling-Test Specs	28	28	01-Feb-11	28-Feb-11
A7110	Test Injection Well 100% Drilling - Test Specs	50	50	01-Mar-11	19-Apr-11
A7120	ASR New Test Injection Well Drilling Advertise	22	22	22-Apr-11*	13-May-...
A7125	ASR New Test Injection Well Drilling Selection (CSP)	15	15	16-May-11*	30-May-...
A7130	SAWS Board - Award Injection Drilling Contract	0	0		12-Jul-11*
A7140	ASR Test Injection Well Contract Execution	10	10	12-Jul-11*	22-Jul-11
A7150	ASR Test Injection Well Drilling Contractor - NTP	0	0	22-Jul-11	
A7160	ASR Test Injection Well Drilling & Testing	46	46	22-Jul-11*	06-Sep-11
A7170	ASR Test Injection Test Well Complete	0	0		06-Sep-11
A7180	ASR Test Injection Well - Tech Memo	30	30	06-Sep-11	06-Oct-11
A7190	ASR Test Injection Well Permit Conversion to Class I	300	300	06-Oct-11	01-Aug-12
Program Management		1355	1355	04-Jan-10 A	13-Mar-15
A1010	PM RFQ Development	74	406	15-Feb-10 A	15-Feb-11
A1020	PM RFQ Advertisement	62	62	01-Jun-11*	01-Aug-11
A1025	Non-Mandatory Pre-Submittal Mtg	0	0	30-Jun-11*	
A1030	PM RFQ Response Due	0	0		01-Aug-11
A1040	PM Selection	90	90	02-Aug-11	30-Oct-11
A1050	PM Scope Definition & Fee Negotiation	60	60	31-Oct-11	29-Dec-11
A1060	SAWS Board Award - PM	0	0		07-Feb-...
A1070	PM Contract Execution	21	21	08-Feb-12*	28-Feb-12
A1080	PM NTP	0	0	29-Feb-12	
A1090	PM Proj. Plan & Schedule Development	60	60	29-Feb-12	28-Apr-12
Well Field Design		172	172	27-Aug-12	23-Apr-13
WF1090	Well Pkg. 2 Design & Spec. Development	150	150	27-Aug-12	23-Jan-13
WF1100	Well Pkg. 2 TCEQ Submittal	0	0		23-Jan-13



Actual Work | Critical Remaining Work | Summary
Remaining Work | Milestone

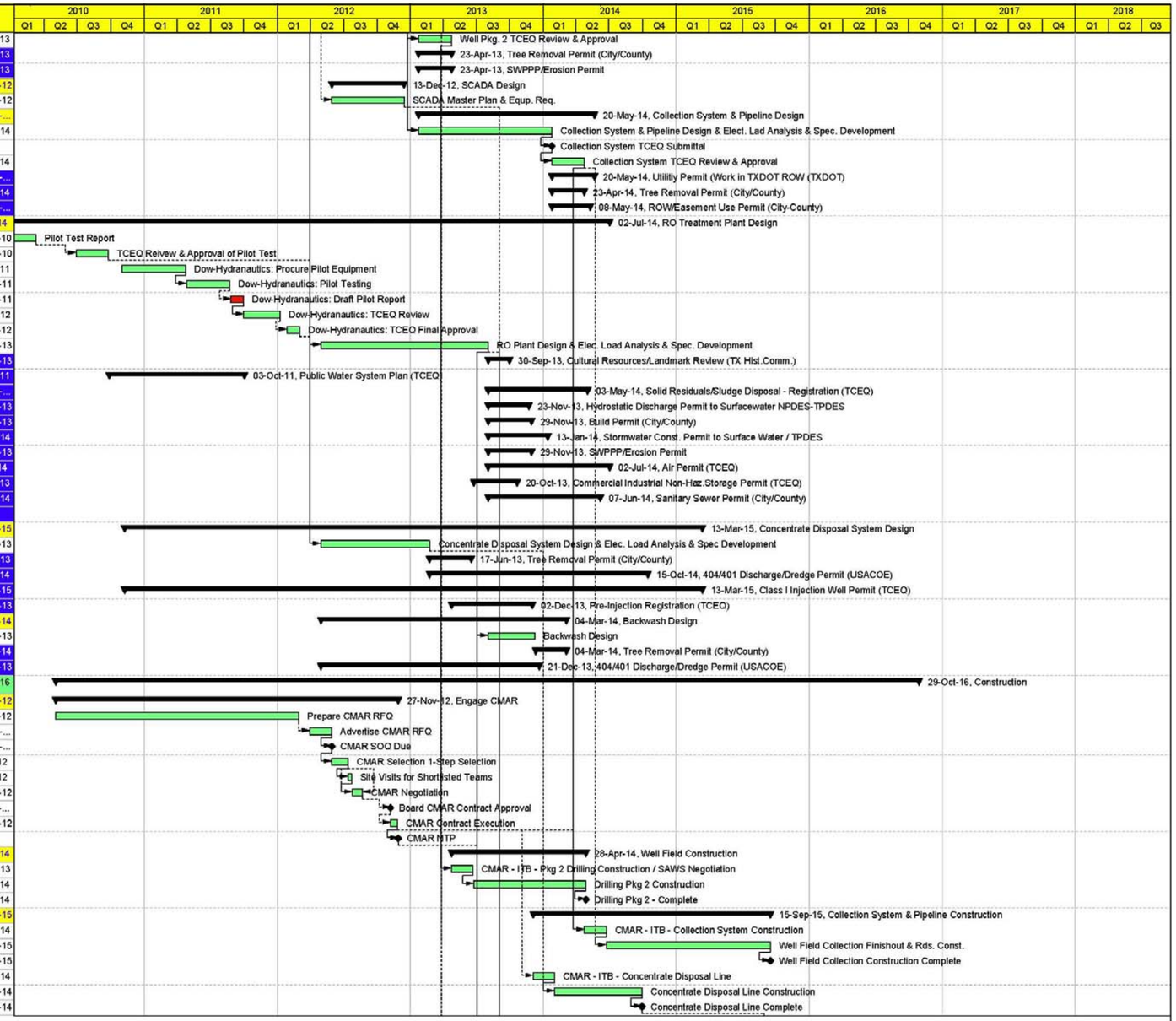
Page 1 of 3

TASK filter: All Activities

(c) Primavera Systems, Inc.

Figure 9-1: Schedule of the BGD Program Phase I (Sheet 1 of 3)

Activity ID	Activity Name	Original Duration	Remaining Duration	Start	Finish
WF1110	Well Pkg. 2 TCEQ Review & Approval	90	90	24-Jan-13	23-Apr-13
Tree Removal Permit (City/County)		64	64	24-Jan-13	23-Apr-13
SWPPP/Erosion Permit		64	64	24-Jan-13	23-Apr-13
SCADA Design		142	142	30-May-12	13-Dec-12
SCA1000	SCADA Master Plan & Equp. Req.	198	198	30-May-12*	13-Dec-12
Collection System & Pipeline Design		344	344	24-Jan-13	20-May-...
C2010	Collection System & Pipeline Design & Elect. Lad An...	365	365	24-Jan-13	23-Jan-14
C2020	Collection System TCEQ Submittal	0	0	24-Jan-14	
C2030	Collection System TCEQ Review & Approval	90	90	24-Jan-14	23-Apr-14
Utilitiy Permit (Work in TXDOT ROW (TXDOT)		83	83	24-Jan-14	20-May-...
Tree Removal Permit (City/County)		64	64	24-Jan-14	23-Apr-14
ROW/Easement Use Permit (City-County)		75	75	24-Jan-14	08-May-...
RO Treatment Plant Design		1173	1173	04-Jan-10	02-Jul-14
RO1000	Pilot Test Report	66	66	04-Jan-10	10-Mar-10
RO1010	TCEQ Reivew & Approval of Pilot Test	90	90	27-Jun-10*	25-Sep-10
RO1100	Dow-Hydranautics: Procure Pilot Equipment	175	175	01-Nov-10*	25-Apr-11
RO1110	Dow-Hydranautics: Pilot Testing	121	121	26-Apr-11	24-Aug-11
RO1120	Dow-Hydranautics: Draft Pilot Report	35	35	27-Aug-11*	30-Sep-11
RO1130	Dow-Hydranautics: TCEQ Review	101	101	01-Oct-11	09-Jan-12
RO1140	Dow-Hydranautics: TCEQ Final Approval	34	34	28-Jan-12*	01-Mar-12
RO1200	RO Plant Design & Elec. Load Analysis & Spec. Dev...	460	460	29-Apr-12	01-Aug-13
Cultural Resources/Landmark Review (TX Hist.Comm.)		42	42	02-Aug-13	30-Sep-13
Public Water System Plan (TCEQ)		266	266	26-Sep-10	03-Oct-11
Solid Residuals/Sludge Disposal - Registration (TCEQ)		196	196	02-Aug-13	03-May-...
Hydrostatic Discharge Permit to Surfacewater NPDES-TPDES		81	81	02-Aug-13	23-Nov-13
Build Permit (City/County)		86	86	02-Aug-13	29-Nov-13
Stormwater Const. Permit to Surface Water / TPDES		117	117	02-Aug-13	13-Jan-14
SWPPP/Erosion Permit		86	86	02-Aug-13	29-Nov-13
Air Permit (TCEQ)		239	239	02-Aug-13	02-Jul-14
Commercial Industrial Non-Haz.Storage Permit (TCEQ)		85	85	23-Jun-13	20-Oct-13
Sanitary Sewer Permit (City/County)		221	221	02-Aug-13	07-Jun-14
Petroleum Storage Tank Registration (TCEQ)		0	0		
Concentrate Disposal System Design		1135	1135	08-Nov-10	13-Mar-15
CDS1100	Concentrate Disposal System Design & Elec. Load A...	300	300	29-Apr-12	22-Feb-13
Tree Removal Permit (City/County)		81	81	23-Feb-13	17-Jun-13
404/401 Discharge/Dredge Permit (USACOE)		428	428	23-Feb-13	15-Oct-14
Class I Injection Well Permit (TCEQ)		1135	1135	08-Nov-10	13-Mar-15
Pre-Injection Registration (TCEQ)		160	160	23-Apr-13	02-Dec-13
Backwash Design		482	482	29-Apr-12	04-Mar-14
BK1110	Backwash Design	130	130	02-Aug-13	09-Dec-13
Tree Removal Permit (City/County)		61	61	10-Dec-13	04-Mar-14
404/401 Discharge/Dredge Permit (USACOE)		430	430	29-Apr-12	21-Dec-13
Construction		1695	1695	03-May-10	29-Oct-16
Engage CMAR		671	671	03-May-10	27-Nov-12
CMAR1000	Prepare CMAR RFQ	665	665	03-May-10*	28-Feb-12
CMAR1010	Advertise CMAR RFQ	60	60	31-Mar-12*	29-May-...
CMAR1020	CMAR SOQ Due	0	0		29-May-...
CMAR1030	CMAR Selection 1-Step Selection	45	45	30-May-12	13-Jul-12
CMAR1033	Site Visits for Shortlisted Teams	10	10	14-Jul-12	23-Jul-12
CMAR1040	CMAR Negotiation	30	30	24-Jul-12	22-Aug-12
CMAR1050	Board CMAR Contract Approval	0	0		06-Nov-...
CMAR1060	CMAR Contract Execution	20	20	07-Nov-12*	26-Nov-12
CMAR1090	CMAR NTP	0	0	27-Nov-12	
Well Field Construction		264	264	24-Apr-13	28-Apr-14
CWF2000	CMAR - ITB - Pkg 2 Drilling Construction / SAWS Ne...	60	60	24-Apr-13	22-Jun-13
CWF2100	Drilling Pkg 2 Construction	310	310	23-Jun-13	28-Apr-14
CWF2200	Drilling Pkg 2 - Complete	0	0		28-Apr-14
Collection System & Pipeline Construction		466	466	03-Dec-13	15-Sep-15
CPL1900	CMAR - ITB - Collection System Construction	60	60	24-Apr-14	22-Jun-14
CPL2000	Well Field Collection Finishout & Rds. Const.	450	450	23-Jun-14	15-Sep-15
CPL2010	Well Field Collection Construction Complete	0	0		15-Sep-15
CPL2015	CMAR - ITB - Concentrate Disposal Line	60	60	03-Dec-13	31-Jan-14
CPL2020	Concentrate Disposal Line Construction	240	240	01-Feb-14	28-Sep-14
CPL2030	Concentrate Disposal Line Complete	0	0		28-Sep-14



Actual Work | Critical Remaining Work | Summary
Remaining Work | Milestone

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TASK filter: All Activities

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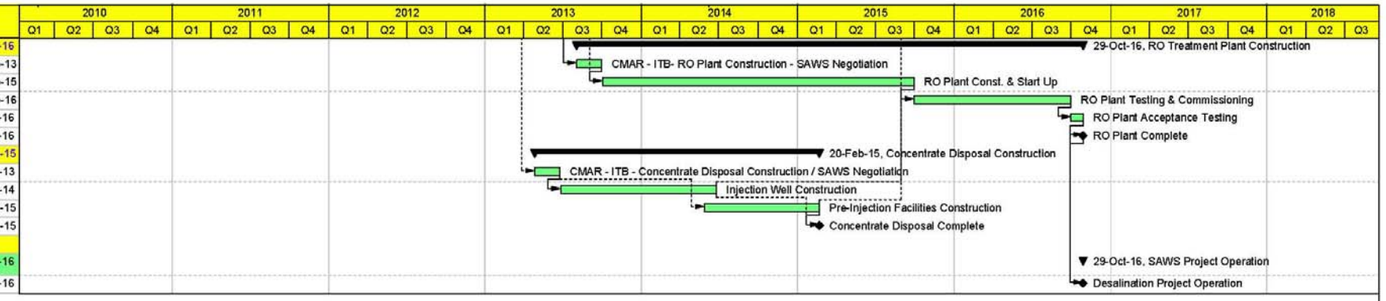
Figure 9-1: Schedule of the BGD Program Phase I (Sheet 2 of 3)

Activity ID	Activity Name	Original Duration	Remaining Duration	Start	Finish
RO Treatment Plant Construction		846	846	02-Aug-13	29-Oct-16
RO2900	CMAR - ITB- RO Plant Construction - SAWS Negotia...	60	60	02-Aug-13	30-Sep-13
RO3000	RO Plant Const. & Start Up	730	730	01-Oct-13	30-Sep-15
RO3010	RO Plant Testing & Commissioning	365	365	01-Oct-15	29-Sep-16
RO3020	RO Plant Acceptance Testing	30	30	30-Sep-16	29-Oct-16
RO3030	RO Plant Complete	0	0		29-Oct-16
Concentrate Disposal Construction		476	476	26-Apr-13	20-Feb-15
CDC3900	CMAR - ITB - Concentrate Disposal Construction / S...	60	60	26-Apr-13*	24-Jun-13
CDC4000	Injection Well Construction	365	365	25-Jun-13	24-Jun-14
CDC4010	Pre-Injection Facilities Construction	270	270	27-May-14*	20-Feb-15
CDC4020	Concentrate Disposal Complete	0	0		20-Feb-15
Backwash Construction		0	0		
SAWS Project Operation		0	0	29-Oct-16	29-Oct-16
A5000	Desalination Project Operation	0	0		29-Oct-16



Actual Work | Critical Remaining Work | Summary
Remaining Work | Milestone

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TASK filter: All Activities

(c) Primavera Systems, Inc.

Figure 9-1: Schedule of the BGD Program Phase I (Sheet 3 of 3)

10.0 Research Needs

10.1 Research Needs Associated with Project

SAWS has completed most of the research needed to implement the BGD Program through the feasibility study and the membrane pilot testing. Finalization of concentrate disposal strategy will be the last major task required to implement the project. SAWS will continue to conduct research on new membrane technology as the state of the art advances and likely purchase a membrane pilot unit to test new membranes in the future as they become available. In addition, SAWS will continue to follow research advancements in the area of concentrate disposal.

SAWS has contracted with R.W. Beck to research brackish desalination and determine if it was a viable option to pursue as an alternative water resource for SAWS. The BGD Feasibility Assessment Report was completed in 2008. The report focused on the variable components associated with brackish desalination and listed the alternatives available to develop the BGD Program. SAWS has since utilized R.W. Beck's study as a resource to develop the BGD Program.

RO membranes are an essential component of the treatment process and as required by TCEQ, research and testing of specific types of membranes was conducted in 2010 and submitted for review and approval. In an effort to qualify additional membrane types SAWS has planned to research and test additional membrane types.

Injection well drilling and pilot testing has also been planned in the BGD Program area to research the subsurface dynamics and geology to determine brine concentrate disposal supportability.

No other research needs are anticipated with the BGD Program.

Appendix A

Water Management Plan Update
San Antonio Water System, 2009

Appendix B

Brackish Groundwater Desalination Feasibility Assessment Report
R.W. Beck, 2008

Appendix C

Supply and Demand Projections (Drought of Record): 2030, 2040, 2050, and 2060
SAWS, 2011

Appendix D

Brackish Groundwater Desalination Project Cost Update
HDR Inc., 2010

Appendix E

Socioeconomic Impacts of Projected Water Shortages for the South Central Texas Regional Water Planning Area (Region L) Prepared in Support of the 2011 South Central Texas Regional Water Plan TWDB, 2010

Appendix F

Environmental Assessment Report (National Environmental Policy Act as implemented by the Texas Water Development Board) SAWS Brackish Water Desalination Production Well Design
LBG-Guyton Associates, 2010

Appendix G

Texas Historical Commission and U.S. Fish and Wildlife Service letters stating No Action required for the first eight production wells of the BGD Program

Appendix H

Permits required for SAWS BGD Program as outlined in Appendix D of "The Brackish Groundwater Desalination Feasibility Assessment Report"
R.W. Beck, 2008

Appendix I

Brackish Groundwater Desalination Project
Sources and Uses