Name of Project:	**Brackish Groundwater Desalination**
Duration of Project:	**50 Years**
Amount of Water Available Annually:	**10 mgd or 11,200 acre-feet/year**
	Phase 1
Date Benchmarking Commenced:	**February 19, 2019**
Date Benchmarking Completed:	**June 18, 2019**
Managing Staff:	**Dr. Saqib Shirazi**

SAWS Mission Statement – Sustainable Affordable Water Services

Executive Summary – The Brackish Groundwater Desalination Project was first identified in the 2005 Water Resource Plan and became operational in 2016. Originally designed to produce 13,440 acre-feet per year (AFY), low transmissivity in the Lower Wilcox formation is limiting the production going forward to 11,200 AFY after some modifications to the wells and pumps. In the view of the CAP, the Project remains practical, beneficial and cost-effective for the following reasons:

- Supplying 3.5-4.0% of SAWS' total demand, the Project is a significant, new and firm water resource that will help support service area growth and relieve pressure on the Edwards Aquifer in times of low regional rainfall.
- It makes use of the large quantity of brackish groundwater in the Lower Wilcox aquifer underlying southern Bexar County and adds diversity to SAWS' water resource portfolio.
- Withdrawing brackish water from the Lower Wilcox will not produce any negative effects on the fresh water Carrizo or any other aquifer. No other entities are currently making use of this brackish resource.
- The quality of water being produced from the Project is fully compatible with SAWS' other water resources.
- The cost of the Project is in line with other available alternatives and although costs per acre-foot will increase due to the needed well modifications, the costs are already reflected in SAWS' 2019 rate structure. The Project will, therefore, have no additional impact on customers' bills.

In conclusion, the Citizens Advisory Panel (CAP) fully supports the SAWS Brackish Groundwater Desalination Program and supports its continued expansion into Phases II and III when deemed necessary and practical. The CAP's one recommendation is for SAWS to continue monitoring the recharge rate in the Lower Wilcox aquifer so that it can be more fully researched and understood.

Benchmarking Document

Introduction

SAWS has developed a Brackish Groundwater Desalination (BGD) program in southern Bexar County that is designed to help meet the city's water demand while reducing dependence on the Edwards Aquifer. The Texas Water Development Board (TWDB) has confirmed that a vast supply of brackish groundwater exists in our region and the South Central Texas Regional Water Planning Group (Region L) has identified brackish groundwater as a supply source to meet future demand.

The BGD plant and wells are located at SAWS H_2Oaks Center on 5,300 acres owned by SAWS that is also home to its Aquifer Storage & Recovery program and Local Carrizo project. The BGD facility is capable of producing up to 10 million gallons of drinking water per day from the brackish Lower Wilcox Aquifer in Phase 1. Future phases will deliver up to an additional 20,160 AFY of water for a project total of up to 33,600 AFY. However, the timing of additional phases of the BGD program will be considered as part of SAWS' ongoing planning efforts.

The CAP has undertaken previous benchmarking reports in 2007, 2009 and 2011; however, this will be the first benchmarking report since Phase I began operation in 2016.

1. <u>How does this project reflect a cooperative relationship with neighboring communities?</u>

The Brackish Groundwater Desalination Program reflects a cooperative relationship with neighboring communities by:

- Reaching out to involved communities during planning stages
- Opening dialogue with county governments and opposition groups
- Improving relations by listening and providing scientific findings
- Continuing to share well monitoring information with Evergreen UWCD

The Brackish Groundwater Desalination Project was first identified in the SAWS 2005 Water Resources Plan. By 2007, a group of Atascosa County citizens raised concerns that caused the Atascosa County Commission to pass a resolution opposing the project.

The *2009 Water Management Plan Update* called for initial production of brackish groundwater entirely from southern Bexar County with additional phases from Atascosa and Wilson Counties. Continued opposition led the Evergreen Underground Water Conservation District (Evergreen) to terminate its 2006 brackish water Agreement with SAWS and revise its rules to make project development more difficult.

In response to the opposition, the SAWS Board of Trustees decided to postpone any Wilson or Atascosa expansion of the Project until the Bexar County phase was

operating. SAWS also formed a Brackish Groundwater Science Committee comprised of elected officials and technical representatives. The purpose was to make the science available to the public.

The opposition voiced concerns that pumping brackish water from the Lower Wilcox aquifer could impact water levels in the Carrizo aquifer which sits many hundreds of feet above the Lower Wilcox.

To ease those concerns, each of the 12 production wells for the project were drilled on SAWS property in Bexar County. A total of six Carrizo monitoring wells were drilled in association with the brackish production wells. A full year after the project came online, the monitoring wells indicate no measurable impact on the Carrizo aquifer water level due to pumping from the Wilcox aquifer. This is primarily due to the existence of the Upper Wilcox Clay aquitard that resides between the two aquifers and prevents direct communication between the fresh Carrizo aquifer and the brackish Lower Wilcox aquifer.

SAWS staff currently maintains an open dialogue with Evergreen staff and provides the Evergreen Board of Directors and staff with monthly reports on production activities at the Project's H_2Oaks facility, including Aquifer Storage & Recovery (ASR), local Carrizo production and brackish groundwater production.

Copies of SAWS *2017 Water Management Plan* (2017 WMP) have been provided to the Evergreen staff and Board of Directors. This WMP identifies additional phases of brackish groundwater to be developed outside Bexar County in the 2040 decade. These details have been communicated to local residents that attend the Evergreen Board meetings.

In January 2019, SAWS Director of Water Resources presented a Desal Operations Overview to the SAWS Board of Trustees and received compliments on the clarity and detail of the presentation regarding current brackish project activities.

Since the original project development over a decade ago, SAWS and Evergreen staffs maintain frequent and open communications on this project as well as other regional activities

2. <u>What are the water sources related to this project?</u>

The water for the BGD Program comes from the Lower Wilcox aquifer in south Bexar County. (Appendix 1)

Studies show (TWDB, The Future of Desalination in Texas, Volume 2, 2004) a significant volume of brackish groundwater in the Lower Wilcox sufficient to support the Project through Phase I and beyond. Operating at its design capacity, the Project further diversifies SAWS' firm water resources because the Lower Wilcox is very drought resistant. Its availability as a firm source will reduce demand on the Edwards aquifer during periods of low regional rainfall, thus benefitting spring flows and endangered aquatic species associated with that aquifer complex.

Running at capacity, the Project generates about one million gallons per day (mgd) of concentrated waste brine which is injected 5,000 feet deep into the Edwards saline zone (Georgetown, Edwards & Upper Glen Rose limestone formation). The injected brine from the Project has from 10,000 -15,000 mg/L Total Dissolved Solids (TDS). This compares to the native water in the Edward saline zone that contains approximately 90,000 mg/L TDS and is unusable for any purpose. The injected brine therefore has no appreciable impact on the quality of the Edwards saline zone water in this location.

3. What volume of water will be available during both average and drought of record conditions?

Under both average and drought of record conditions, 11,200 AFY(10 mgd) is available for production.

Under maximum sustained pumping from the Lower Wilcox at 10 mgd production rate, measurements show sufficient water available on an annualized basis. Studies indicate that the amount of water in the Lower Wilcox will not be measurably reduced during a drought of record, making it a firm supply. At this time, SAWS is the only entity making use of the brackish water in the Lower Wilcox formation.

The volume of water for this project and future phases of this project have been incorporated into the Desired Future Condition by Groundwater Management Area 13 (GMA 13). The DFC is calculated from the end of 2012 conditions to the year 2070.

4. Is water available for the duration of this project in adequate quantity to justify the project?

Yes. Sufficient brackish water in the Lower Wilcox will be available to the Project for its planned 50-year life span. With brackish water salinity of 1,500 mg/L TDS, it is cost-effective for the long-term operation of a reverse osmosis (RO) treatment plant.

However, during initial operation of the Project, the transmissivity of the Lower Wilcox proved lower than hydrologic modeling predicted. The presence of extremely fine sand and silt has reduced brackish water production from the wells.

SAWS has undertaken steps to modify the production wells by lowering the pumps several hundred feet in the well casings to increase the available water above the pumps in seven of the existing production wells. In addition, two new production wells have been added to the system that will bring total volume back to the 10 mgd production level.

5. Is this project based on reliable scientific data?

Yes. During the feasibility stage of the Project, three Lower Wilcox test wells were drilled to determine water quality and production parameters. Testing, drilling, modeling and analysis verified that brackish water from the Lower Wilcox can be treated and made compatible with the rest of the water in the SAWS distribution system.

Pilot testing of the RO membranes indicated that salt rejection was very good (99.6%) and membrane flux was good, producing 13-15 gallons per square foot per day. These tests predicted 85-90% water recovery and rejection of 10-15% as brine. Initial actual operation of the plant is in line with these early predictions.

Initial water quality testing determined that adjustments in water chemistry would be required before water from the RO plant could be placed in the SAWS distribution system. By adding calcite contactors to the post-treatment process, water hardness and alkalinity increased, making it compatible with the water in the SAWS distribution system. A small amount of brackish water bypasses the RO process and may be used to further adjust the minerality of the water.

SAWS also tested the waste brine injection well into the Edwards saline zone. Subsequent real-world operation found the injection well in Wilson County (just across the Bexar County line due to Edwards Aquifer Authority regulations) operated as designed. Injection well pressure monitoring uncovered no discernable negative effects on the Edwards saline zone formation or adjacent formations.

6. Is there any adverse impact to groundwater? If so, what types of mitigation are possible and what will they cost?

Yes. An inescapable adverse impact of any groundwater production project is aquifer drawdown in the vicinity of the production wells. However, the projected drawdown will have no meaningful impact on the Wilcox or Carrizo formations as a whole. During the early Project feasibility stage, information from the test pumping was inputted into the southern Sparta-Queen City-Carrizo-Wilcox Groundwater Availability Model (GAM). This model predicted 300-350 feet of drawdown of the Lower Wilcox in the vicinity of the production wells after 50 years of pumping, with drawdown occurring at a faster rate in the initial five to ten years of production.

During the 50-year project life, the overlying Carrizo formation is predicted to experience only 4-8 feet of drawdown. This minimal impact on the Carrizo fresh water formation has been verified during initial Project operation.

At this point in time, no mitigation is required or contemplated.

7. Is there any adverse impact to surface water? If so, what types of mitigation are possible and what will they cost?

No. Due to the extreme depths of both the production wells (1,500 – 1,800 feet) and the injection wells (5,000 feet), surface water is not impacted at any time during the operation of the Project and therefore surface water mitigation is not required or contemplated.

8. What are environmental impacts of this project other than those related to groundwater and surface water?

The Environmental Assessments (EA) for the Project area did not identify any environmental concerns. The Project currently complies with all regulations and permits from federal, state, and local agencies.

9. How does this project ensure quality of the delivered water supply?

Reverse osmosis, a mature state-of-the-art water treatment process capable of removing metal-ion-sized particles, yields nearly pure water. The Texas Commission on Environmental Quality (TCEQ) accepted SAWS test results of the water conducted during the start-up of the Plant. In addition, post treatment steps are designed to make sure the water from the desalination plant is fully compatible with other water sources within SAWS distribution system. Those steps are:

- Adding chlorine and calcium carbonate
- Blending up to 20 percent of the original brackish raw water supply

10. Does this project document a long-term hydrologic balance between recharge and discharge of any aquifers involved?

Phase 1 of the BGD program utilizes a small portion of a large water resource. The Wilcox formation recharges at a relatively slow rate over a large geographic area but its rate of recharge is not well understood. Recharge occurs not only from the outcrop, but also from other areas adjacent to the well field. The Project does not use water that is actively involved or related to the recharge of the Carrizo aquifer.

The CAP recommends that SAWS continue to monitor the hydrologic balance between recharge and Project production.

11. Is this project in accord with the SAWS Water Management Plan?

Yes. The Project helps fulfill the goals of the SAWS 2017 WMP in several ways:

- The planning projections for the 2017 WMP assume the population of the SAWS service area will grow at a slightly higher rate than forecasted by the 2015 WMP.
- The Desalination Project adds to the portfolio of water resources available to meet customer demand over the next 50 years.
- The Project is consistent with the 2017 WMP overall strategy of diversifying water supply sources to relieve impact on System demands.
- The Project, an expandable design, gives SAWS additional operational flexibility to meet future System demands.

12. Is this project in accord with the Region L Plan?

Yes. Groundwater desalination was identified in the 2016 Region L Water Plan as a water resource worthy of further development and expansion. The brackish groundwater projects have been updated for inclusion in the 2021 Region L Plan.

There are five brackish groundwater projects proposed as Recommended Water Management Strategies by project sponsors for the development of the 2021 Region L Plan.

Brackish Project	Volume AFY
Brackish Wilcox groundwater for CRWA	14,700
Brackish Wilcox groundwater for SAWS	70,160
Brackish Edwards for County Line	1,500
Brackish Wilcox (Gonzales County) for SSLGC	5,000
Brackish Wilcox Groundwater for SSWSC	1,120
Total Volume	92,480

13. Will this project support economic growth in the SAWS service area?

Yes. The Project will supply approximately 45,000 households (four households per acre-foot), supporting economic growth in SAWS' service area. Diversifying water resources will increase sustainability in meeting future water demand.

14. Is this project in accord with Texas water law? Are there any unusual risks of litigation?

Yes, the Project complies with current Texas water laws. There are no unusual risks of litigation; however, all water projects are potentially controversial and subject to unforeseen litigation.

15. Is this project suitable for all of the geographic areas served by SAWS?

Yes, the water from this project is suitable for all geographic areas served by SAWS.

16. Has a benefit-cost analysis been done in connection with this project?

No. SAWS reviews the economics of all water projects on an annual basis. Staff has determined that a full benefit-cost analysis would not be more useful than the ongoing economic analysis.

While a benefit-cost analysis was not performed, the benefits of the Project include:

- Water supply diversification
- Firm yield during drought

17. Has a social and economic impact analysis been done in connection with this project?

No. No formal socio-economic study has been completed on the Project.

18. What is the cost per acre-foot of water for this project?

The 2017 WMP cost per acre-foot for Phase 1 of this Project is $1,374, (Appendix 2) based on production volume of 13,440 AFY. This cost was estimated during the feasibility period. Subsequent operation of the Plant determined that the initial production volume could not be met. SAWS has subsequently determined that a new production volume of 11,200 AFY is feasible with these modifications:

- Drilling one new production well
- Converting current test well to production well
- Building additional transmission mains
- Budgeting additional energy costs.

Consequently, the cost per acre-foot will increase. A new water supply project costs per acre-foot analysis will be conducted by SAWS in the next iteration of the water management plan.

19. What is the effect on the ratepayer?

There is no added rate impact for the BGD Phase I project to the SAWS customer. The costs of BGD Phase I debt service, operations and maintenance, as well as those for other implemented 2017 WMP projects, are already included in current SAWS blended rates. SAWS does not have separate rates for different water supply sources.

The customer impact of BGD Phase I costs, therefore, can only be expressed in terms of its pro rata share of 2019 Water Supply Fee and Water Delivery operating revenue, and by extension, its share of the 2019 monthly charges for the average residential customer. As can be seen in the table below, the cost of the BGD Phase I project accounts for only $1.42 per month on the average residential bill.

2019 Water Supply Fee & Water Delivery Projected Operating Revenue	$	445,276,413
2017 Water Mgt. Plan Desal Ph. I cost per acre foot (BGD I)	$	1,374
2017 Water Mgt. Plan acre-feet to be generated by BGD I		13,440
Total Cost	$	18,466,560
BGD I Pctg. of Water Supply Fee and Water Delivery Projected Revenue		4.15%
2019 Avg. Res. Bill for Water Supply Fee & Water Delivery Charges *	$	34.20
Share of BGD I costs on 2019 Avg. Residential bill	$	1.42
**Assumes 7,092 gallons per month average monthly residential consumption.*		

20. How does this project rank in comparison to other SAWS projects?

Due to the effects of inflation over time, all new water resource projects tend to be more expensive on an acre-foot basis than previous projects. However, based on estimates during planning, plus estimates for the modifications needed to achieve 11,200 AFY, SAWS believes the cost per acre-foot of water from the Project will still be in line with available current and planned water supply projects (See Appendix 2 – Water Supply Projects Cost per Acre-Foot compared to other water resources in the SAWS portfolio).

21. Are there any other issues that need to be addressed?

No.

Conclusion

The CAP concludes that the BGD project is a significant step in the continuing diversification of SAWS water supply at a cost that is in line with other alternatives. Phase I of the project will supply between 3.5–4.0% of total System demand, enhancing SAWS' ability to deliver quality water to a rapidly growing service area during both wet and dry years. By tapping the unused Lower Wilcox brackish formation, SAWS is expanding its supply portfolio without impacting any other producing aquifer. The cost of modifying Phase I of the project to enhance its production rate, is already reflected in the 2019 rate structure and will, therefore, have no added impact on customers' bills. Phases II and III, when completed in the 2040 timeframe, will further add to the Project's diversification and operational flexibility.

Glossary

AFY	Acre-Feet per Year
BGD	Brackish Groundwater Desalination
CAP	Citizens Advisory Panel
EUWCD	Evergreen Underground Water Conservation District
GBRA	Guadalupe Blanco River Authority
GAM	Groundwater Availability Model
Membrane Flux	Measure of the capacity (gal. per day per ft^2 of membrane area)
MGD	Million Gallons per Day
mg/L	Milligrams per liter
RO	Reverse Osmosis
SAWS	San Antonio Water System
SCADA	Supervisory Control and Data Acquisition
TCEQ	Texas Commission on Environmental Quality
TDS	Total Dissolved Solids
TWDB	Texas Water Development Board
WRIP	Water Resources Integration Pipeline

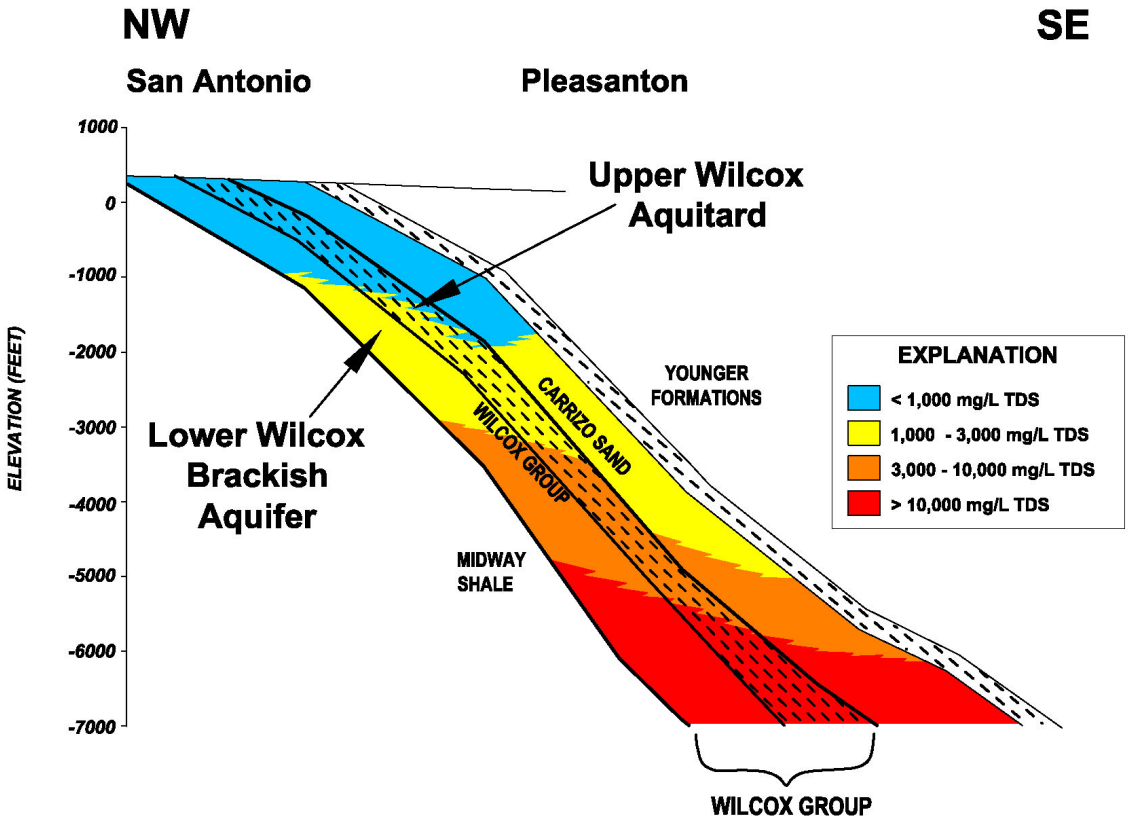
Definitions

Desired Future Condition – Defined by Title 31, Part 10, §356.10 (6) of Texas Administrative Code as "the desired, quantified condition of groundwater resources (such as water levels, spring flows or volumes) within a management area at one or more specified future times as defined by participating groundwater conservation districts within a groundwater management area as part of the joint planning process."

Modeled Available Groundwater – The amount of groundwater production, on an average annual basis, that will achieve a desired future condition. (TWDB)

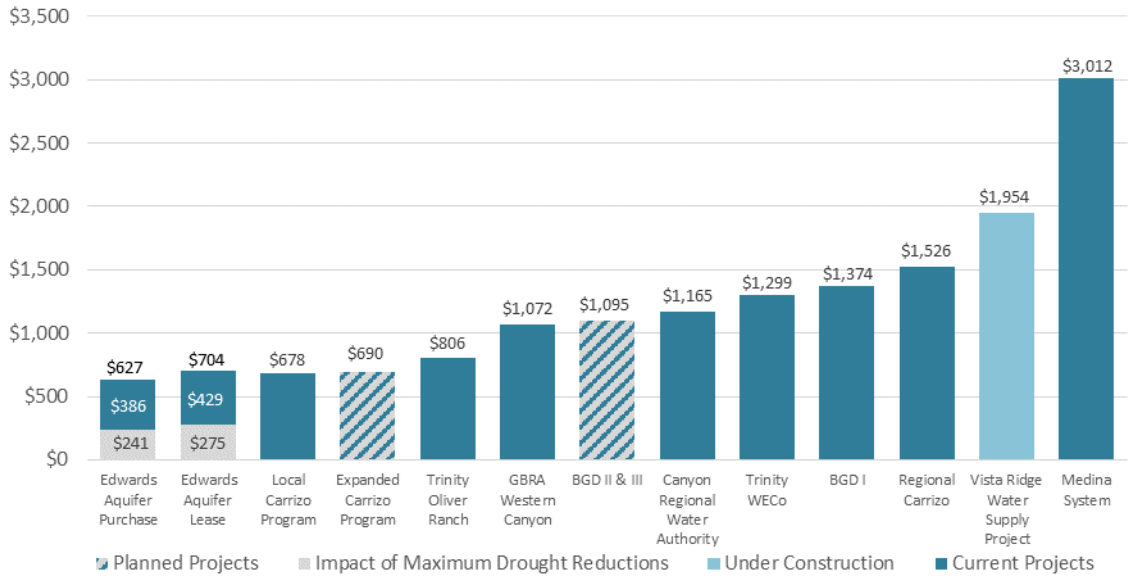
Firm Yield – The volume of water which can be produced from a defined source during a repeat of the drought of record under existing regulatory, legal, contractual, hydrological or infrastructure constraints.

APPENDIX 1


NW
SE
San Antonio
Pleasanton
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
ELEVATION (FEET)
Upper Wilcox
Aquitard
Lower Wilcox
Brackish
Aquifer
YOUNGER
FORMATIONS
CARRIZO SAND
WILCOX GROUP
MIDWAY
SHALE
WILCOX GROUP
EXPLANATION
< 1,000 mg/L TDS
1,000 - 3,000 mg/L TDS
3,000 - 10,000 mg/L TDS
> 10,000 mg/L TDS

APPENDIX 2

Water Supply Projects Cost per Acre-Foot



Source: *2017 Water Management Plan*, pages 68 and 94.