Texas Water
Development Board

An Integrated Wind-Water Desalination Demonstration Plant for an Inland Municipality

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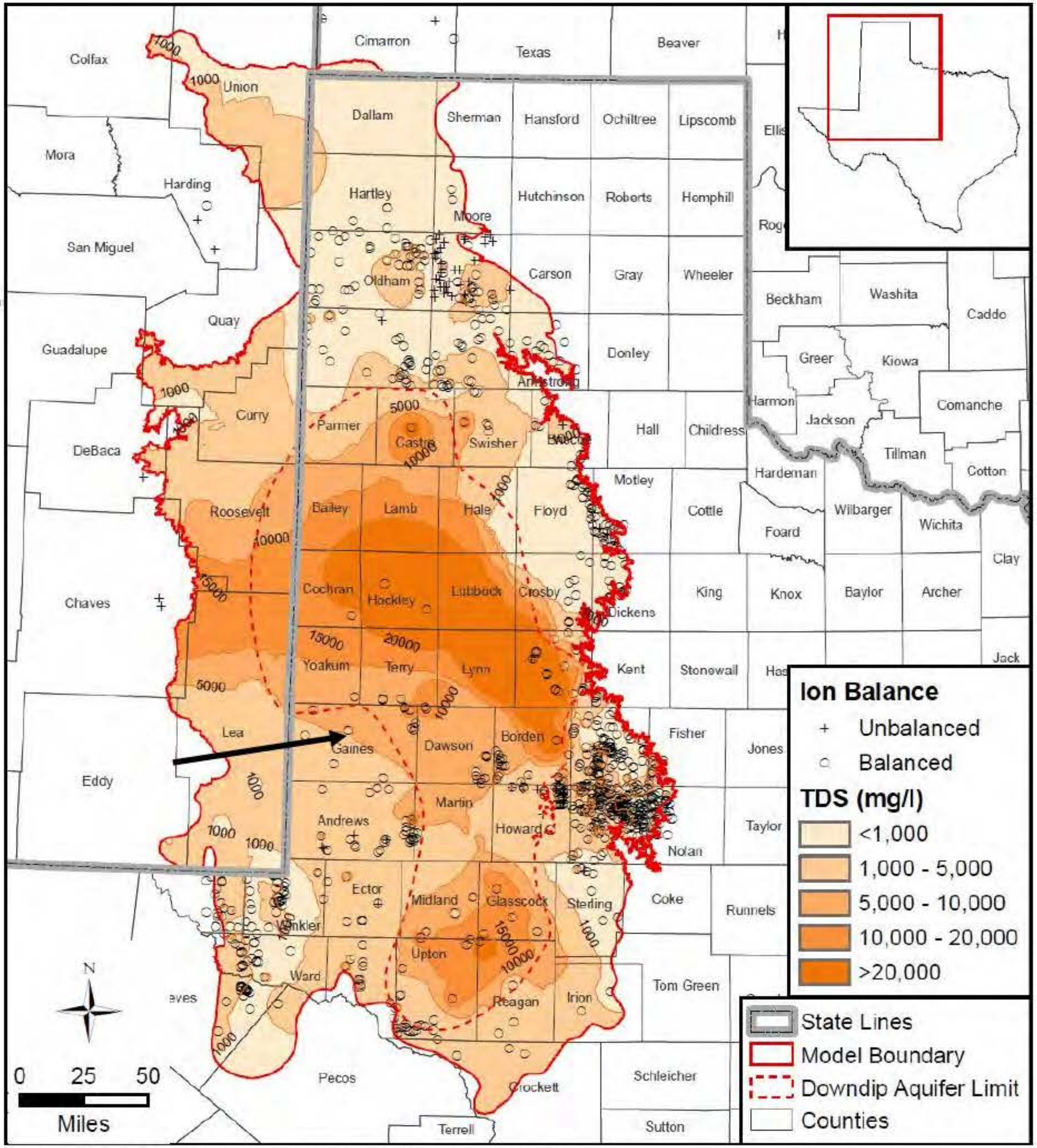
[1]Water Resources Center, [2]Department of Geosciences, [3]National Wind Institute

Texas Tech University, Lubbock, TX

Demonstration Site

- City of Seminole, Texas (pop. 6430)
  - Approached team to be an early-adopter
  - Ogallala wellfield depleting within 25 years
  - As, F, and TDS exceedances
  - Interested in Dockum alternative
    - Used to deep wells with oil and gas production
    - Concentrate disposal by deep well injection?



Source: TWDB, Panhandle GCD; USGS/New Mexico; Hart and others (1976)

U.S. 180
Hobbs Hwy
NW 11th St
NW Ave F
385
62
114
SW 6th St
S Main St
209
181
402
Project Site
306
© 2015 Google
9009 ft
308

Capital Funding Sources

City of Seminole	$235,461
Texas Department of Agriculture	$724,625
Texas Water Development Board	$300,000
Texas Tech University	
– State Energy Conservation Office	$162,000
– Department of Energy	$167,363
Llano Estacado UWCD	$40,000
Total Capital Expenses	*$1,629,449*

Brackish Water

- Dockum well (TWDB/TDA funds)
  - Target 50-60 gpm production
  - West Texas Water Well Service, 1800 ft depth
    - Perforated in three zones based on geophysical logs
    - Original static depth to water 750 ft
    - Pump test 150 gpm for 36 hr
    - Eventual static depth to water 100 ft
  - TDS ranges 2000 to 30000 ppm
    - Typically 8000 ppm at 55 gpm

Energy and Treatment

- Wind Turbine (SECO, TDA)
  - 50 kW capacity
  - Entegrity Wind
  - Displaces grid power
- RO System (TTU DOE)
  - Inflow capacity 50-60 gpm
  - Pretreatment to reduce fouling
  - Crane Environmental
  - Concentrate to sanitary sewer

Demonstration Results

- Well production
  - Total 20 MG, average 56 gpm, 8000 ppm TDS
- RO system
  - Permate average 41 gpm, 520 ppm TDS
- Wind turbine
  - 37000 kWh, 47% of electrical demands

Lessons Learned

- Better quality in upper Dockum
- Pretreatment to prevent fouling
- Good cooperation from city staff
- First year technical adjustment period
- Opportunity for third party operations

Texas Water Development Board

STW Water Process & Technologies
Alan Murphy- President

"A Water Solutions Company"

About STW Water Process & Technologies

STW
Resources Holding Corp

STW WATER PROCESS & TECHNOLOGIES: STW assesses the customer's water processing needs and oversees all project phases including; Analysis, Regulatory, Technology, Implementation and Operation.

STW BUSINESS MODEL: STW Water will design, build, own and operate water systems for some customers simply offering our reclamation and water management services. NO capital expense to our Customers for our systems. STW will process water for a fee per 1,000 gallons.

DESALINATION: Seawater or Geothermal Water: STW's DyVaR system combined with a Seawater Reverse Osmosis System or the water from geothermal operations will have <u>no environmentally sensitive concentrated brine reject discharged into the local waterways</u>.

ZERO LIQUID DISCHARGE: The STW system is Zero Liquid Discharge and 95%+ of the fresh water is recovered in the process.

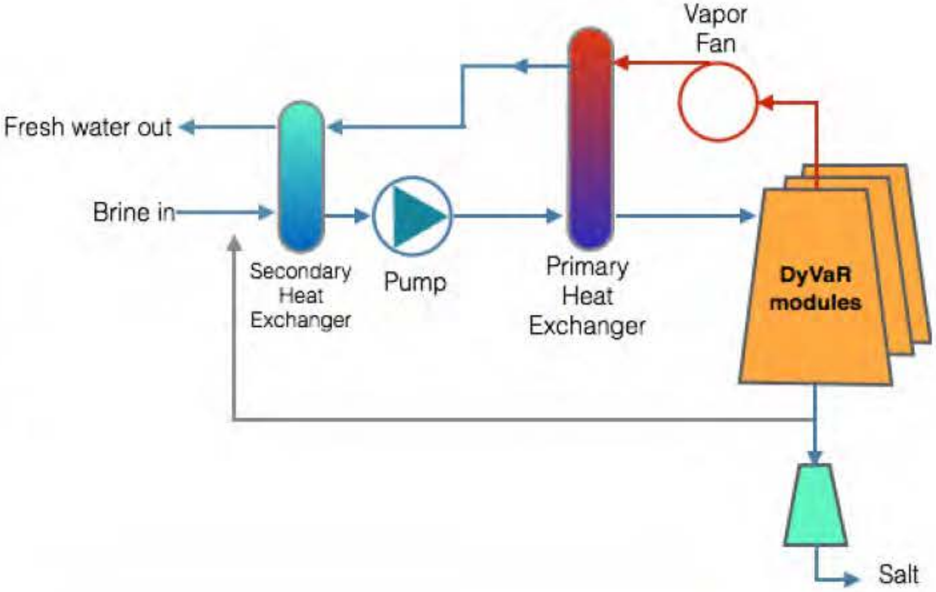
Predictable Clean Water

Ranchland Hills Country Club Hybrid Reverse Osmosis System
700,000 gallons/day or 16,666 barrels/day

Salttech DyVaR Desalination Solution

This system is currently operating in West Texas processing brackish water for a municipality

DyVaR Process Flow



ENVIRONMENTAL BENEFITS: If the STW/Salttech DyVaR Technology is placed inline with a Seawater Desalination System or used with a Geothermal Operation, there will be NO potentially environmentally sensitive brine concentrate discharged into the local waterways since the system is Zero Liquid Discharge and 93-97% of the fresh water is recovered in the process. The waste stream is salt crystals and minerals.

STW/Salttech Technology: Dynamic Vapor Recompression (DyVaR) DESALINATION TECHNOLOGY

- DyVaR applicable for all kinds of highly concentrated fluids
  - Removes Total Dissolved Solids (TDS)
  - Removes Hardness
  - Removes TSS
  - Removes Volatiles
  - Disinfection technology
- DyVaR is a ***modular system***
- DyVaR uses ***no chemicals***,
- DyVaR uses ***no membranes***
- *DyVaR requires* ***no pretreatment***
- DyVaR requires little operator attention
- DyVaR has very high energy efficiency
- DyVaR is ***insensitive to scaling or fouling***
- DyVaR is designed for continuous operation

- **ENVIRONMENTAL IMPACT: If placed inline with a Seawater RO System or used with a geothermal operation, there will be no potentially environmentally sensitive brine concentrate discharged into the local waterways since the system is Zero Liquid Discharge and 93-97%+ of the fresh water is recovered in the process. The waste stream is salt crystals and minerals.**

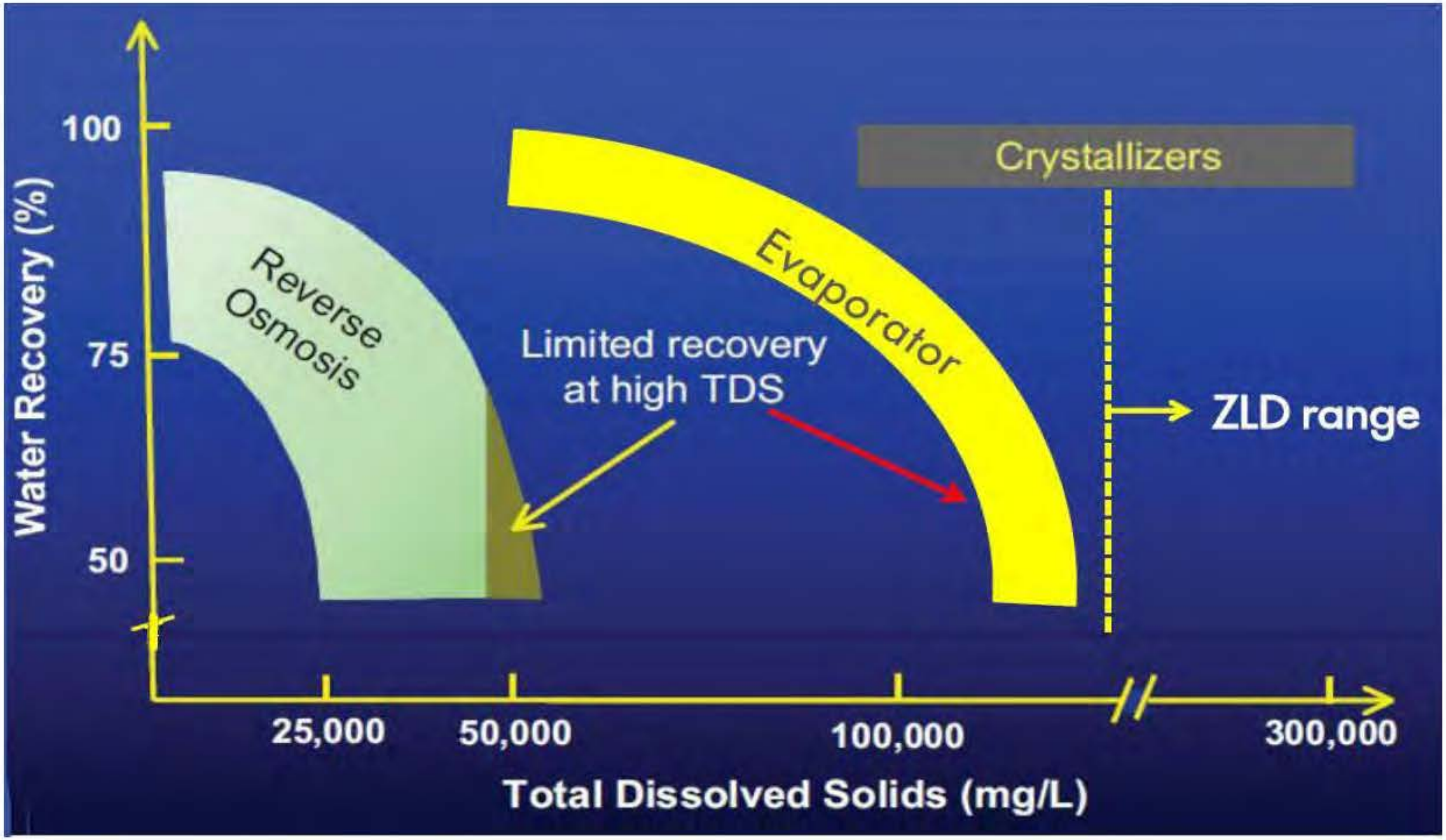
STW Water Process & Technologies

"A Water Solutions Company"

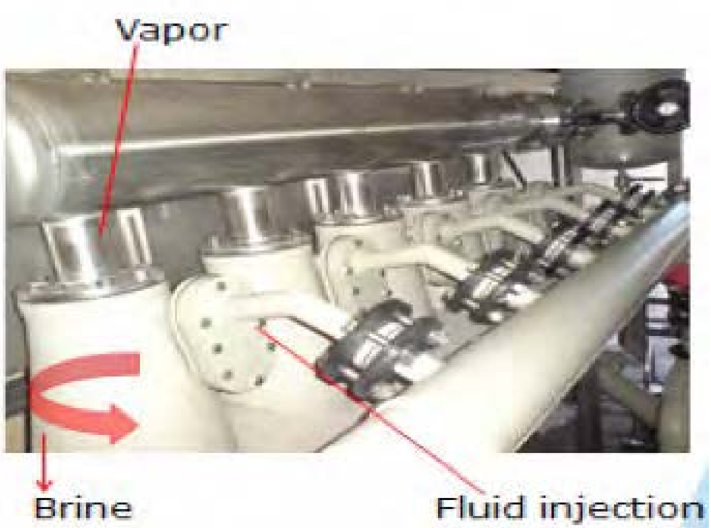
A Subsidiary of STW Resources Holding Corp

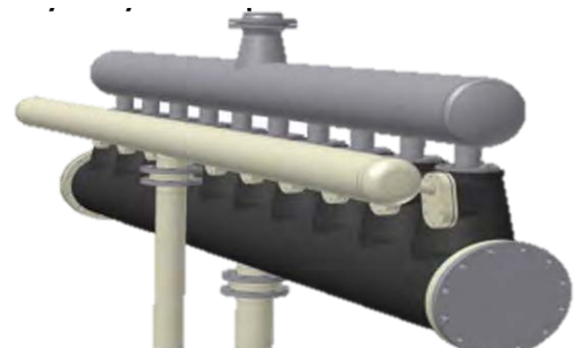
DyVaR

*basics for this diagram are based on information of Royal Dutch Shell/Shell Oil



DyVaR PICTURES





Influent is injected from side manifold, pure water vapor comes out the top and concentrated brine flows out the bottom.

DyVaR PICTURES

Texas Water
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M&G Resins USA, LLC
Corpus Christi

DESALINATION PLANT

FLÁVIO ASSIS
FLAVIO.ASSIS@GRUPPOMG.COM.BR

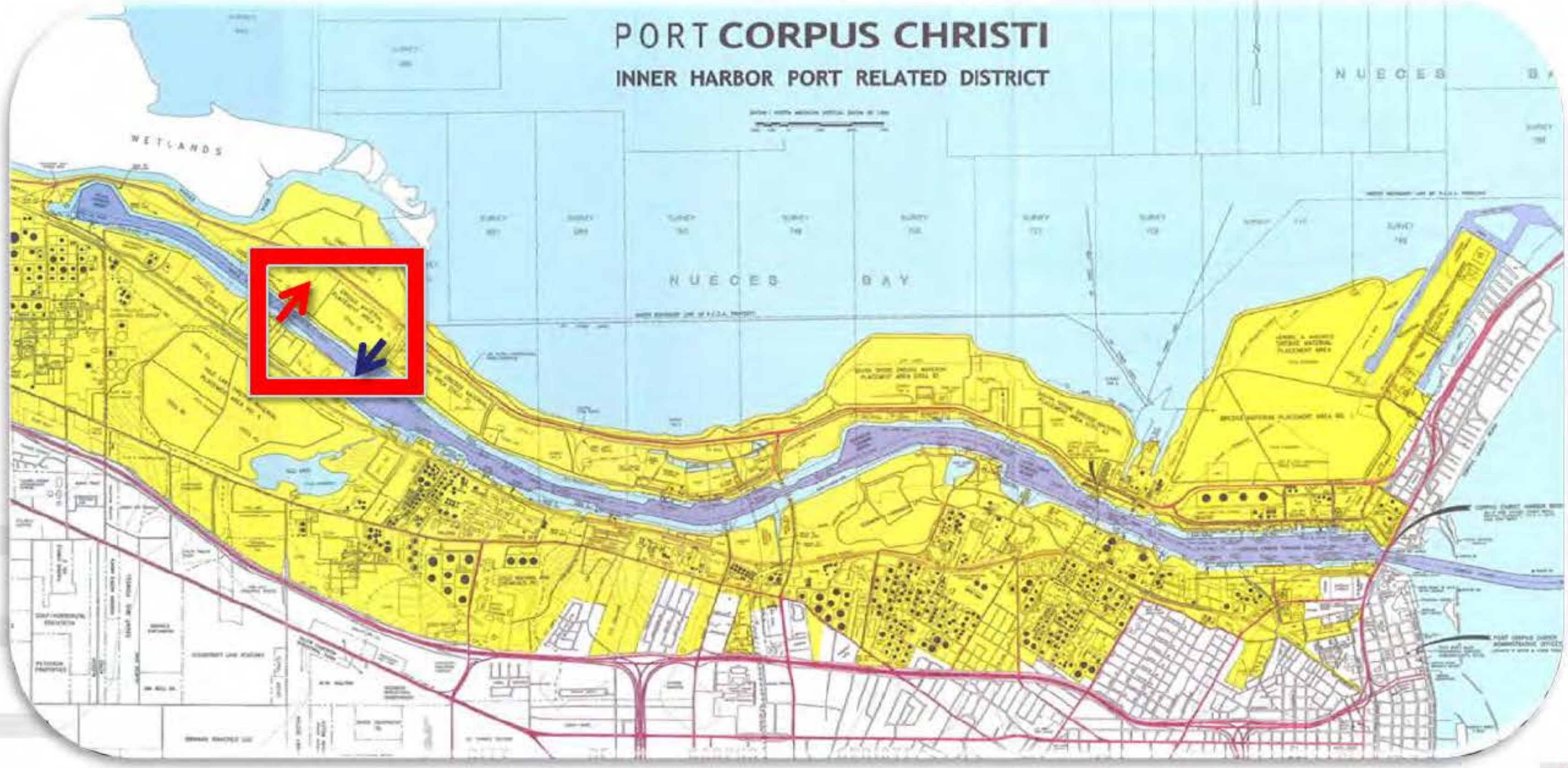
June 2014

Water Usage

- **Desalinization Plant is intended to be the water production unit dimensioned solely on M&G plant needs**

Sea Water Flow Rate:	2380 m3/hr ; 10400 gpm (15 MGD)
Desalinated Water Production:	**960 m3/hr ; 4200 gpm** (6 MGD)
Brine Flow Rate:	1420 m3/hr ; 6200 gpm (9 MGD)
Power Consumption:	5210 Kwh/hr
Desalinated Water Quality:	< 500 µS (soft water) < 0.2 µS (demi water)
Technology Used:	Reverse Osmosis Membrane

Sea Water Intake & Brine Outlet



Sea Water Intake & Brine Outlet

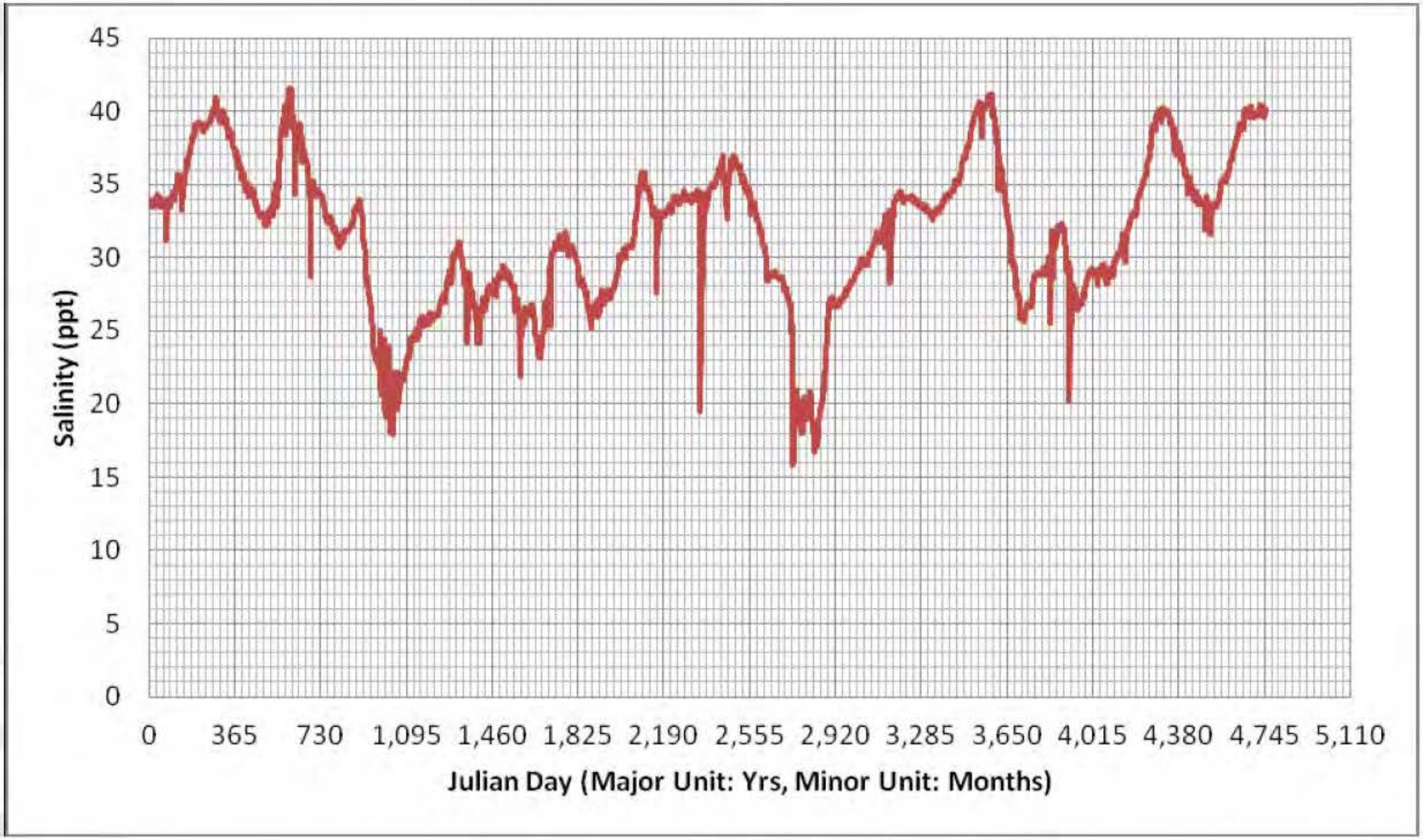
Sea Water from Viola Channel

Intake flow = 15 MGD
Salinity = 35 ppt

Brine to Viola Channel

Discharge flow = 9 MGD
Salinity = 63 ppt (at end of pipe)

Historic Daily Salinity at Segment 22 – M&G Intake



Questions

Texas Water Development Board

ORANGE COUNTY WCID #1
TWDB INNOVATIVE TECHNOLOGY PRESENTATION

- Norman Blackman, P.E. –
  - General Manager
  - 30 years Consulting Engineering
- District built 3 MGD WWTP fund by TWDB
- Facility is unique not because it utilizes a new and innovative technology, but because it utilizes existing technology in an innovation way. This presentation will explain how.

CURRENT AERIAL PHOTO

ORANGE COUNTY WCID
AERO-MOD TREATMENT UNIT

CONSTRUCTION PROGRESS PHOTO

WWTP DESIGN

The design of our WWTP achieved the following key goals we set for it:

- Handle a high ratio of Peak Flow to design Average Daily Flow
- Utilize only corrosion-resistant materials
- No moving parts below the water surface
- Utilize effective, but easy-to-operate controls for automatic operation

WASTEWATER TREATMENT

- WWTP Processes
  - Headworks
  - Activated Sludge
  - Clarification
  - RAS/WAS Pumping
  - Aerobic Digestion
  - Filtration
  - Disinfection
  - Sludge Dewatering

- Aero-Mod Solution
  - Common-wall concrete construction
  - No mechanical moving parts below water
  - Regulate effluent flow rate & create in-basin surge storage
  - Low maintenance corrosion resistant materials
  - Simple, operator-friendly controls

AEROMOD ACTIVATED-SLUDGE TREATMENT UNIT

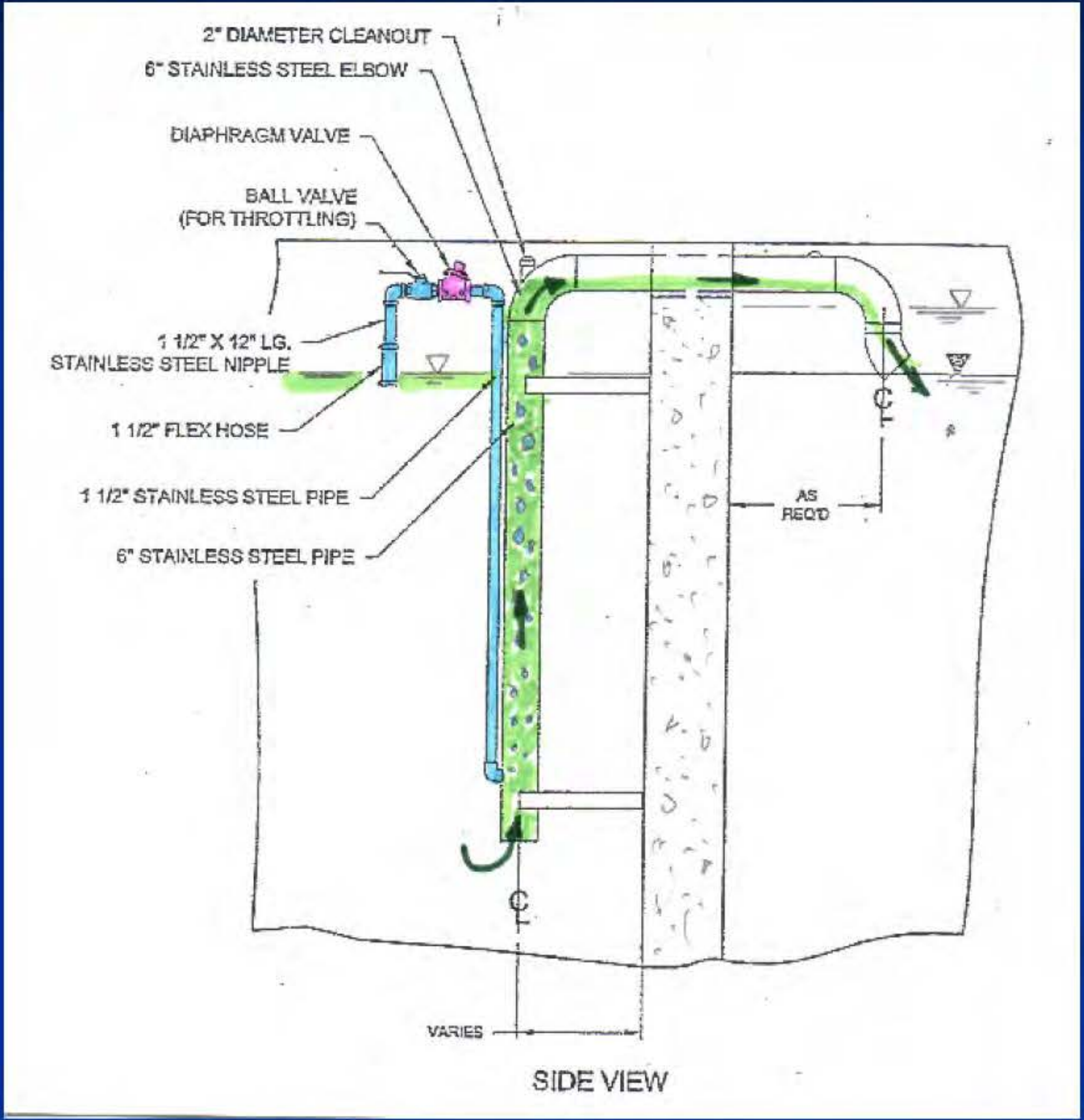
- The Activated Sludge Treatment Unit is the **ENGINE** of the treatment plant where most of the work gets done, most of the biological treatment is achieved, most of the electrical energy is consumed, and where our WWTP is somewhat unique.
- This treatment plant utilizes blowers to provide low pressure air for aeration and operation of air-lift pumps

AEROMOD ACTIVATED-SLUDGE TREATMENT UNIT

What is it that makes achieving these goals possible? I think the primary factors are:

- Extensive Use of Air-Lift Pumps (444)
- Unique Clarifier Design

AIR LIFT PUMP



TYPICAL CLARIFIER DESIGN

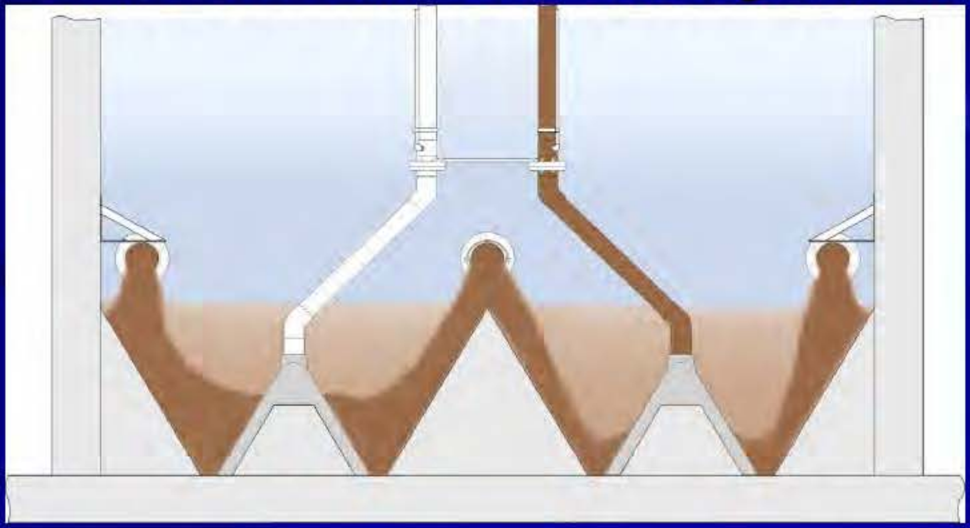
- Most typical clarifiers in use today
  - Use Circular shape not conducive to common-wall construction
  - Use motors & gearboxes to turn sludge rake & skimmers
  - Use pumps & piping to transfer settled sludge

UNIQUE CLARIFIER DESIGN

- Avoids expensive mechanical equipment and the associated maintenance burdens
- Utilizes aeration air supply to power air-lift pumps
- Results in no moving parts below the water and no moving parts at all except for pneumatically controlled ball valves to control air on and off
- Requires the use of 440 air-lift pumps for sludge recirculation and skimmers

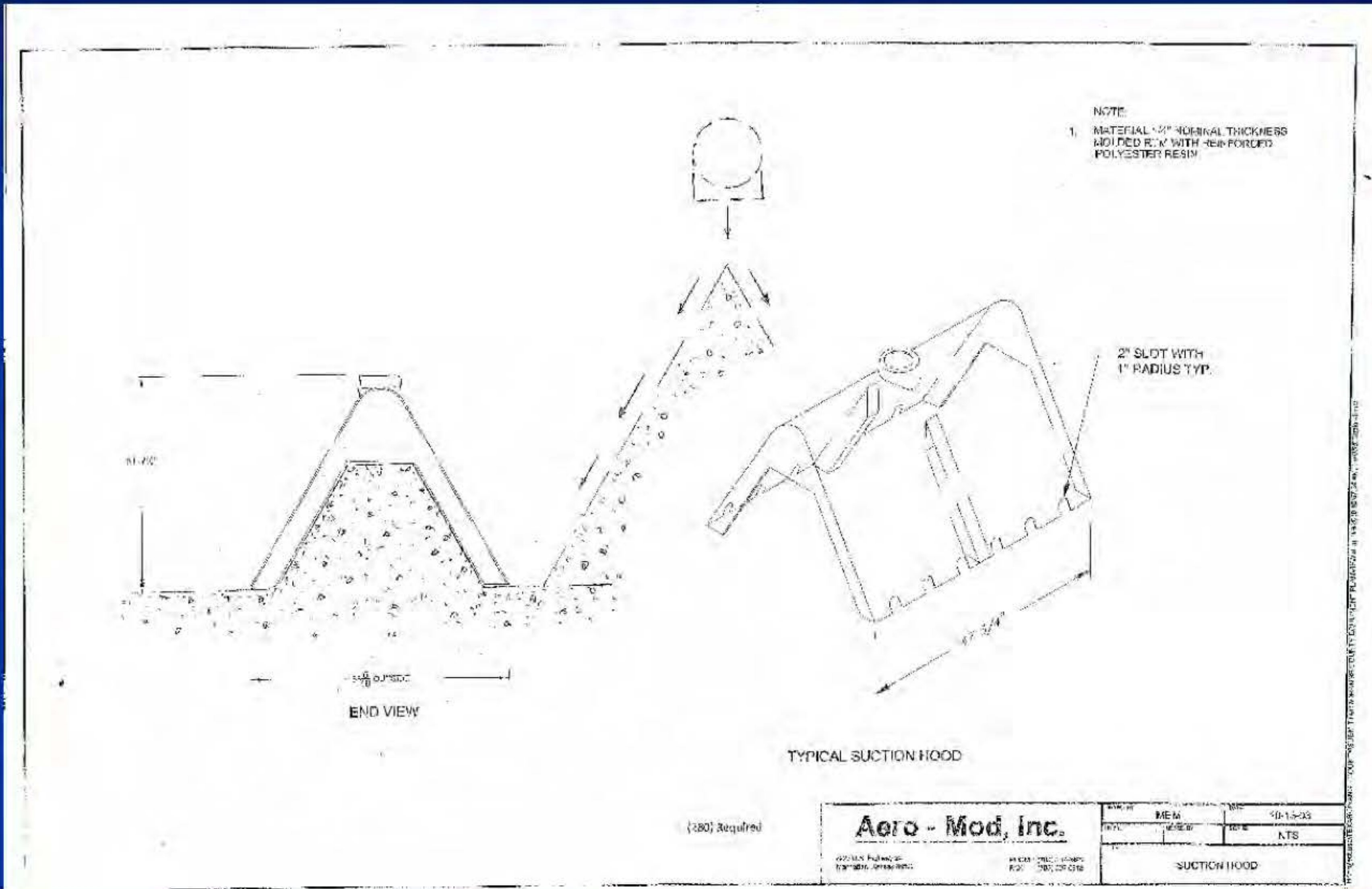
CLARATOR CLARIFIER SLUDGE REMOVAL ADVANTAGES

- Every Good Clarifier Requires a Removal Mechanism and a Transfer Pump
  - ✓ Stationary suction hood is the removal mechanism serving the same purpose as a scraper arm in a circular clarifier
  - ✓ Airlift is the transfer pump
- Every Unit Clarifier Section (4' x 10' area) Operates Identically
  - ✓ Each suction hood operates independently of its neighbor due to isolation baffles
  - ✓ Each suction hood utilizes its own high rate airlift

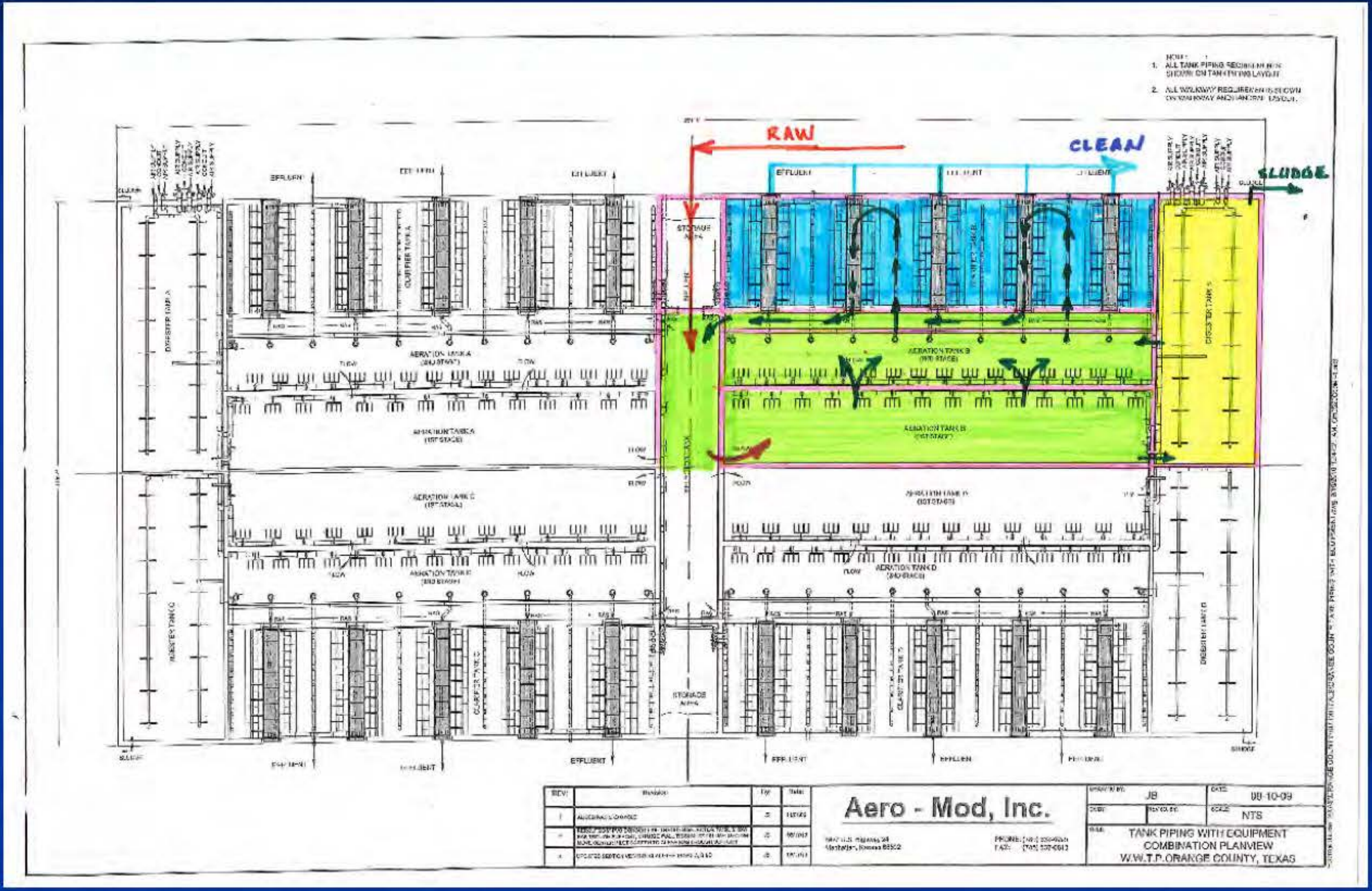


Aero-Mod®
Wastewater Process Solutions

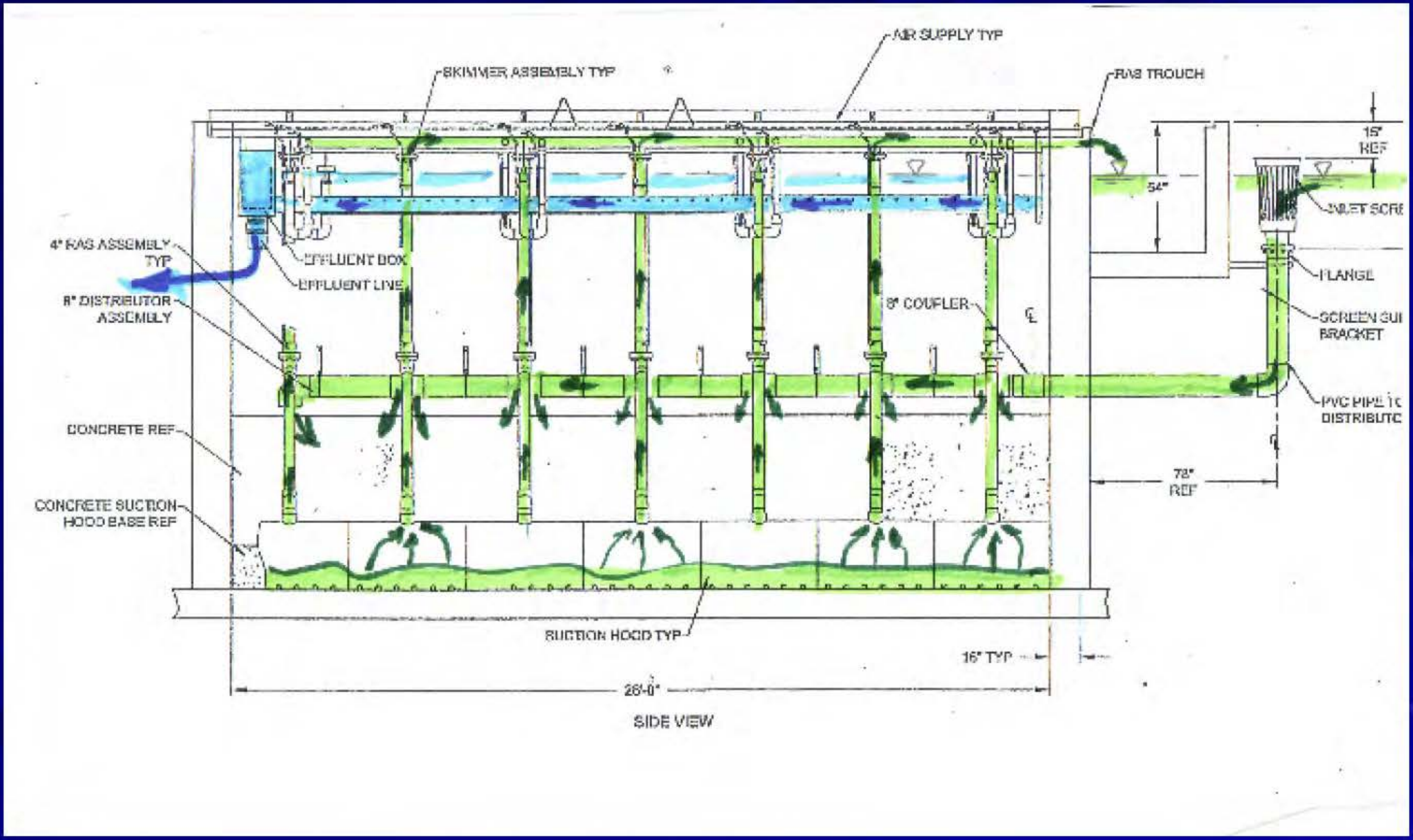
SUCTION HOOD

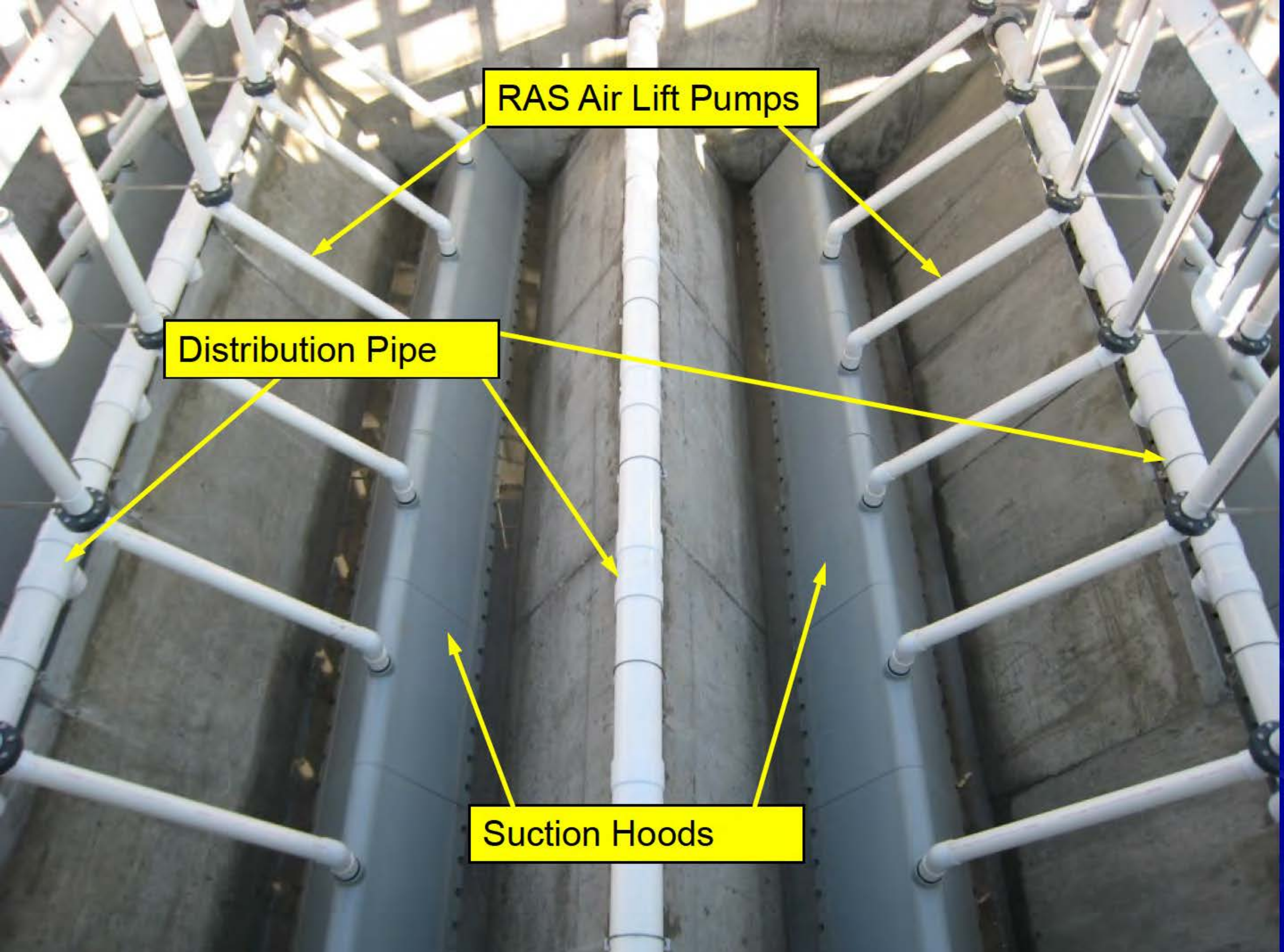


PLANT FLOW DIAGRAM



CLARIFIER FLOW DIAGRAM




RAS Air Lift Pumps
Distribution Pipe
Suction Hoods

ClarAtor Clarifier - Additional Advantages

- RAS Maintained by Simple Timer Control
- No Moving Parts Under the Water
- Fabricated of Stainless Steel, Fiberglass, PVC and Concrete

IN SUMMARY

How does the use of air-lift pumps and rectangular clarifies yield the stated benefits?

- Air-lift pumps make it possible to utilize rectangular clarifiers and no mechanical equipment below water surface
- Rectangular clarifiers make it possible to utilize total common-wall concrete construction

- Common-wall construction lowers construction costs, reduces the required land area, and allows transfer piping to be minimized or eliminated
- With no mechanical or electrical equipment required in the treatment unit and with transfer piping eliminated, the whole operation can be controlled with simple pneumatically operated valves

Texas Water
Development Board

E3 WATER™

EARTH ENVIRONMENT ENERGY

Watch Bill Gates Drink Water That Was Once Human Poop!

FROM: YOUTUBE.COM

QUANTITY

AND

QUALITY

OF

WATER

STERILE WASTEWATER TREATMENT TECHNOLOGY

Raw Wastewater to Potable Water
in Hours vs. Months

Ken Roberson Drinks Water That Was Once Human Poop!

E3 WATER™
EARTH ENVIRONMENT ENERGY

MISSION STATEMENT

The mission of E3 Water, LLC, is to dramatically increase the quantity and quality of water by integrating innovative water and wastewater treatment technologies into the global market.

E3 WATER™

EARTH ENVIRONMENT ENERGY

Texas Water Development Board

GOLDWATER PROJECT

Texas Water Foundation

Averitt & Associates

Texas Water Development Board

January 2015

SUPPORTING ORGANIZATIONS:

San Jacinto River Authority
SJRA
www.SJRA.net

REGION H

West Harris County Regional Water Authority

North Harris County
REGIONAL WATER
Authority

THE CYNTHIA & GEORGE
MITCHELL
FOUNDATION

Freese and Nichols

The Meadows
Foundation

HOUSTON ENDOWMENT

A PHILANTHROPY ENDOWED BY JESSE H. AND MARY GIBBS JONES

TEXAS WATER DEVELOPMENT BOARD

awbd

HARRIS-GALVESTON
HGSD
SUBSIDENCE DISTRICT

NORTH FORT BEND
WATER AUTHORITY

LONE STAR
Groundwater Conservation District

REGIONAL CONSERVATION GOALS

Sample Municipal Conservation Goals

Region H 105,494 ac-ft 7%

Region C 284,916 ac-ft 17%

Region G 21,346 ac-ft 3%

Region I 20,600 ac-ft 8%

Region K 54,750 ac-ft 10.6%

Total Goal from all Strategies in SWP (2060): 9,004,839 ac-ft

Cost for all Strategies: $27 billion in State Funds ($53 billion total)

Cost per Acre-foot: $3,230

Total Goal for Municipal Conservation: 647,361 ac-ft (7.2%)

Individual Reports

<u>Feature 4 Primary Sections:</u>

- How to build political consensus for strategies
- Tracking tool results with utility's specific data and selected measures
- How to adjust to changes in rates and revenue requirements
- Dealing with implementation successes and pitfalls

SNAPSHOT PROVIDED TO EACH UTILITY

Annual Goal for Fort Bend County (MG)	127
Sugar Land's Potential Annual Savings with Conservation Measures (MG) (Low Projection)	12.3
Sugar Land's Potential Annual Savings with Conservation Measures (MG) (High Projection)	45.2
Sugar Land's Potential 5-year Savings with Conservation Measures (MG) (Low)	61.5
Sugar Land's Potential 5-year Savings with Conservation Measures (MG) (High)	225.9
Sugar Land's Expected 5-year Savings from Water Loss Plan (MG) (TWDB submission)	141
Sugar Land's Water Conservation Plan Current GPCD (2013)	187
Sugar Land's Water Conservation Plan 5-year Goal GPCD	182
Potential 5-year Reduction in GPCD with Measures (Low)	1.99
Potential 5-year Reduction in GPCD with Measures (High)	7.32
Sugar Land's 5-year Water Loss Target GPCD (TWDB Submission)	17
Low Projection	
Costs for Suite of Programs over 5 years	$331,512
Benefits for Suite of Programs over 5 years	$1,097,611
Benefit-Cost Ratio	3.31
High Projection	
Costs for Suite of Programs over 5 years	$1,902,110
Benefits for Suite of Programs over 5 years	$5,341,502
Benefit-Cost Ratio	2.81

Galveston County Matrix

Galveston County Utility	City of Dickinson (WCID #1)	City of Galveston	City of League City	City of Sante Fe (WCID#8)	Estimated Savings by Measure (MG)	
Measures						
Residential HE Toilets, SF	X	X	X	X	1.8	
Residential HE Toilets, MF						
Residential LF Showerhead, SF						
Residential LF Showerhead, MF						
Res. Irr. Controller, SF Customer Financed						
Residential Meter Installation						
CII Tank-Type ULFT Rebate						
CII Tank-Type HE Toilet	X	X	X	X	0.4	
CII Valve-Type HE Toilet						
CII Dishwasher	X	X	X	X	2.0	
CII Spray Rinse Valve	X	X	X	X	1.0	
CII Food Steamer						
CII Cooling Tower						
Large Landscape Surveys						
Large Landscape Water Budgets						
Large Land. Irrigation Controller						
						County Savings Goal (2015) (MG)
Estimated Savings by Utility (MG)	0.9	1.4	2.3	0.6	5.2	4.2

Galveston County Matrix (cont.)

Adoption/Implementation Rates	City of Dickinson (WCID #1)	City of Galveston	City of League City	City of Sante Fe (WCID#8)
Residential HE Toilets, SF				
10% over 5 years [built before 1992]	**22** single-family homes/yr.	**61** single-family homes/yr.	**77** single-family homes/yr.	**22** single-family homes/yr.
CII Tank-Type HE Toilet				
7.5% over 5 years	**7** CII customers per year	**8** CII customers per year	**16** CII customers per year	**4** CII customers per year
CII Dishwasher				
7.5% over 5 years.	**7** CII customers per year	**8** CII customers per year	**16** CII customers per year	**4** CII customers per year
CII Spray Rinse Valve				
7.5% over 5 years	**7** CII customers per year	**8** CII customers per year	**16** CII customers per year	**4** CII customers per year

FINANCIAL VIABILITY OF MEASURES

	City of Dickinson (WCID #1)	City of Galveston	City of League City	City of Sante Fe (WCID#8)
Residential HE Toilets, SF				
Unit Cost in $/MG	$1,184	$1,184	$1,184	$1,184
Present Value Cost for Total Program	$19,100	$52,960	$66,851	$19,100
Unit Benefit in $/MG	$3,125	$1,571	$1,406	$1,892
Present Value Benefit for Total Program	$50,403	$70,256	$79,372	$30,513
Benefit/Cost Ratio	2.64	1.33	1.19	1.6
CII Tank-Type HE Toilet				
Unit Cost in $/MG	$1,026	$1,015	$1,018	$1,034
Present Value Cost for Total Program	$6,077	$6,946	$13,891	$3,473
Unit Benefit in $/MG	$3,125	$1,571	$1,406	$1,892
Present Value Benefit for Total Program	$18,509	$10,753	$19,177	$6,353
Benefit/Cost Ratio	3.05	1.55	1.38	1.83
CII Dishwasher				
Unit Cost in $/MG	$1,119	$1,119	$1,119	$1,119
Present Value Cost for Total Program	$30,387	$34,728	$69,456	$17,364
Unit Benefit in $/MG	$2,977	$1,497	$1,340	$1,802
Present Value Benefit for Total Program	$80,852	$46,444	$83,150	$27,969
Benefit/Cost Ratio	2.66	1.34	1.2	1.61
CII Spray Rinse Valve				
Unit Cost in $/MG	$665	$665	$665	$665
Present Value Cost for Total Program	$4,558	$5,209	$10,418	$2,605
Unit Benefit in $/MG	$2,946	$1,481	$1,325	$1,783
Present Value Benefit for Total Program	$20,206	$11,607	$20,780	$6,990
Benefit/Cost Ratio	2.66	2.23	1.99	2.68
Utility Revenue Requirement and Rate Impacts				
Change to annual sales requirement from baseline	-$3,762	-$1,343	-$1,434	-$1,003
Change to average water rate	0.12%	0	0.05%	0.38%
Change to annualized bill ($/Month)	-0.05	0	0	-0.03
Total Cost if Zero Benefit from avoided supply and wastewater:	$60,122	$99,843	$160,616	$42,542
If Utilties used debt service financing: (5-year note with 2.5% interest rate)	$12,804	$21,264	$34,212	$9,060

Objectives for Stakeholder Process

- Assess the ***right*** information to…
- Develop a plan that is ***right*** for all those involved, and…
- Find the ***right*** people to see it through.

GOLDWATER PROJECT

Texas Water Development Board

January 2015

Texas Water

Development Board

Urban Water Conservation

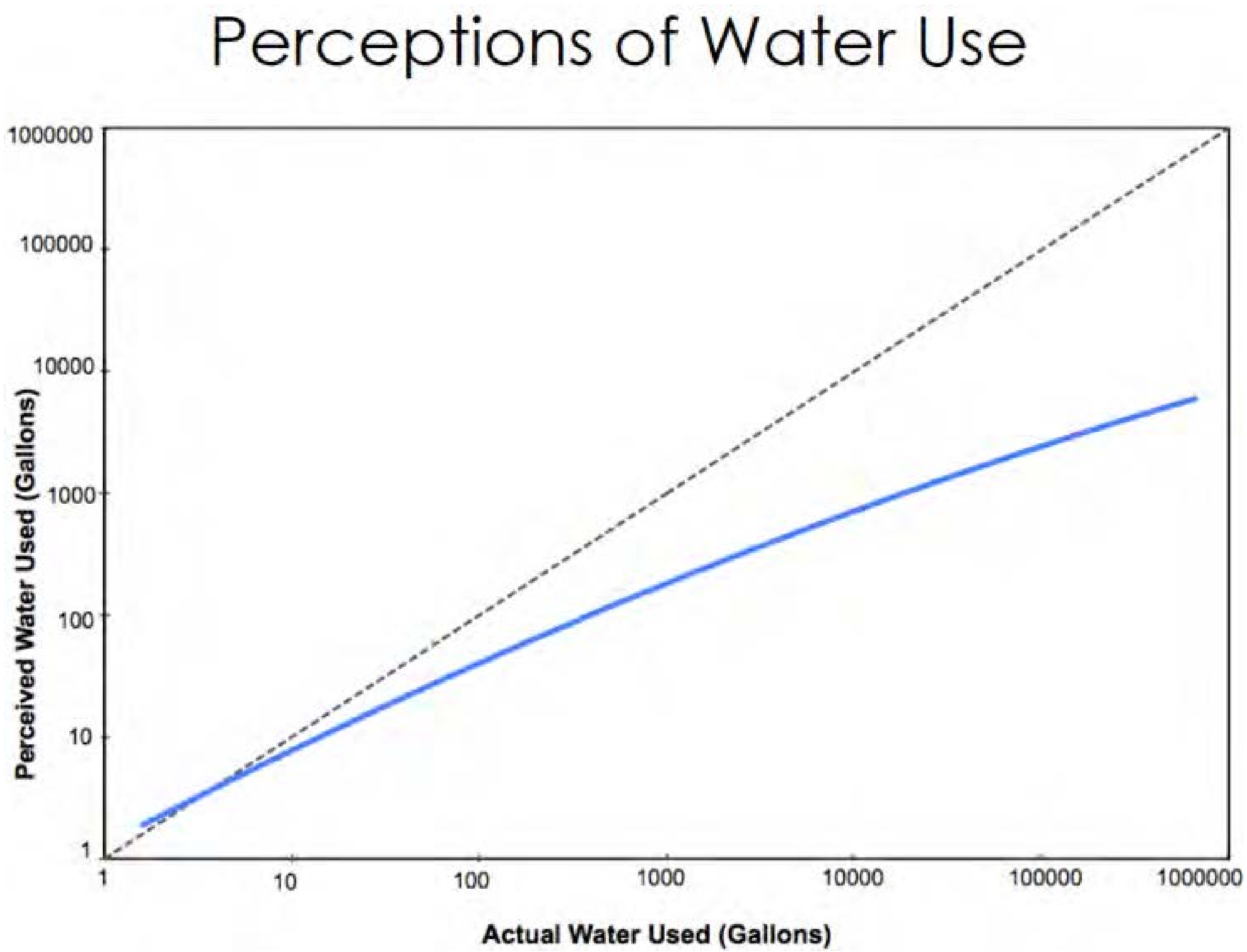
Presentation to TWDB

WaterSmart
SOFTWARE

Opportunity for Conservation

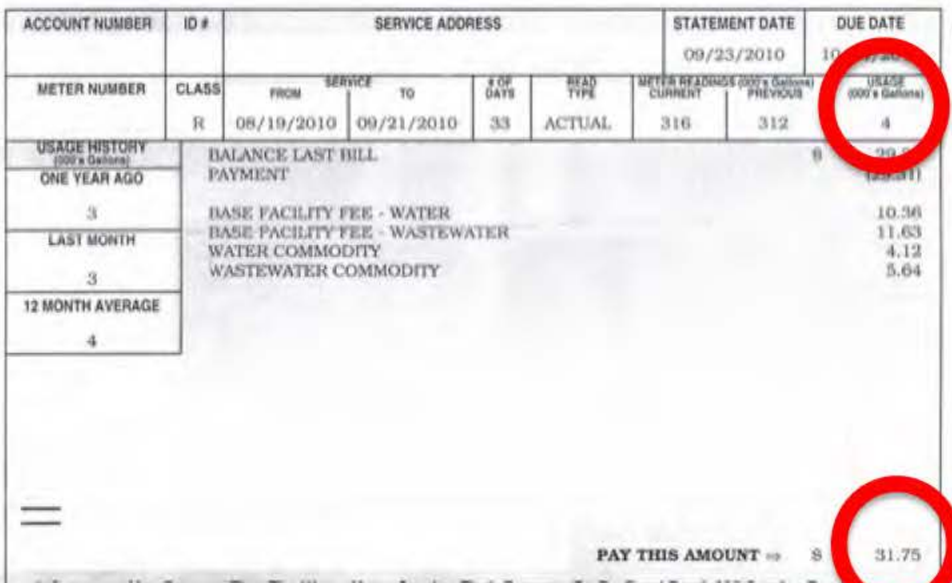
Sources: AWWA and TWDB

We don't know much about our own water use….



Source: Attari et al (2014)

Not best tool for engagement…



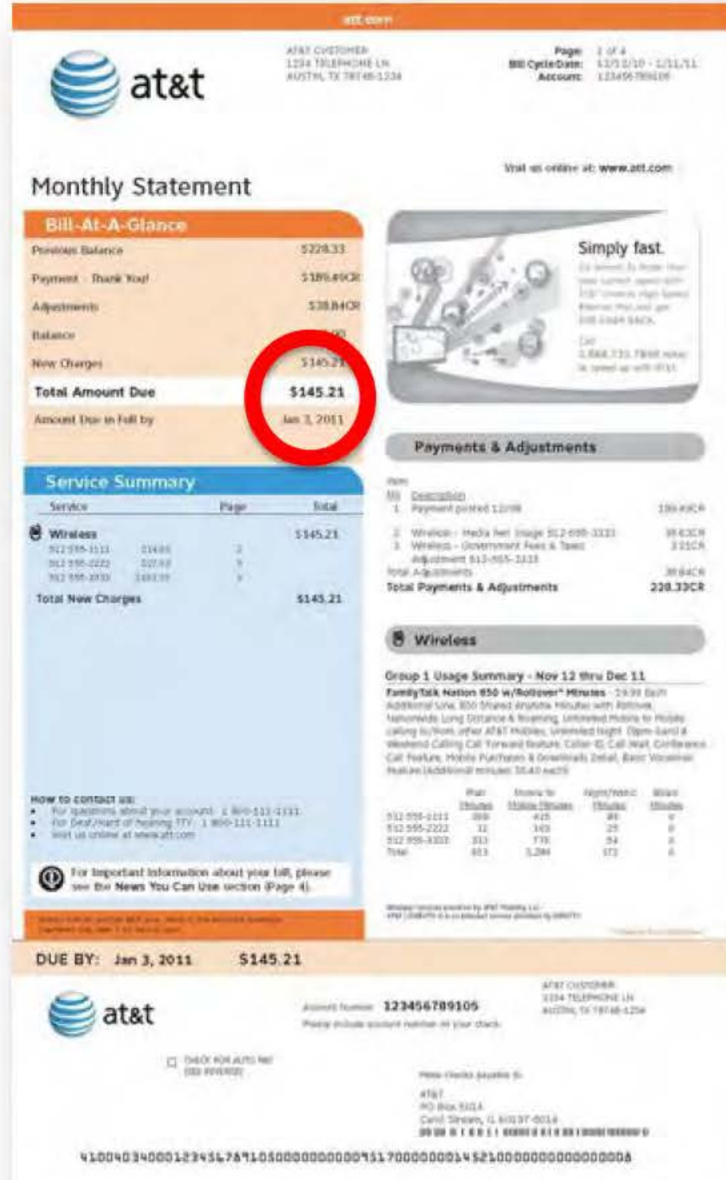
ACCOUNT NUMBER	ID #	SERVICE ADDRESS	STATEMENT DATE	DUE DATE
			09/23/2010	10/…

METER NUMBER	CLASS	SERVICE FROM	SERVICE TO	# OF DAYS	READ TYPE	METER READINGS (000's Gallons) CURRENT	METER READINGS (000's Gallons) PREVIOUS	USAGE (000's Gallons)
	R	08/19/2010	09/21/2010	33	ACTUAL	316	312	4

USAGE HISTORY (000's Gallons)
ONE YEAR AGO 3
LAST MONTH 3
12 MONTH AVERAGE 4

BALANCE LAST BILL	$	29.…
PAYMENT		(29.…)
BASE FACILITY FEE - WATER		10.36
BASE FACILITY FEE - WASTEWATER		11.63
WATER COMMODITY		4.12
WASTEWATER COMMODITY		5.64

PAY THIS AMOUNT ⇒ $ 31.75



att.com

at&t

AT&T CUSTOMER
1234 TELEPHONE LN
AUSTIN, TX 78748-1234

Page: 1 of 4
Bill Cycle Date: 12/12/10 - 1/11/11
Account: 123456789100

Visit us online at: www.att.com

Monthly Statement

Bill-At-A-Glance

Previous Balance	$228.33
Payment - Thank You!	$189.49CR
Adjustments	$38.84CR
Balance	$…
New Charges	$145.2…
Total Amount Due	**$145.21**
Amount Due in Full by	Jan 3, 2011

Simply fast.

Payments & Adjustments

Total Payments & Adjustments 228.33CR

Service Summary

Service	Page	Total
Wireless		$145.21
Total New Charges		$145.21

Wireless

Group 1 Usage Summary - Nov 12 thru Dec 11

How to contact us:

For important information about your bill, please see the News You Can Use section (Page 4).

DUE BY: Jan 3, 2011 $145.21

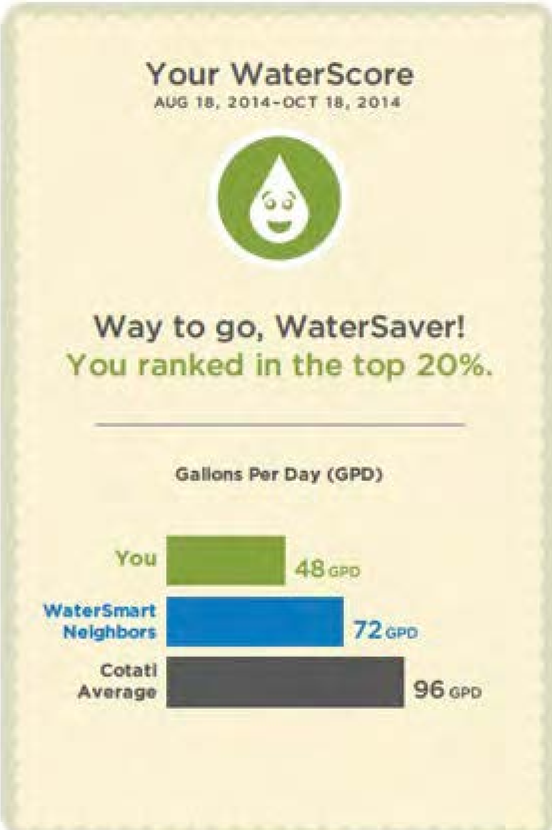
at&t

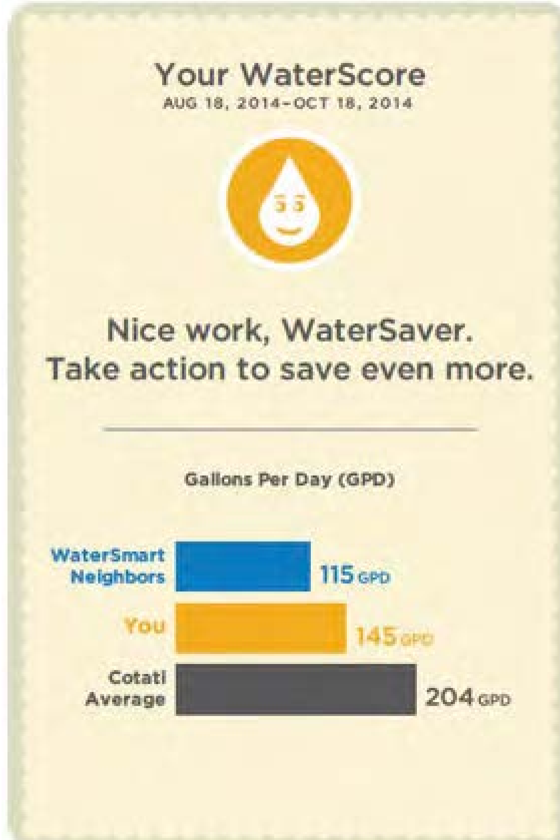
Account Number 123456789105

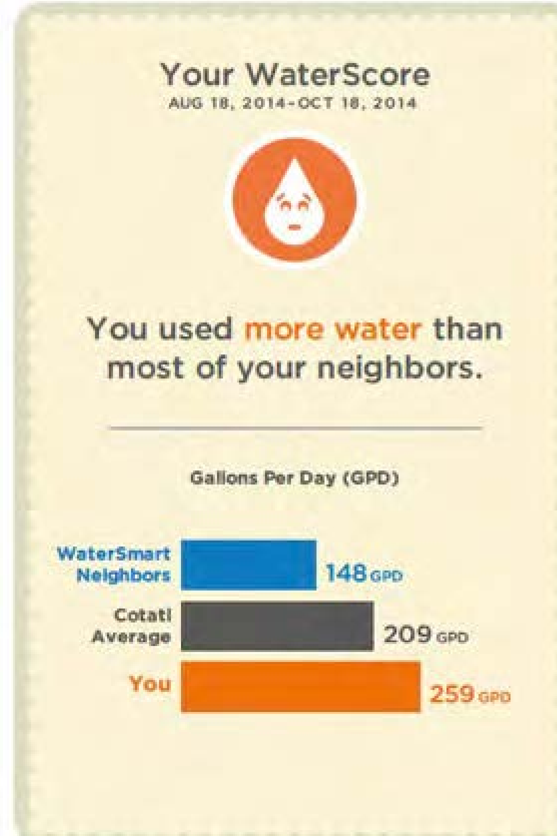
AT&T CUSTOMER
1234 TELEPHONE LN
AUSTIN, TX 78748-1234

Social Norms!!!

- Group behavior is a is a powerful force on most individuals


Your WaterScore
AUG 18, 2014-OCT 18, 2014
Way to go, WaterSaver!
You ranked in the top 20%.
Gallons Per Day (GPD)
You
48 GPD
WaterSmart Neighbors
72 GPD
Cotati Average
96 GPD


Your WaterScore
AUG 18, 2014-OCT 18, 2014
Nice work, WaterSaver.
Take action to save even more.
Gallons Per Day (GPD)
WaterSmart Neighbors
115 GPD
You
145 GPD
Cotati Average
204 GPD

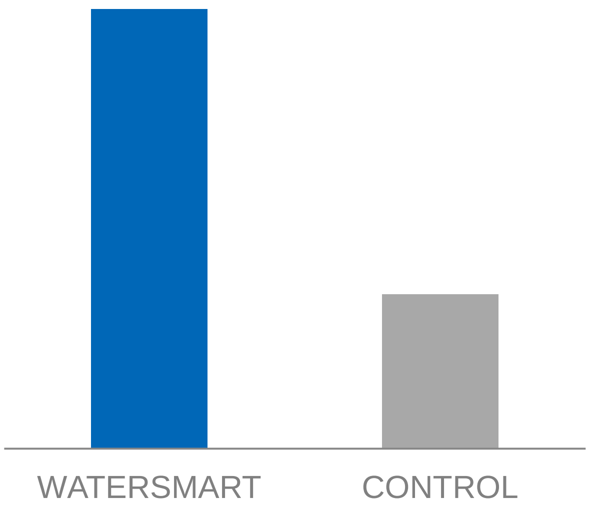

Your WaterScore
AUG 18, 2014-OCT 18, 2014
You used more water than most of your neighbors.
Gallons Per Day (GPD)
WaterSmart Neighbors
148 GPD
Cotati Average
209 GPD
You
259 GPD

Outcomes

5%+
WATER SAVINGS

EBMUD Pilot Launched June 2012
Cumulative Percent Saved

3x
CUSTOMER ENGAGEMENT



Participation in Existing Programs

Thank you!

Dominique Gómez, Director of Market Development
dominique@watersmart.com

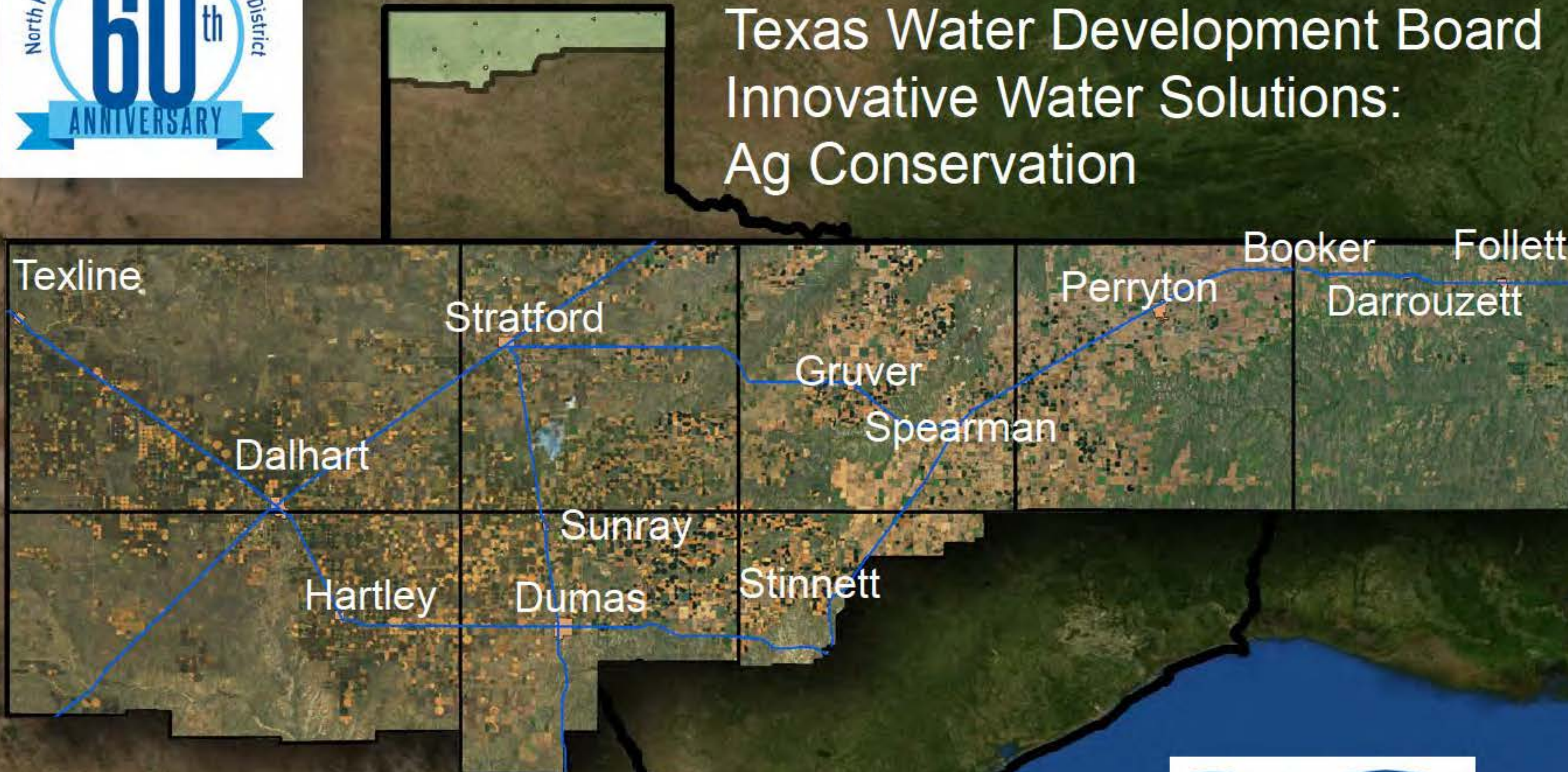
WaterSmart SOFTWARE

Texas Water

Development Board

North Plains Groundwater Conservation District 60th ANNIVERSARY

Texas Water Development Board Innovative Water Solutions: Ag Conservation



NORTH PLAINS GROUNDWATER Conservation District

Water Conservation Outreach

Demonstrations
- Practices &
- Technologies

Soil Moisture Probe with Telemetry

Practices

- Tillage Practices
- Seed selection
- Seeding Populations
- Planting Timing
- Nutrient Monitoring
- Pest Control

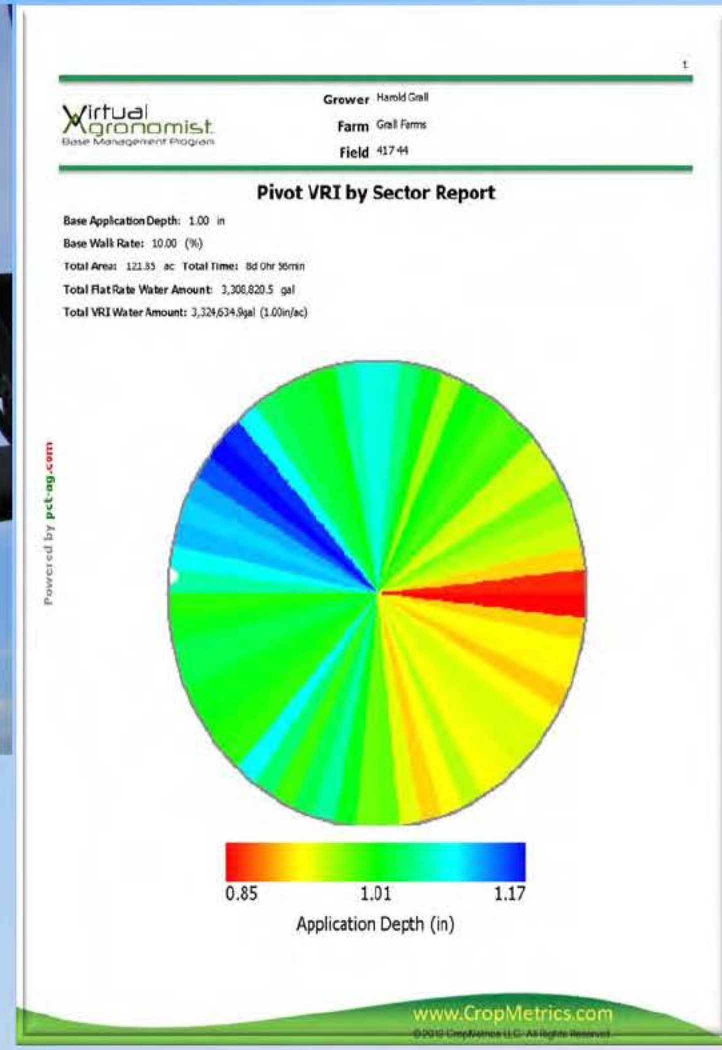
Technologies

- Soil moisture monitoring
- LESA and LEPA Pivot Irrigation
- Irrigation system monitoring and control
- Precipitation monitoring
- Remote Telemetry
- Water Metering
- Soil surveys
- Irrigation Prescriptions
- Irrigation Support Tools

LEPA -Low Energy Precision Application

LESA -Low Elevation Spray Application

NORTH PLAINS GROUNDWATER Conservation District



Pivot Monitoring and Control

NORTH PLAINS GROUNDWATER Conservation District

Irrigation Prescriptions (Variable Rate Irrigation)

Variable
Frequency Drives

Flow Meters

NORTH PLAINS
GROUNDWATER
Conservation District

North Plains GCD Water Conservation Center

A combination of traditional and social media to advance the message

Options

(One size doesn't fit all)

- Conservation Education – Demonstrations
- Engagement – Incentivize producer trials
- Adoption – Believers become practitioners and advocates

3" of saved groundwater in the NPGCD = 250,000 ac/ft.

NORTH PLAINS GROUNDWATER Conservation District

Discussion

Steve Walthour, General Manager
swalthour@northplainsgcd.org
806-935-6401

Texas Water
Development Board

Rainwater Harvesting in 2015

TRCA
Texas Rainwater Catchment Association

ARCSA
AMERICAN RAINWATER CATCHMENT SYSTEMS ASSOCIATION

RWH is Adaptable, Scalable and Resilient

- **Adaptable**, in that RWH morphs into a form that is appropriate for the current situation

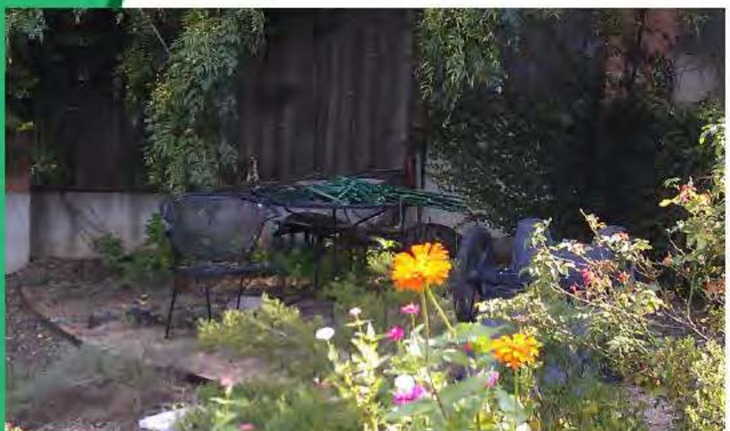
- **Scalable**, in that RWH works economically and efficiently when utilizing a 50 gallon drum, 100,000 gallon irrigation supply or anything in between

- **Resilient**, in that properly sized RWH system maintain full function during periods with no rainfall and refill quickly with modest rain events

RWH – Urban Advantages

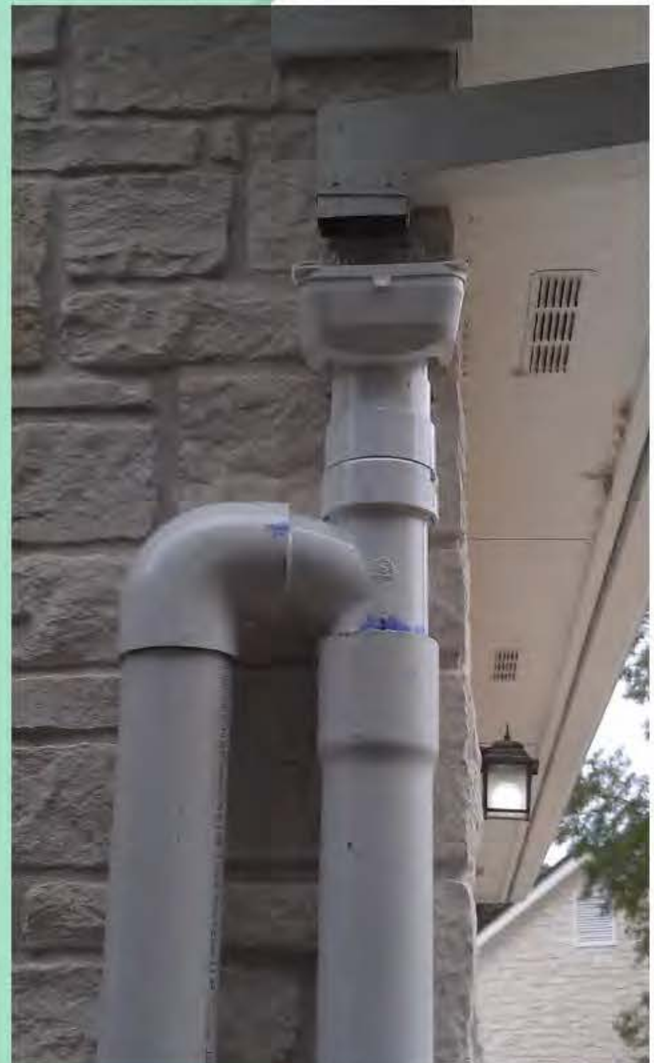
1. It reduces reliance on finite municipal sources, especially important during times of drought, and it offsets the need for additional capital investments, which generally carry a much higher per unit cost than already developed, existing supplies.
2. It substitutes rainwater for treated water, thus avoiding the embedded environmental costs and energy consumption of treatment and delivery associated with using potable supplies for non-potable purposes.
3. It provides an emergency, onsite source of water in case of temporary, even prolonged interruption of municipal supplies, for example as the result of an earthquake (stored rainwater can relatively easily and cheaply be rendered potable through boiling, microfiltration, or chlorination).
4. It reduces the volume and peak flows of stormwater runoff, reducing the risk of both urban flooding and non-point source pollution.

RWH – Suburban Considerations



1. Typically only a very minor fraction of the total rain falling onto the watershed makes it into the "cisterns" of that rainwater harvesting system – the aquifers and reservoirs. The rest is lost to evapotranspiration, a "loss" which maintains the ecology of the watershed. It substitutes rainwater for treated water, thus avoiding the embedded environmental costs and energy consumption of treatment and delivery associated with using potable supplies for non-potable purposes.
2. water supply is centered on building-scale rainwater harvesting, "waste" water management centers on project-scale reclamation and reuse, and stormwater management employs distributed green infrastructure to maintain the hydrologic integrity of the site.
3. So bottom line, broadscale practice of rainwater harvesting off all the buildings in a watershed would actually ***improve*** the overall yield from the watershed of water that would be directly usable by humans, without any significant impact on the rest of the ecology, in particular on "environmental flows" in our rivers.

RWH – Rural Considerations



My company's model customer is semi-retired or retired living on acreage in rural Texas and their primary source of water is a well, not municipal water. The drought and increased development in Central Texas has taxed the aquifers to critical levels affecting the availability and quality of well water that until now has been the best water source available for rural Texas.

Over the last seven years, many of these people have been forced to consider extreme conservation measures, investigate alternative water sources, or move to a place that has reliable water. Many contact us seeking information about rainwater collection after their wells have failed or the quality of the groundwater that they utilize has become so poor that they are not comfortable using the water as their primary source….especially as their source for drinking water.

Mark Leatherman, owner, Rain Harvest Resources, VP, Texas Rainwater Catchment Association, Accredited Professional and Inspector Specialist in the American Rainwater Catchment Systems Association, ARCSA

RWH – Rural Considerations

Rainwater Harvesting practices can be applied in settings that it is impractical or not feasible to service with other water supplies.

- Wildlife waterers are small roofed structures tied to watering troughs located in remote locations to water wildlife and remote livestock. Some ranchers even have trailer-mounted versions that they move around from pasture to pasture with the livestock.
- Remote hunting camps use their systems to provide water where it is either not otherwise available or economically unfeasible to drill a well for such short stays.
- Individual homes or entire subdivisions can employ rainwater systems to provide high quality, dependable potable water in locations not served by water purveyors and where no dependable water supplies are available from drilled wells.
- Remote located businesses can collect their roof runoff and use the stored water to eliminate a significant portion of their stormwater runoff and/or use the water to feed their landscape irrigation system, non-potable in-building demands, process water demands, cooling water demands or even treated to full potable standards for unrestricted uses.

TEXAS LAND & WATER DESIGNS

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TRCA

Texas Rainwater Catchment Association

ARCSA

AMERICAN RAINWATER CATCHMENT SYSTEMS ASSOCIATION

Texas Water
Development Board

Lone Star Milk Producers, Inc.

January 2015

Lone Star Milk Producers

- LSMP is a farmer owned dairy cooperative, based in Texas with membership across the southern part of the United States.

- LSMP markets approximately 3.5 billion pounds (1.7 billion liters) of raw milk per year for its 170 members.

- LSMP as the 13th largest dairy cooperative in the USA.

Plant description

- LSMP is designing and constructing a dairy ingredients plant in the Panhandle of Texas.
- Milk intake capacity 2,500,000 lbs. per day (1,134,000 liters) at 90% utilization.
- Plant will produce cream and further dry the product.
- Dried product includes NFDM/SMP and other premium products.

Reclaimed Water

- Milk is about 87% water. Dried Powders are about 3-4 % water.
- Thus, the dairy ingredient plant produces water.
- That seems important given the water supply in the Panhandle.
- The plant is incorporating technology to separate and clean the water. That technology has been available for some time.

Reasons For Reclamation

- Reduce reliance on an outside water source
- Reduce cost for outside water source
- Produce water adequate for cleaning-in-place (CIP)

.

- Reduce effluent discharge volume

Reclamation Process

- The water is separated from the milk initially through a Reverse Osmosis Membrane system (RO) and/or a Mechanical Vapor Recompression (MVR) evaporator system.

- It is thereafter polished using another RO system and UV sanitizing system to allow the water to be used as a final rinse for the cleaning in place system.

- The costs for the equipment to clean and polish the water will exceed $1,600,000.00. Plant costs only.

Clean-in Place

- The CIP system only needs approximately ½ of the recovered water.
- This leaves the other ½ for another and, possibly a higher, use.
- **What to do with the other ½**
- The previous costs items do not include infrastructure to handle the unused water.

Questions ?

Texas Water

Development Board

Texas Water Development Board
Conservation & Innovative Water Technologies
Austin, Texas

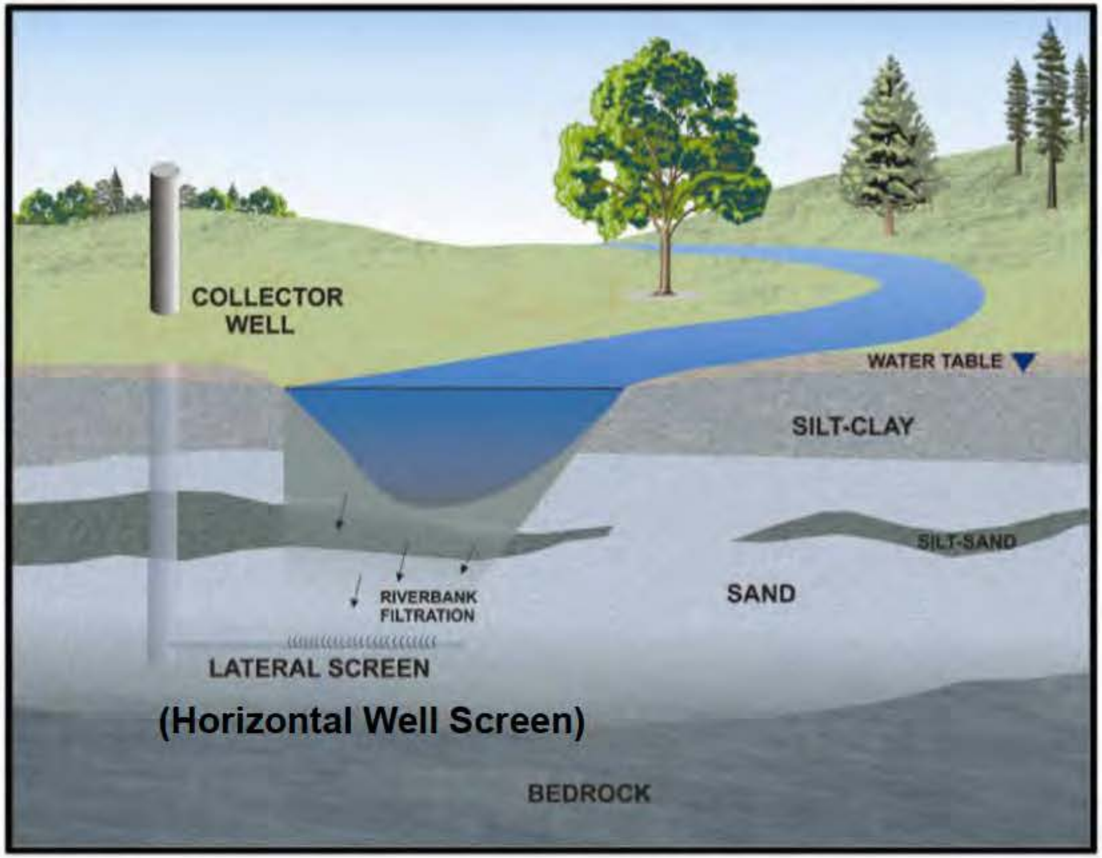
Layne

WATER · MINERAL · ENERGY

Horizontal Wells For Groundwater Extraction

January 2015

Riverbank Filtration



Use horizontal wells to extract underutilized alluvial ground water and "filtered" surface water.

Horizontal wells make full use of aquifer saturated thickness and can use aquifer storage during periods of low stream flow.

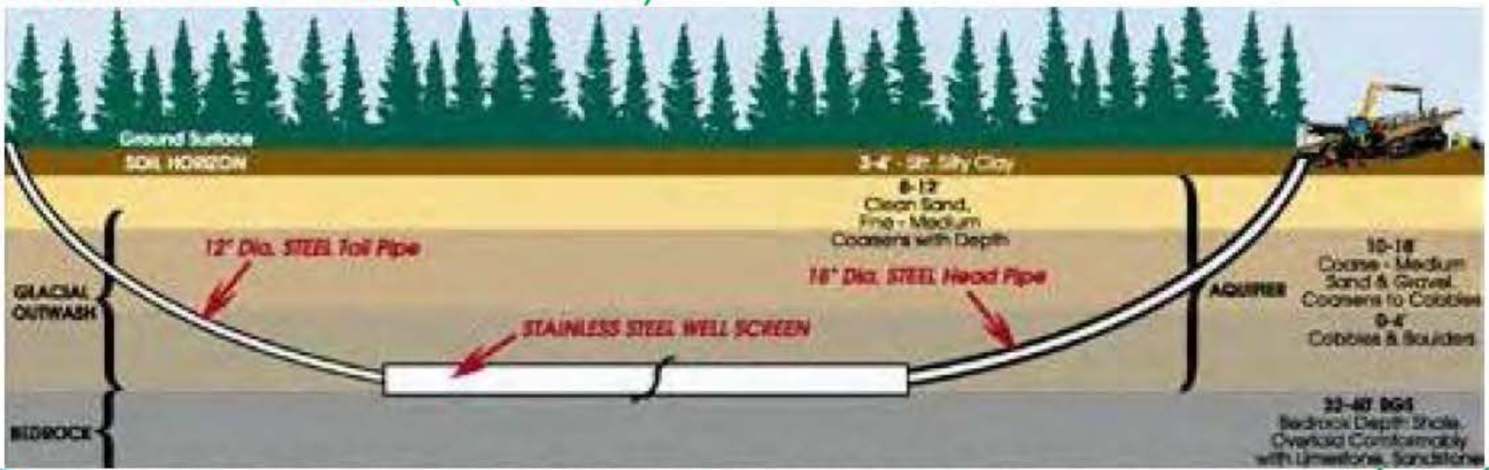
Proven Technology for high and low yields.

- Allows for the use of underutilized alluvial aquifers and the shift of pumping away from over pumped regional aquifers.
- Provides water quality improvements over direct surface water intakes by using aquifers as filters.

Horizontal Well Types

HDD Wells – Adapted from utility applications. New use with very few US installations.

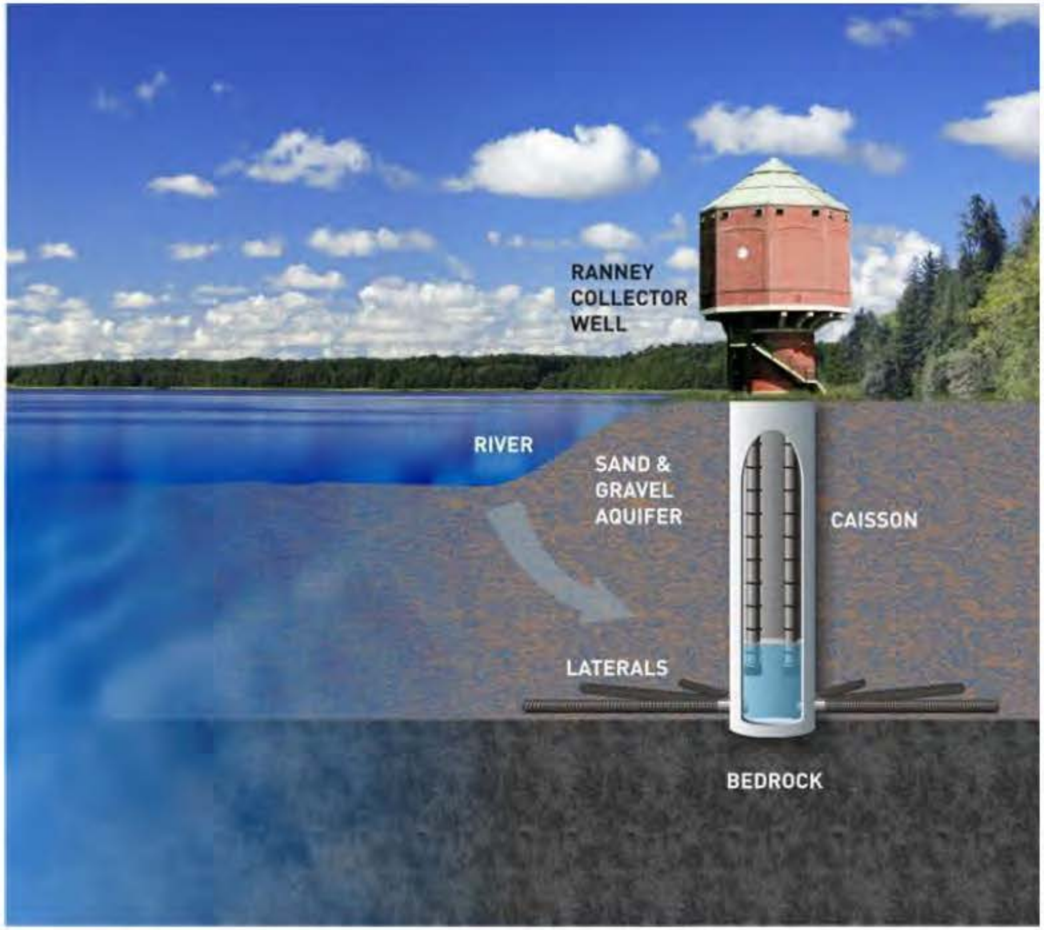
- Low capital costs
- Site in Granular Unconsolidated Aquifers
- Low Yields (100 to 500 gpm)
- Drilling Mud Difficulties
- Non-Vertical Pump Alignment
- Uncertain Lifetime Costs (new use)



Horizontal Well Types

Horizontal Collector Wells (Radial or Ranney Wells) - Used for water supply since 1933. Installed in over 35 US States, Canada, Mexico, Europe & Asia.

- Higher Capital Investment to Install
- Site in Granular Unconsolidated Aquifers
- High Yields (1 to 40 mgd)
- High Quality Water (filtered surface water)
- Efficient Pump Configurations
- Low Lifetime Costs



Filtered Surface Water (Ohio River Example)

Parameters	River Water	Collector Well	Groundwater
pH	7.7 - 7.9	**7.4 - 7.5**	**7.2 - 7.3**
Total Hardness (mg/L)	90 - 205	**205-250**	**530 - 582**
TDS (mg/L)	184	**234**	**606**
TOC (mg/L)	2.1 - 4.9	**0.3 - 0.6**	**0.4 - 0.7**
Turbidity (NTU)	2 - 1,500	**<0.08**	**NA**
D.O. (mg/L)	>5.0	**<0.1**	**NA**
Iron (mg/L)	<1	**2.5**	**15.8**
Temperature (^{0}F)	32 - 86	**50 - 78**	**About 55**

Horizontal Wells for Groundwater Extraction

Proven Technologies for high and low yields.

- Allows for the use of underutilized alluvial aquifers and the shift of extraction away from over pumped regional aquifers.
- Provides water quality improvements over direct surface water intakes.
- Reduction/elimination of surface water borne pathogens and THM precursors.
- Elimination of zebra mussels & quagga mussels.
- Can provide efficient source of pumping, with low operating costs.

Contact Information

To view an informational video, go to the Layne company web page at: http://www.layne.com/en/solutions/construction/ranney-collector-wells.aspx?mid=464

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MATTHEW REED
RANNEY COLLECTOR WELLS| Project Manager / Hydrogeologist
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Texas Water Development Board

Regional Planning and Partnerships

Robert R. Puente
President/CEO

January 29, 2015

Texas Water Development Board

San Antonio Water System

Local Partnerships with Private Companies

- $1.3 Billion in Contracts awarded over past 5 years
- Develop and Support for SMWBE Businesses
- Thousands of Jobs for Local and Regional Area
- Education and Workforce Development for Youth
- Innovation and Best Practices

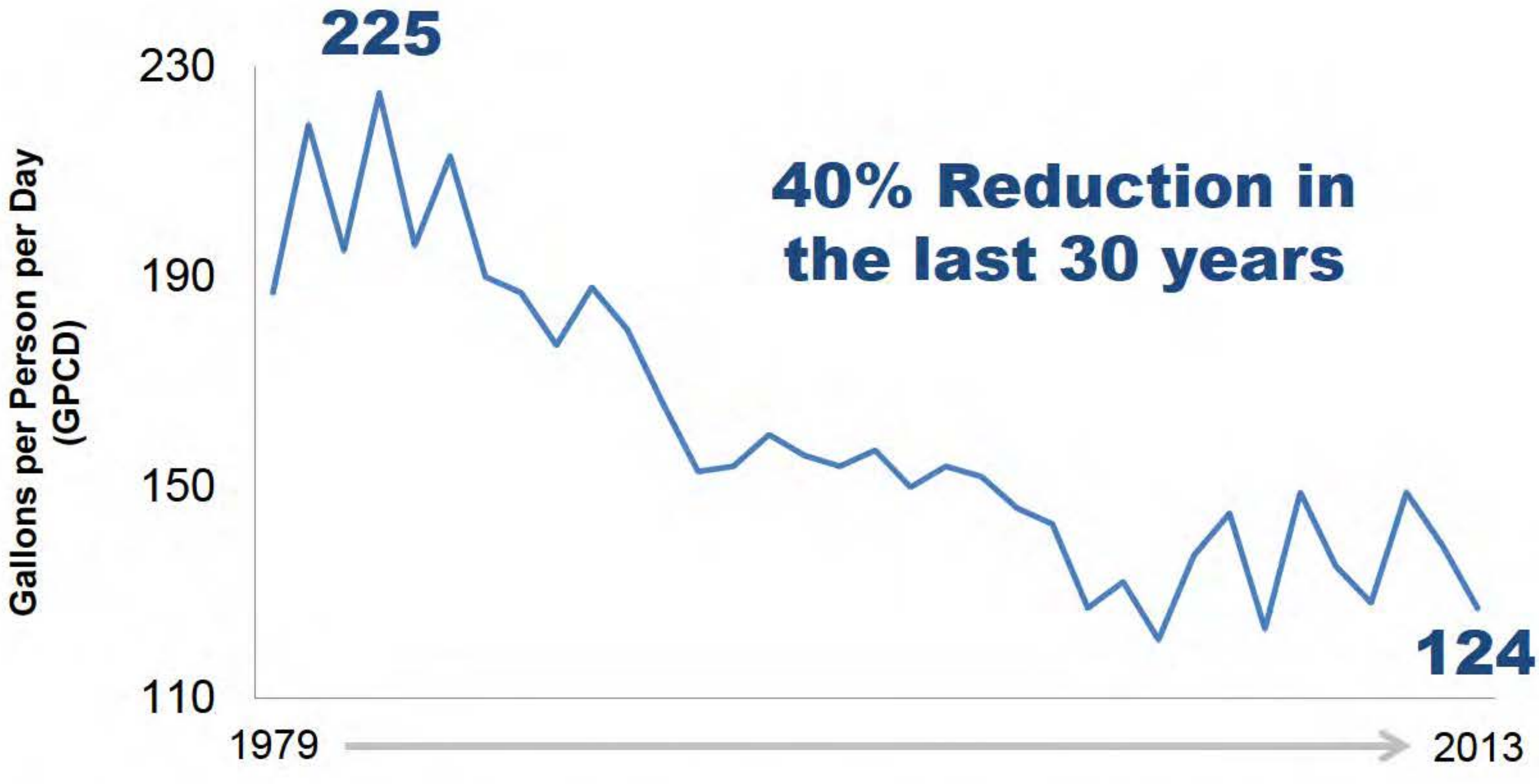
Water Management for San Antonio

Planning for the Future

- Meeting water demands to sustain Regional economy
  - New Sustainable Water Supplies
  - Continued Water Conservation
  - Drought Conditions
  - Regulatory and Legal Uncertainty
  - Maintaining Financial Strength

Continued Focus on Conservation

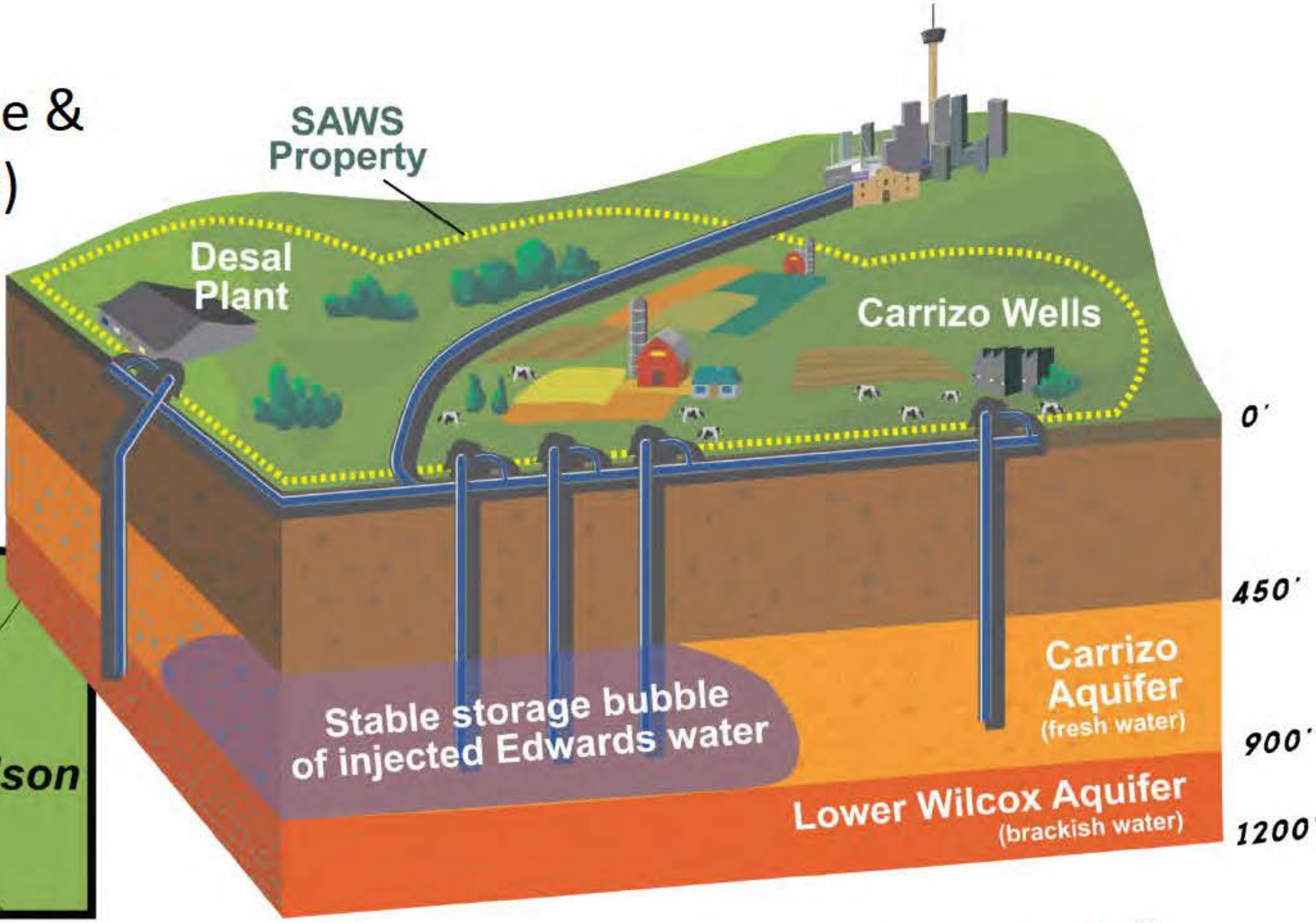
16,500 acre feet water savings planned by 2020

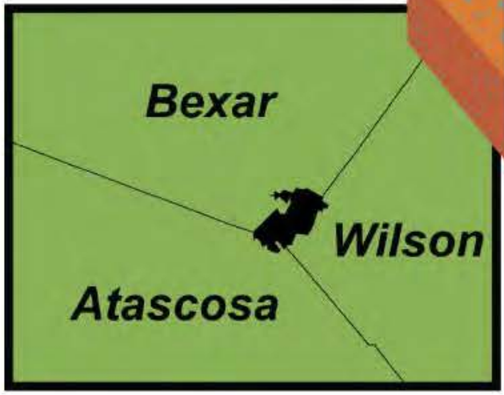


Current Water Supply Projects

Three Projects on One Site

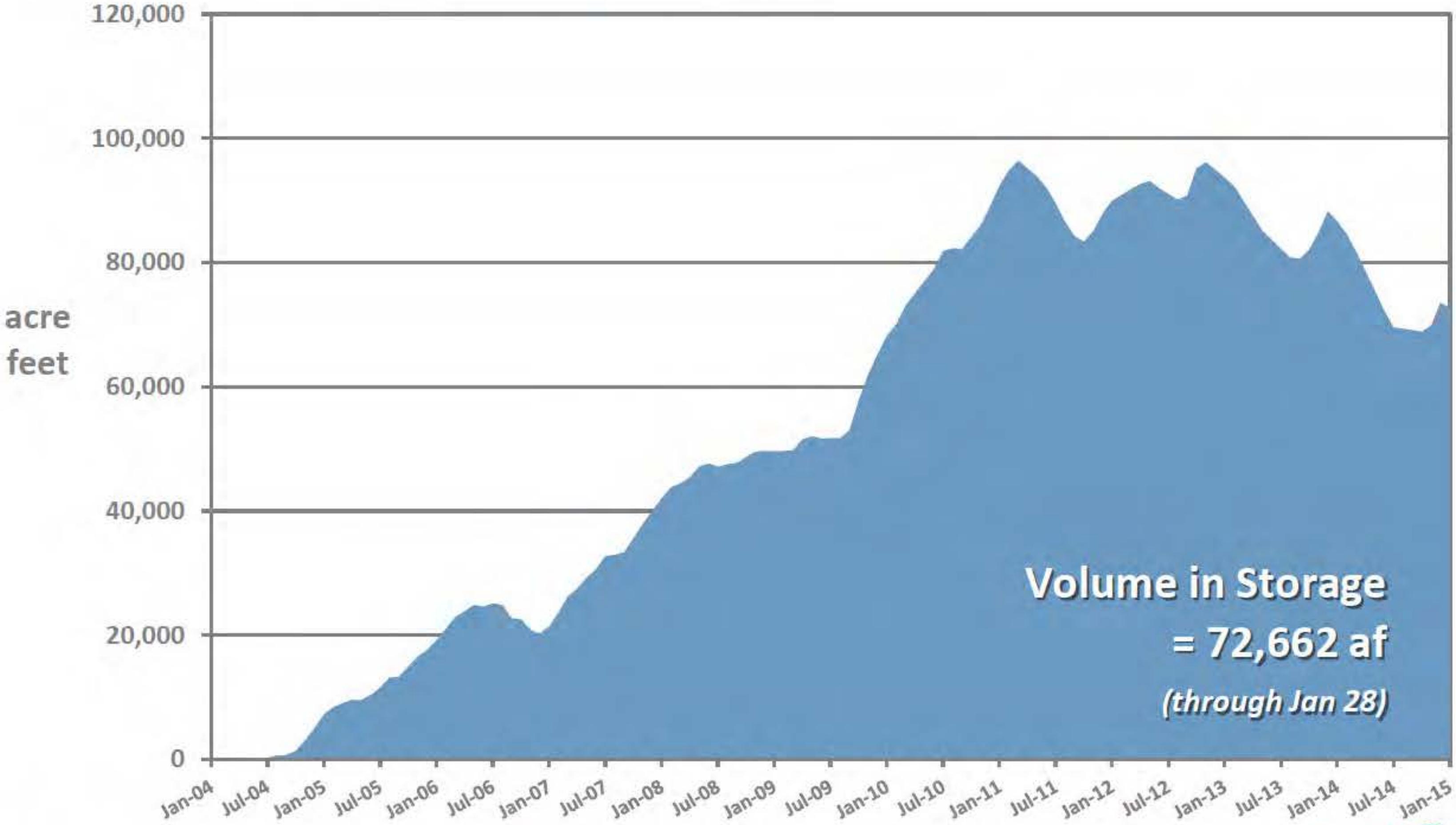
- Aquifer Storage & Recovery (ASR)
- Desalination
- Expanded Local Carrizo





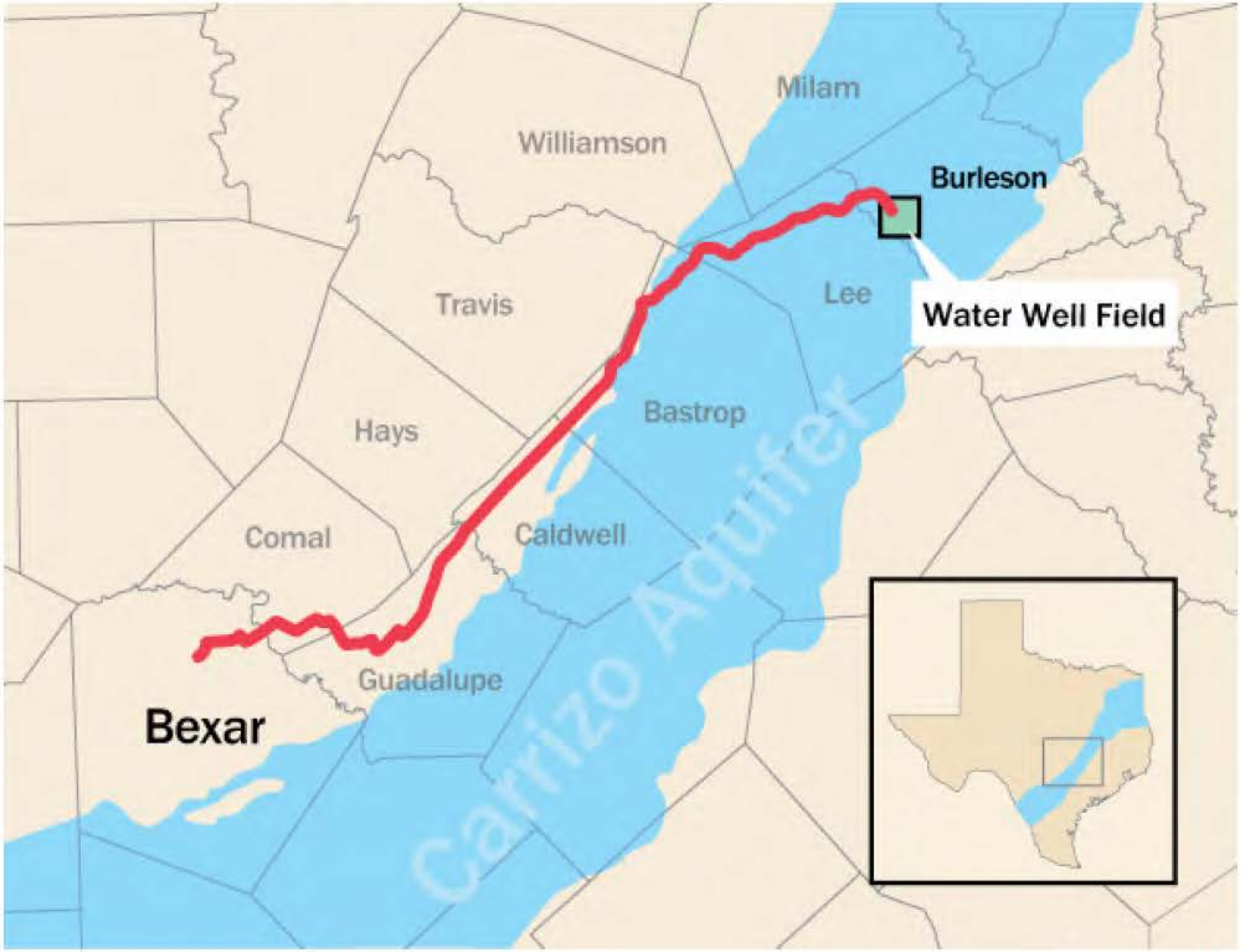
Twin Oaks ASR Storage Volume

Potential Capacity over 200K ac-ft



Brackish Groundwater Desalination

Vista Ridge Regional Water Project



Vista Ridge Consortium

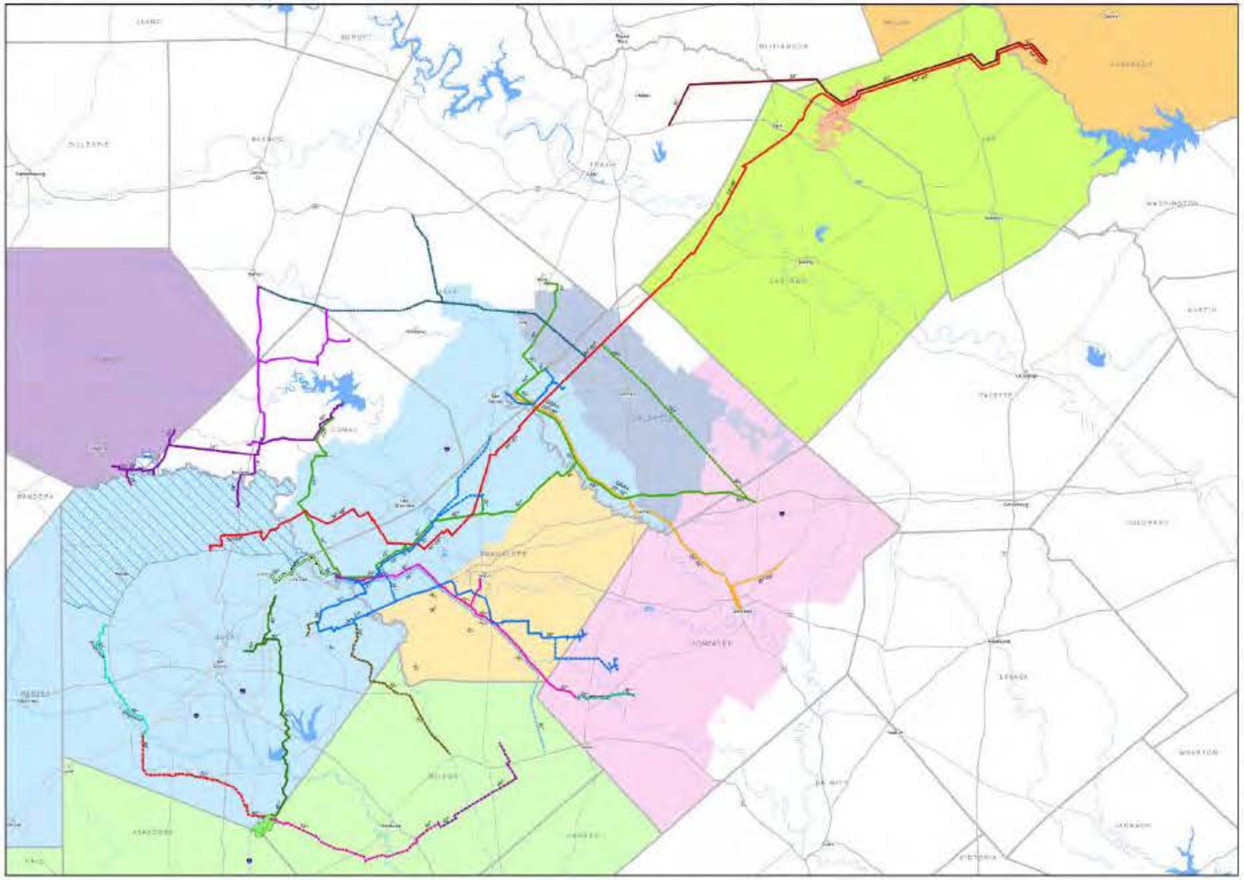
- Up to 50,000 ac-ft per year for 30 years
- SAWS pays **<u>only</u>** for water made available
  - Water Supply risks shifted away from ratepayer
- Fixed Cost *est.* $1,694 - $1,959 *(interest rate dependent)*
- End of Term
  - Assets and Infrastructure transfer to SAWS
  - SAWS retains right to purchase water at end
    - Landowners royalty payments increased to 50%
- Maintains local groundwater management

Timeline for Vista Ridge Contract

Contract Negotiation Phase completed → Development Phase 0-30 months → Construction Phase 42 months → Operation Phase 30 years → Project continues (P&I drop off)

Regional Backbone of Water

Opportunities for Regional Agreements



Local and Regional Water Supply Projects

San Antonio Water System

Win – Win – Win for Community

- Water for Regional Economic Hub
- Water Supply and Financial Risks Transferred
- 50,000 ac-ft at fixed cost for 30 years
- Biggest Diversified Supply in history
- Abundant Supply for Children & Grandchildren
- Water beyond 30 years
- Regional Pipeline
- Environmental Benefits and firm supply

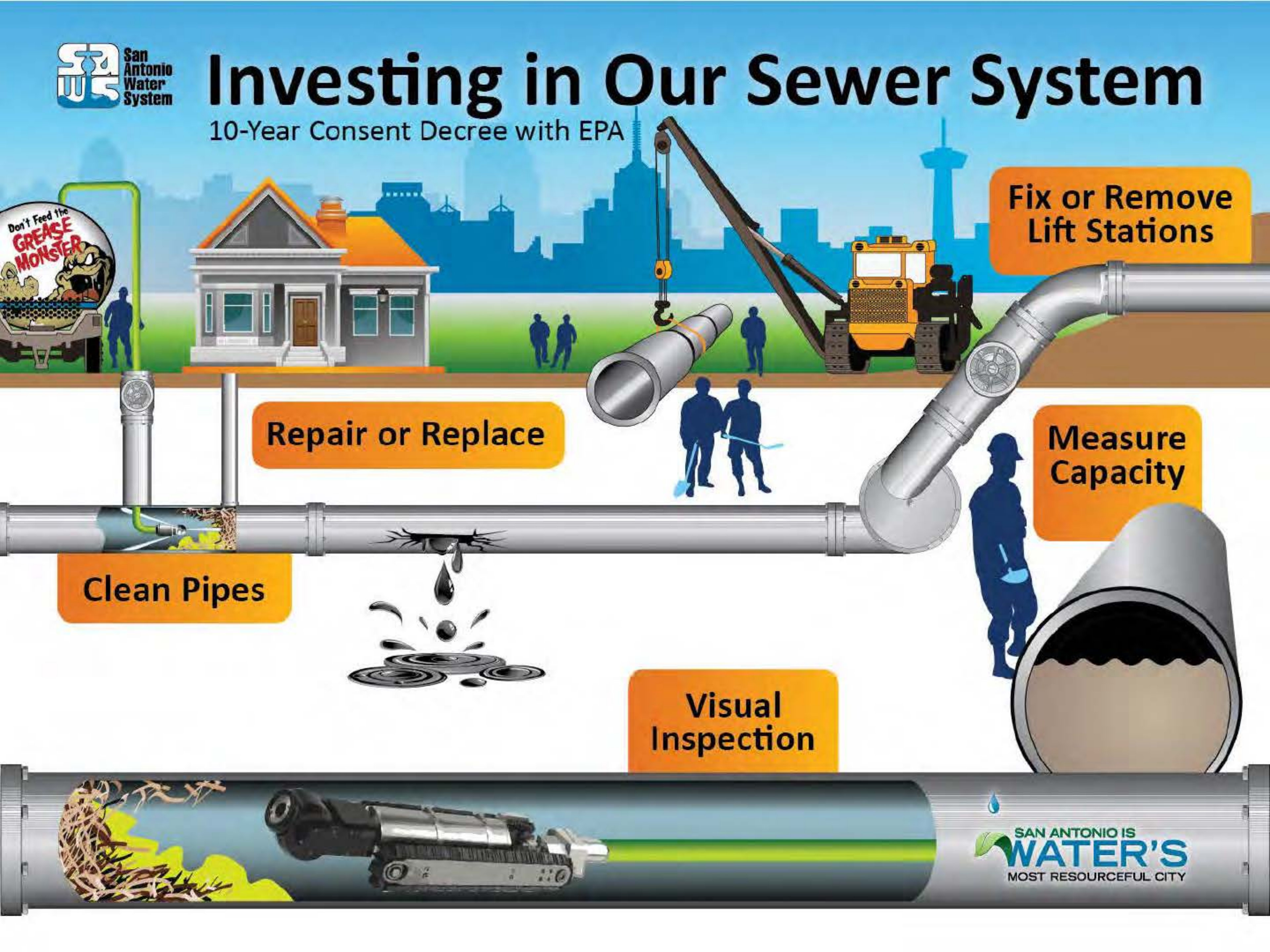
Developing Southside through Partnerships

- Massive 96” Sewer Pipeline built through private local partnership
  - $124 Million

- Help Spur growth and revitalize area

TOYOTA

TEXAS A&M UNIVERSITY SAN ANTONIO


San Antonio Water System
Investing in Our Sewer System
10-Year Consent Decree with EPA
Don't Feed the GREASE MONSTER
Fix or Remove Lift Stations
Repair or Replace
Measure Capacity
Clean Pipes
Visual Inspection
SAN ANTONIO IS WATER'S MOST RESOURCEFUL CITY

Innovative Success

- **Largest** Recycled System in the Nation
- **First** in Nation conversion from gas to energy
- **Largest** groundwater based ASR system in nation
- **Largest** inland desalination plant under construction
- **International** model for Conservation

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