San Antonio Bay Partnership
www.sabaypartnership.org

GSA BBASC Study No. 5:
Strategy Options for Meeting Attainment Frequencies for the Estuaries

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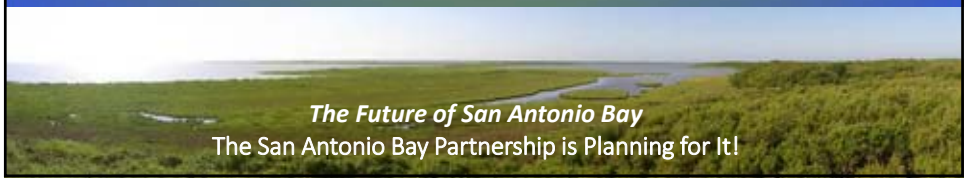

Project Goal

To identify strategies for achieving the greatest ecological benefit to the receiving estuaries given the limited amounts of freshwater available to the environment during drought periods.

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Project Approach

The study:

(1) Determined the volumes and timing of freshwater inflows needed to meet *Strategy Target Frequencies*,

(2) Quantified freshwater volumes that could be made available to supplement inflows with implementation of a strategy option based on

  (1) The dedication of wastewater return flows,

  (2) the donation, purchase, or lease of existing water permits, or new appropriations, and

  (3) the use of Aquifer Storage and Recovery (ASR) to "bank" water for managed releases for environmental flows

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Project Approach

The study:

3) Used the "Region L" WAM – a modified TCEQ Run 3 version of the WAM -- as the starting point for defining baseline conditions; modeling assumptions included:

- Effluent discharge / return flow in the Guadalupe - San Antonio River Basin reported for 2006 and adjusted for current SAWS direct recycled water commitments;
- Edwards Aquifer withdrawals;
- critical period management, and resulting springflows consistent with the Edwards Aquifer Habitat Conservation Plan (Phase I) developed through the Edwards Aquifer Recovery Implementation Program, and
- several modifications affecting operations of specific water rights (RWP 2016).

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DETERMINATION OF VOLUMES AND TIMING OF FRESHWATER INFLOWS NEEDED TO MEET STRATEGY TARGET FREQUENCIES

Spring (March - May)

B&E Inflow Goal (for *Rangia*) = 150,000 af

STF Goal: *In no more than 9% (5 years) of the 56 year period of record, should the Mar-May combined inflow be less than 150,000 af*

Region L Baseline WAM assuming no effluent results:
Spring B&E inflow less than 150,000 af in 16 years, or
11 years more than desired under the STF goals

If years with the maximum shortfalls are excluded, a Supplemental Supply of 100,000 af could reduce the Spring shortfalls to the STF Goal of no more than 5 years in the period of record

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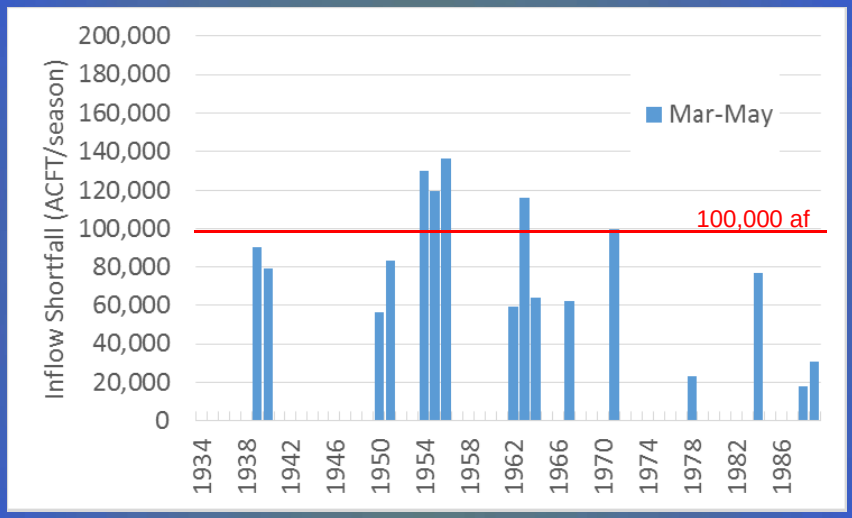
Spring Shortfalls



Modeled Shortfalls for Spring Freshwater Inflow Targets

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DETERMINATION OF VOLUMES AND TIMING OF FRESHWATER INFLOWS NEEDED TO MEET STRATEGY TARGET FREQUENCIES

Summer (July - Sept)

STF B&E Inflow Goal (for oysters) = 50,000 af:

STF Goal: ***In no more than 6% (3 years) of the 56 year period of record, should the Jul – Sep combined inflow be less than 50,000 af***

Region L Baseline WAM assuming no effluent results:
Summer B&E inflow less than 50,000 af in 9 years, or
6 years more than desired under the STF goals

A supplemental supply of 50,000 af could eliminate the summer shortfalls, exceeding the STF Goal of no more than 3 years in the period of record

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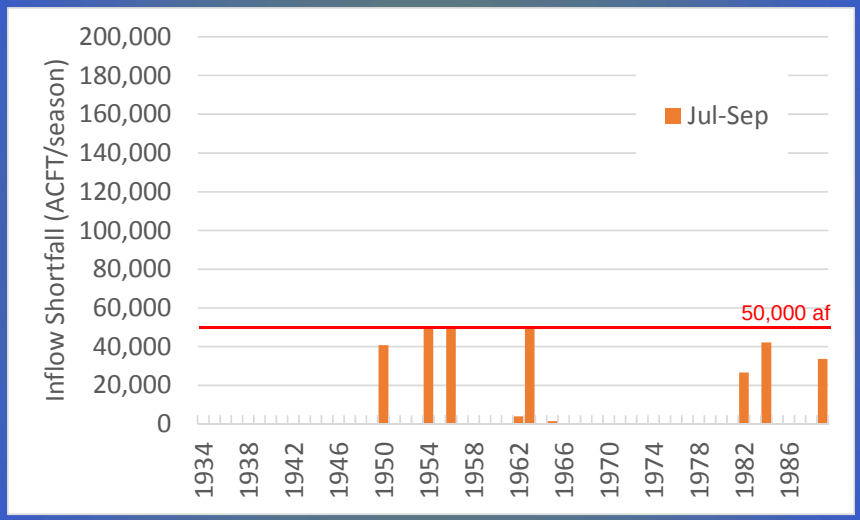
Summer Shortfalls



Modeled Shortfalls for Summer Freshwater Inflow Targets

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Identifying and Evaluating Strategies to Provide Additional Freshwater Inflows During Drought

Strategies for acquiring surface water to supplement B&E inflows evaluated in this study included:

- *Dedication of Wastewater Return Flow*
- "Dry Year" option on irrigation water rights*
- Purchase/conversion of "underutilized" existing water rights*
- *Applying for and obtaining a new (junior) water rights permit, and*
- *Using **Aquifer Storage and Recovery (ASR)** to bank surface water (obtained via the various methods mentioned above) for future managed releases to meet specific B&E STF targets*

* Strategies investigated previously in "*Report on Strategies to Meet Environmental Flow Standards*" by National Wildlife Federation, and "*WAM-Based Hydrologic Analyses of Strategies to Meet SB3 Environmental Flow Standards for the Guadalupe Estuary,*" by Intera. More recent information indicates most of these water rights are now more fully utilized and less available for dedication for environmental flow purposes, so they were therefore not included in the modeling analysis.

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Dedication of Wastewater Return Flows

Jurisdiction / Discharger	Existing Return Flows	Guadalupe	San Antonio	*63.2% Dedication*	Guadalupe	San Antonio
Victoria	6,603	6,603	0	4,171	4,171	0
New Braunfels	4,889	4,889	0	3,088	3,088	0
San Marcos	4,740	4,740	0	2,994	2,994	0
Seguin	3,088	3,088	0	1,950	1,950	0
San Antonio - Dos Rios	72,005	0	72,005	45,485	0	45,485
San Antonio - Leon Creek	29,242	0	29,242	18,472	0	18,472
San Antonio - Medio Cr.	7,645	0	7,645	4,829	0	4,829
SARA - Upr. Martinez	5,956	0	5,956	3,762	0	3,762
San Antonio, Breck. Park	4,250	0	4,250	2,685	0	2,685
Cibolo Crk. Mun. Auth. (Selma, Schertz)	4,042	0	4,042	2,553	0	2,553
TOTAL (10 largest*)	142,459	19,319	123,140	89,990	12,204	77,787
Channel Loss Factor		18.0%	31.1%		18.0%	31.1%
TOTAL to Estuary (SA) or Victoria (Guad.) after Channel Losses		15,836	84,827		10,004	53,585
* Total of all return flow in the Guadalupe and San Antonio Basins = 157,160						

Note: The study not only looked at the ten largest return flows, but also a range of return flows from zero to 100%, to estimate the likely impact upon the scale of ASR facilities required to achieve the STF goals.

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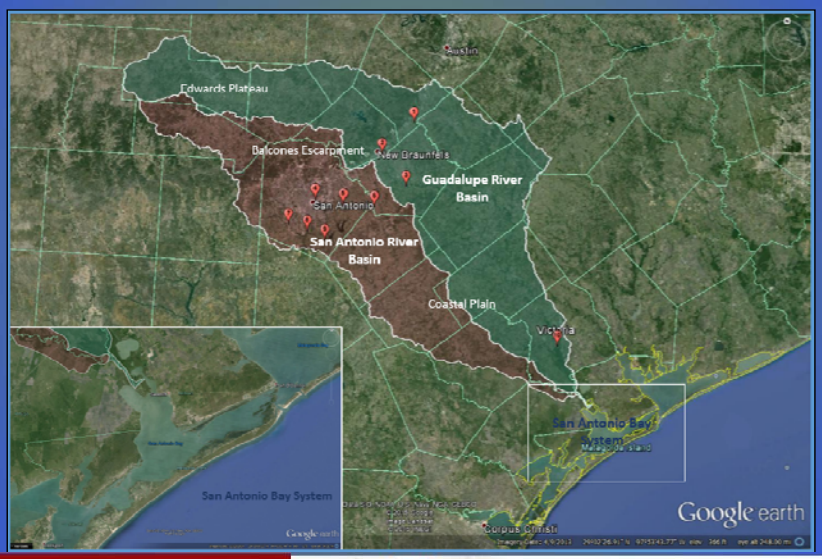
Map of San Antonio Bay System and Contributing Drainage Area, Showing Location of 10 Largest WWTP Discharge Points



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Identifying and Evaluating Strategies to Provide Additional Freshwater Inflows During Drought:
Aquifer Storage & Recovery (ASR)

ASR wells have been operating in the USA since 1969 and are utilized in many other countries to achieve a variety of goals.

Principal goals include:

- Achieving water supply sustainability and reliability through providing seasonal storage from wet months to dry months within a given year;
- Emergency storage for those systems reliant upon water sources that are vulnerable to interruption,
- Long-term storage, or "water banking," to meet demands with high reliability during severe droughts, and
- ***More recently: meeting environmental flow requirements by augmenting dry weather flows and maintaining lake levels.***

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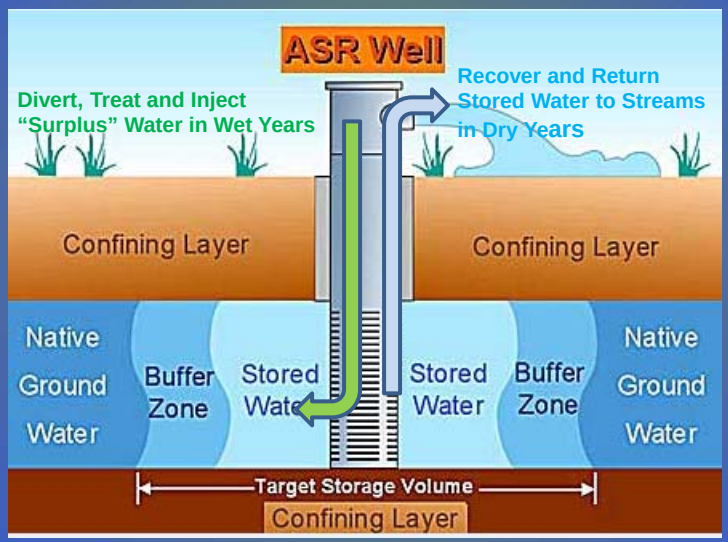
Identifying and Evaluating Strategies to Provide Additional Freshwater Inflows During Drought:
Aquifer Storage & Recovery (ASR)



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AQUIFER WATER BALANCE MODEL

Spreadsheet model using outputs from the WAM and FRAT programs, to determine how much water can be diverted from the river (subject to availability constraints including environmental flow requirements), stored in the aquifer, and then recovered from the aquifer in order to augment freshwater inflows during times when the standards would not otherwise be satisfied.

Parameters include
- aquifer capacity,
- initial volume,
- recharge rate (includes river diversion, treatment and injection), and
- aquifer recovery rate.

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Aquifer Water Balance Model

1) Assumes the aquifer starting storage is 100,000 ACFT on January 1, 1934.
2) Dedicated return flows are simulated first, then available unappropriated flows.
3) 15 day look-back window
4) Recovery operations
5) Recharge operations

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Map Indicating Location of Guadalupe River Water Rights Diversion Point (CP 15) and Combined Guadalupe and San Antonio Rivers Discharge Point into San Antonio Bay (CPEST)

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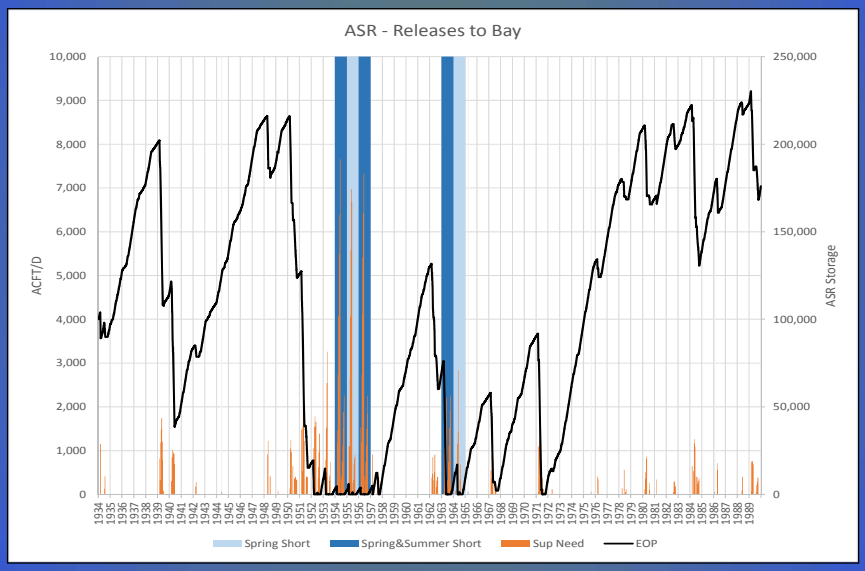
ASR Needed to Fully Satisfy STF Goals (5 Spring / 3 Summer Shortfalls)
Recharge Rate = 347 MGD Recovery Rate = 39MGD



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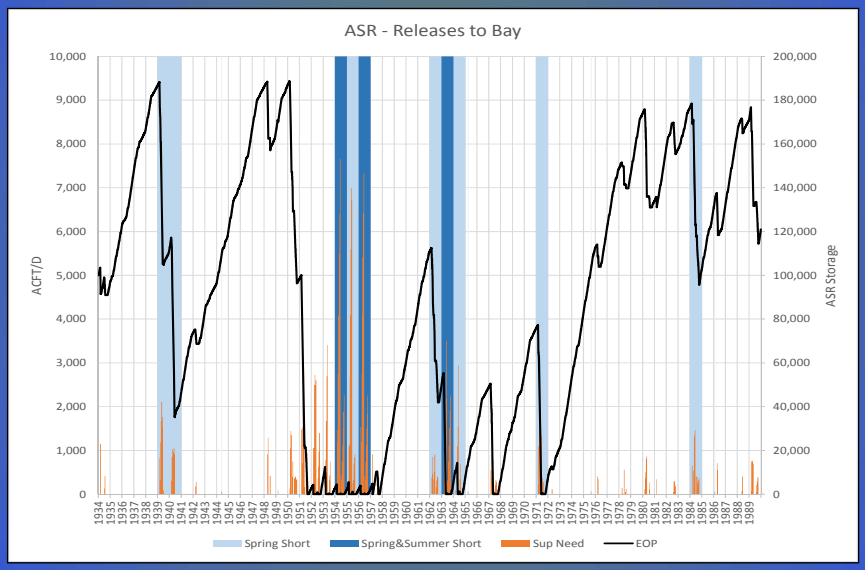
ASR Needed to Fully Satisfy Alternative Goals (10 Spring / 3 Summer Shortfalls)
Recharge Rate = 283 MGD Recovery Rate = 33 MGD



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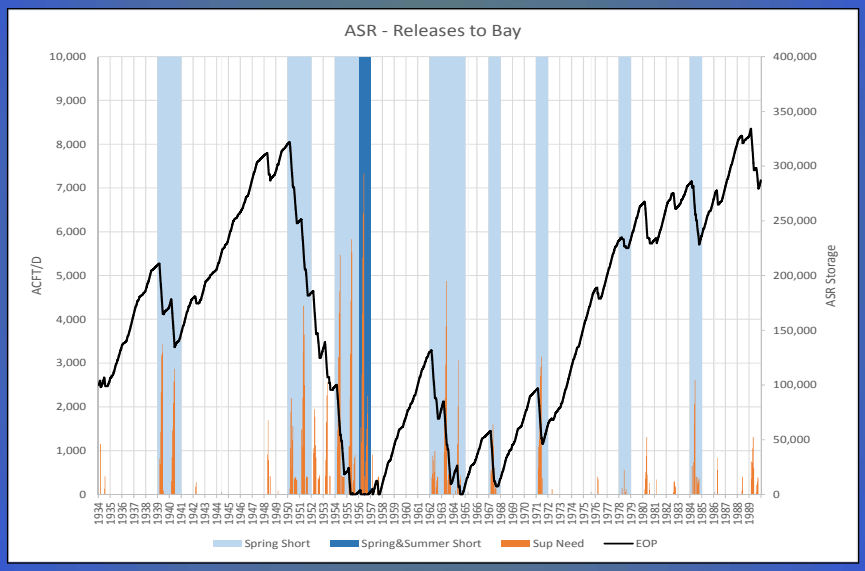
Benefits of Specifically Sized ASR (Recharge Rate = 142 MGD Recovery Rate = 33 MGD)
14 Spring / 1 Summer Shortfalls



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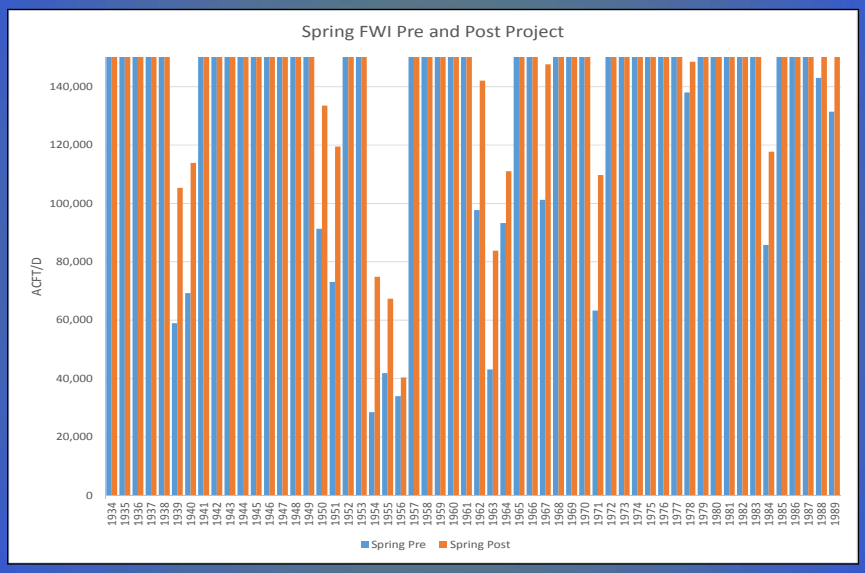
Benefits of Specifically Sized ASR
Reduction in the Magnitude of Shortfalls



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General Location of Proposed ASR Wellfields
25 Mile Reach, centered on Victoria, Texas

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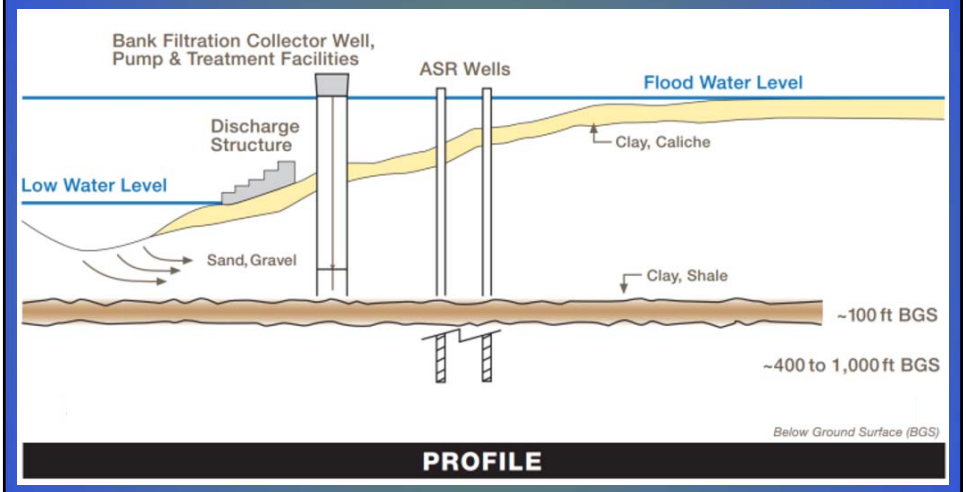
Proposed Wellfields near Victoria, Texas:
ASR Wellfield Conceptual Plan and Profile



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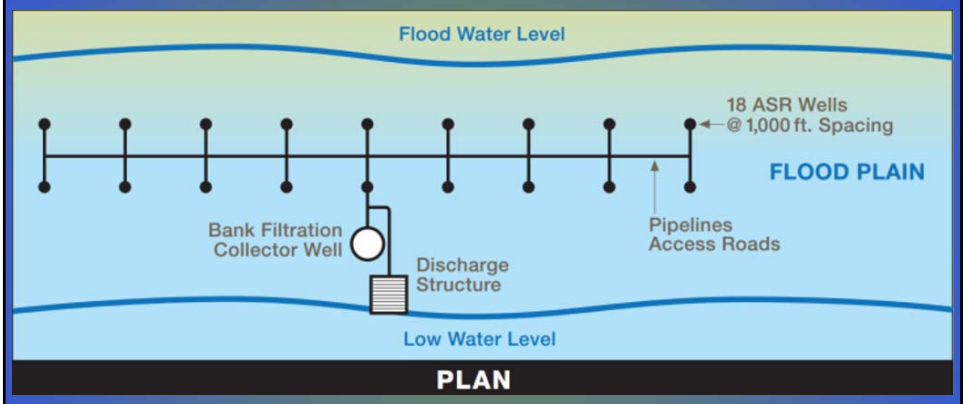
Proposed Wellfields near Victoria, Texas:
ASR Wellfield Conceptual Plan and Profile



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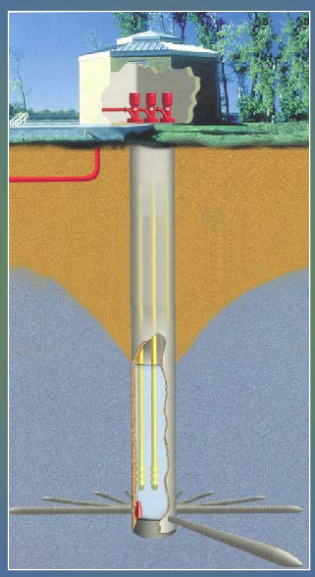
Proposed Wellfields near Victoria, Texas:
Typical Diagram for a Bank Filtration Collector Well



(Figure courtesy of Ranney Collector Wells – a Layne-Christensen Company)

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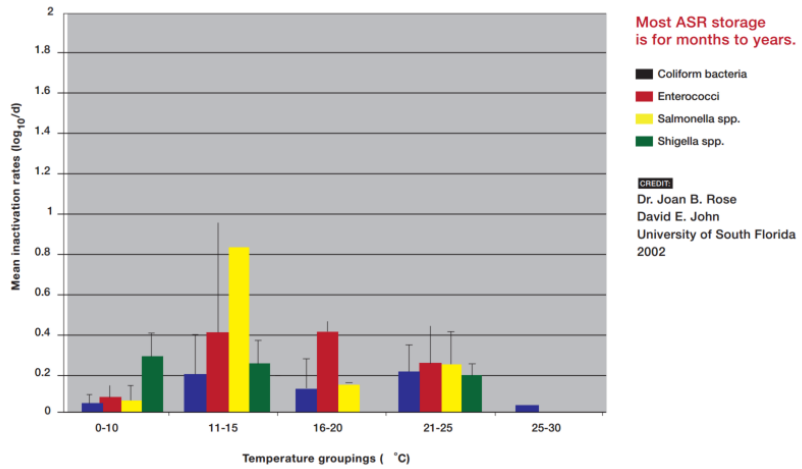
Proposed Wellfields near Victoria, Texas: Bank Filtration – Effectively Inactivates Bacteria



Most ASR storage is for months to years.

- Coliform bacteria
- Enterococci
- Salmonella spp.
- Shigella spp.

CREDIT:
Dr. Joan B. Rose
David E. John
University of South Florida
2002

Error bars reflect standard deviation of rate values observed in each temperatire group.

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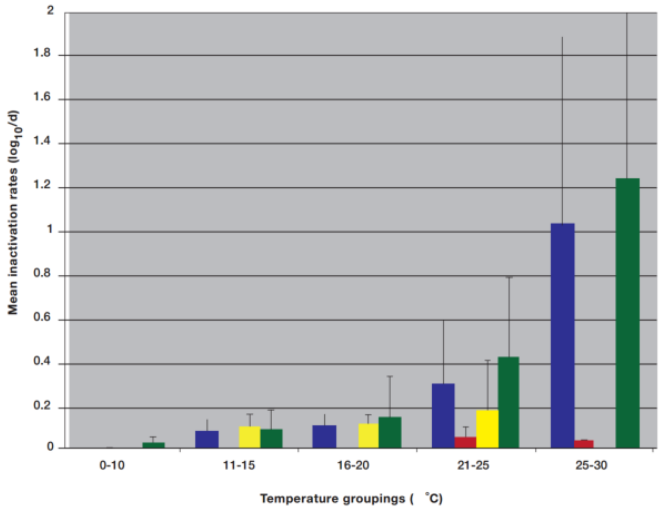
Proposed Wellfields near Victoria, Texas: Bank Filtration – Effectively Inactivates Viruses



- Poliovirus
- Hepatitis A
- Echovirus
- Coliphage

CREDIT:
Dr. Joan B. Rose
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University of South Florida
2002

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ASR Wellfield Implementation Plan:
Phased Wellfield Development

1. Surficial Aquifer Hydrogeologic Investigations
2. Evangeline Aquifer Hydrogeologic Investigations
3. Bank Filtration and ASR Well Demonstration Program
4. ASR Wellfield Feasibility Assessment and Conceptual Design Report
5. Water rights acquisition
6. Secure sites for wells and wellfield facilities
7. Design, construct and place into operation the first ASR wellfield cluster of 16 additional ASR wells, discharge structure and related facilities
8. Design, construct, place into operation and monitor performance for the remaining ASR wellfield facilities

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ASR Wellfield Implementation Plan:
Phased Wellfield Development

Implementation Plan, Phased Wellfield Development.	Capital Costs
1. Initial hydrogeologic investigations – Surficial Aquifer	$ 250,000
2. Initial hydogeologic investigations – Evangeline Aquifer	$ 250,000
3. Bank Filtration and ASR Demonstration Testing (One Bank Filtration Well; 2 ASR wells)	$ 12,000,000
4. ASR Feasibility Assessment, Draft and Final	$ 300,000
5. Water Rights Acquisition and Related Startup Costs	$ 2,000,000
6. Purchase or Lease Land for Wellfield Facilities	$ 4,000,000
7. Complete Initial well cluster, 16 ASR wells, 32 MGD	$ 35,200,000
8. Remaining 9 well clusters, including all facilities	
162 ASR wells, 324 MGD	$ 356,400,000
9 Bank Filtration wells	$ 54,000,000
Total	**$464,400,000**

* Note: Total cost for Items 1-7 (full development of the initial well cluster): $ 54,000,000

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ASR Wellfield Implementation Plan: *Phased Wellfield Development*

Operating Costs

Baseline operation costs would include those years when only recharge is occurring. A suggested reasonable estimate of annual average baseline operating costs is $5,000 per year per MGD of ASR recovery capacity, or about $10,000 per year per ASR well. This would be equivalent to $180,000 per year per well cluster. To this would need to be added the operating cost for a 5 MGD bank filtration well, 5-micron filtration and chlorination of the recharge flows. These are estimated to cost $200,000 per year. Total annual operating cost per well cluster is estimated at $380,000. This assumes no need for post-treatment other than aeration. Upon wellfield completion, the annual baseline operating cost is estimated at $3,800,000 for all ten well clusters.

During approximately 25% of the years ASR recovery will occur. Operating costs will be greater due to the need for electrical power for pumping water from the ASR wells to the river. A preliminary estimate of the per well electrical cost is $100/day, assuming a flow rate of 1,400 gpm and a pumping lift of 100 feet for discharge to the river. Depending upon the number of wells in operation, and the duration of the recovery period, the seasonal cost for a very dry spring season might be up to $1.4 million for 90 days of environmental flow augmentation. For most years in which ASR recovery occurs, the electrical power cost would be less than this.

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Conclusions

This study demonstrates, at a conceptual level, how the use of dedicated wastewater return flows and unappropriated water in the Guadalupe-San Antonio River Basin, in combination with the development of Aquifer Storage and Recovery facilities for managing the volume and timing of instream flows, could help realize recently adopted standards and goals for inflows to the San Antonio Bay estuarine system.

Additionally, this work holds promise for how freshwater flows in rivers and streams across Texas can be more effectively managed to achieve instream flow and estuary inflow targets.

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Recommendations

As promising as these potential strategies may appear based on this work, prior to embarking down the path towards implementation of these strategies, it would be prudent to undertake several additional technical studies, both "desktop" simulations and field tests, in order to:

1) provide a "reality check" on the actual impact the modeled addition of freshwater inflows would have on salinities in San Antonio Bay, and
2) verify some of the hydrogeologic assumptions regarding the potential aquifer recharge rates and water quality which could be achieved using bank filtration wells located in the alluvium of the Guadalupe River.

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Recommendations

These additional technical studies would involve:

1) Using the Texas Water Development Board's "TxBLEND," a two-dimensional hydrodynamic and salinity transport model developed and calibrated for San Antonio Bay (TWDB, 2015b), to look at salinity zonation throughout the bay system.
2) Determining more accurately the hydrogeologic properties of both the surficial portion of the alluvial aquifer adjacent to the Guadalupe River and the underlying Evangeline Aquifer along the river reach identified in this study as most likely suitable for the development of ASR wellfields. Soil borings, cores and water samples should be obtained to characterize the aquifer parameters for the surficial aquifer and a test well should be installed to simulate the effects of the proposed bank filtration wells and to collect water samples which can identify the source of the well's production – whether it is river water being drawn in as anticipated, or native groundwater, which would indicate no connection to the river has been established by the pumping.

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Recommendations

In order to obtain water for ASR recharge and facilitate the use of ASR for environmental flow management, several areas of Texas water law and policy could be changed to :

1) Encourage and facilitate the dedication of wastewater return flows for environmental flow needs,
2) Allow the granting of new non-consumptive water rights for currently available unappropriated flows (and amending existing non-consumptive permits) for the authorized purpose of instream flow and estuarine inflow protection, and
3) Promote the development of jointly sponsored, multi-purpose ASR facilities, particularly in conjunction with existing or proposed Off-Channel Reservoirs, in order to more effectively "drought proof" both M&I and environmental water supplies.

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Potential Funding Sources

Federal: RESTORE Act and more traditional federally funded environmental restoration programs

State: Specific Legislative appropriations

Regional/Local: New "user fee," similar to fee assessed to support the EAHCP, possibly administered through the South Texas Watermaster program

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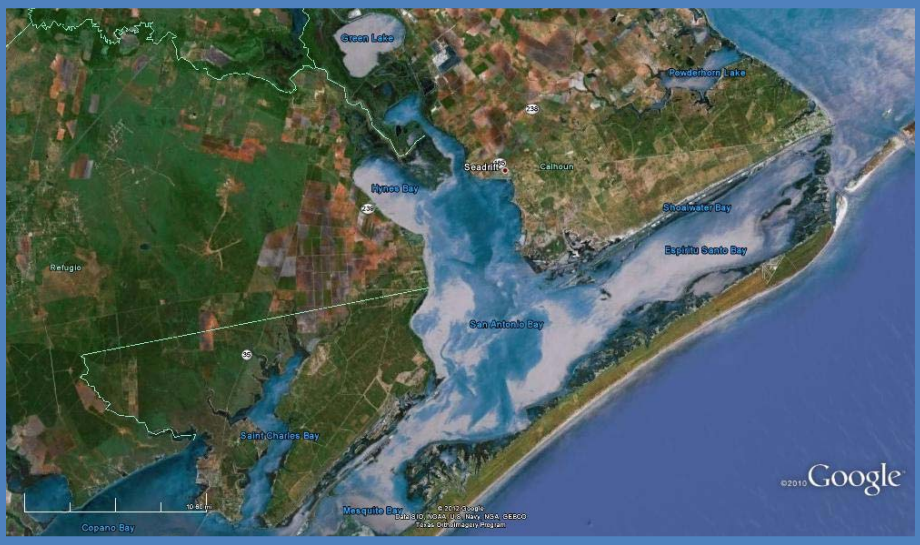
Questions?



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