Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Area Stakeholder Committee (BBASC)

Wednesday, September 30, 2015; 10:00 am
GBRA River Annex
905 Nolan Street, Seguin, TX

AGENDA

I. Introductions and Roll Call

II. Public Comment

III. Discussion and Agreement on Agenda

IV. Approval of Minutes

V. Discussion and Appropriate Action Regarding filling the Municipality Vacancy on Stakeholder Committee

VI. Discussion and Appropriation Action Regarding nominations for the Environmental Interests Vacancy on the Stakeholder Committee

VII. Briefings and Presentations from Science Teams awarded TWDB SB 3 Contracts
   c. Assessing the effects of freshwater inflows and other key drivers on the population dynamics of blue crab and white shrimp using a multivariate time-series modeling framework -- UTMSI
   d. Strategy Options for Meeting Attainment Frequencies for the Estuaries — San Antonio Bay Partnership
   e. Texas Instream Flow Program Studies — SARA, Bio-West Inc., Baylor University, Texas State University & Texas A&M University

VIII. TWDB Next Steps / Future Environmental Flow Studies

IX. Set Next Meeting Date, Time and Location

X. Agenda Items for Future Consideration

XI. Public Comment

XII. Adjourn
I. Introductions and Roll Call
II. Public Comment
III. Discussion and Agreement on Agenda
IV. Approval of Minutes

a. Friday, May 22, 2015
Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Area Stakeholder Committee (GSA BBASC) meeting

Friday, May 22, 2015; 10:30 am
Victoria County Community Center; 2905 E North St.
Victoria, TX 77901

MEETING MINUTES

Members Present
Suzanne Scott (Chair); Diane Wassernich (Vice-Chair); Bill Braden; Doris Cooksey; Milan Michalec; James Lee Murphy; Mike Peters; Jennifer Ellis; Jay Gray; Con Mims; James Dodson for Ken Dunton; Liz Smith for Chris Hale; Mike Mecke; Eddie Sidensticker for Mike Mecke; Jack Campbell; Tommy Hill for James Murphy; Jerry James; Steven Bereyso for Robert Puente; Thurman Clements; Julia Carillo for Roland Ruiz

Public Comment
No public comments were made at this time.

Discussion and Agreement on Agenda
A quorum was present at the meeting and all members agreed to accept the agenda as drafted.

Approval of Meeting Minutes
Members unanimously approved the November 21, 2013, April 11, 2014, and December 9, 2014, draft meeting minutes.

Action Regarding the Chemical Manufacturing Group Vacancy on Stakeholder Committee
Leslie Patterson, TCEQ, informed members that two nominations were received for the Chemical Manufacturing Interest Group vacancy, Brad Breeden and Lance Thomasson. A short background on each nominee was provided to members. Members voted 10 to 8 affirming Mr. Thomasson as the new representative for Chemical Manufacturing.

Discussion and Appropriation Action Regarding Soliciting Nominations for the Environmental Interests Vacancy on the Stakeholder Committee
Chair Suzanne Scott informed members that BBASC member, Tyson Broad, representing Environmental Interest Groups had resigned. Members present supported soliciting nominations from stakeholders, science committee members, and other entities prior to the next BBASC meeting.

Briefings and Presentations from Science Teams Awarded TWDB S.B. 3 Contracts
a) Rangia Clam Investigation in the Upper San Antonio Bay System – Marty Heaney, Bio-West and Dr. Bryan Black, University of Texas Marine Science Institute (UTMSI), in partnership with San Antonio River Authority (SARA), and National Wildlife Federation (NWF)
Mr. Heaney presented a summary of the status of *Rangia* clam investigations in the upper San Antonio Bay system. He stated that the goals of the project are to identify the location and extent of *Rangia* within the upper San Antonio Bay system as well as collect *Rangia* for subsequent growth increment analysis. Workshops held with stakeholders identified two locations, Mission Lake and the upper Guadalupe Bay, as likely to have *Rangia* beds. Side-scan sonar, bathymetry data, ground-thruthing, and biological collections were used to conduct investigations in the two identified areas. Preliminary data analyses and field collections supported the presence of *Rangia* in Mission Lake and upper Guadalupe Bay, with 20 dredge tows out of 80 at all sites resulting in collection of 41 live *Rangia*. In addition, 59 sites sampled contained evidence of deceased *Rangia*.

Dr. Black provided members an update on the status of cross-dating *Rangia* growth ring chronologies. He demonstrated how growth rings can be correlated to climate parameters such as temperature and river discharge. At present, preliminary analyses are ongoing of living and deceased *Rangia* from the Trinity, Sabine, and Mission Rivers. From the limited data analyzed, no age-specific differences between dead and live individuals from the Sabine watershed have been observed; however, in Mission Lake, dead specimens appear to have been much longer lived when compared to shells for collected live specimens. In addition, in an analysis of the shells of living specimens across basins, growth of *Rangia* appears correlated with river discharge such that lower flows equal slower growth. Dr. Black stated that in general wet and warm years equals stronger *Rangia* growth. Members inquired as to whether Dr. Black could determine at what point a dead *Rangia* died and if stitching of growth increments together would yield a more extensive chronology/climate history? Dr. Black informed members that while it is theoretically possible to overlay growth increments to make more comprehensive chronologies, using a short-lived species, such as *Rangia*, is problematic because it limits the ability to confidently overlap chronologies. He further explained that collection of longer-lived specimens or species would increase the robustness and reliability of cross-dating the growth increments. In addition, members asked whether additional areas will be searched and Dr. Black indicated that field investigations will continue further upriver, although time is limited. The next steps for the project team include finalizing the data analyses and submitting a draft report to TWDB with the final report due August 31, 2015.

b) Guadalupe – San Antonio River Delta Measurements and Modeling of Flows University of Texas – Dr. Ben Hodges and Dr. Paola Passalacqua, Center for Research in Water Resources (UT-CRWR)

Dr. Passalacqua provided an update to members concerning the status of hydrodynamic modeling of the Guadalupe Delta and Estuary system. The defined study area of the project is the region south of the Guadalupe, San Antonio River confluence to Mission Lake, more specifically the four bayous and HW 35 diversion canal within the Guadalupe Wildlife Management Area. Dr. Passalacqua identified the project’s objectives as to produce inundation maps to identify channel connectivity in the system, use field work to identify potential flow
restrictions and install sensors, and analyze the system using Frehdi modeling. To date she indicated that water feature classification and inundation maps have been completed as well as sensor deployment had commenced. Data retrieval is currently ongoing from the sensors, in addition to preparing bathymetry data for incorporation into the model. Dr. Hodges showed members a preliminary model run depicting how freshwater would flow through the system without the presence of the salt-water dam or other restrictions. He requested members provide feedback on the areas included in the model that could restrict water flow such as addition dams, barriers, etc. Members inquired whether the model included any information from the San Antonio River. Dr. Hodges indicated that the model looks at total flows at one USGS gaging station which reflects flow information below the confluence of the San Antonio and Guadalupe Rivers. He indicated the next steps for the project include retrieving the deployed sondes and additional model analysis, before submitting a draft report to TWDB. Post meeting, BBASC/BBEST members were invited to participate in a conference call to facilitate Dr. Hodges modeling efforts and provide feedback on modeling scenarios.

c) Texas Instream Flow Program Studies – Dr. Tim Bonner, Texas State University (TSU) in partnership with San Antonio River Authority (SARA), BioWest, Baylor University, and Texas A&M University

Dr. Bonner provided an overview of the funded Environmental Flows Validation study. The stated goals of the project are to enhance the understanding of flow-ecology relationships and develop a methodology for testing established flow standards, specifically high flow pulses. Dr. Bonner indicated twelve sites had been selected to analyze factors affecting aquatic and riparian communities, fish recruitment, and oxbow connectivity. He indicated that at least one sampling event had occurred for each of the 12 sites; however, the mussel component of the study had been postponed. Determination of relationships between flow tiers and aquatic and riparian species is ongoing, but preliminary analyses indicate some correlation with specific flow tiers. In addition, Dr. Bonner reported that 7 total floodplain lakes (5 on lower Guadalupe and 2 on lower San Antonio) had been sampled to evaluate oxbow connectivity and fish community composition. Current results show that per site species richness ranges for 2 to 32 species with the initial estimates of connection discharge range from 207 cfs to greater than 10,000 cfs. He further indicated that one additional sampling event is scheduled in early June. Lastly, Dr. Bonner informed members that the draft report is due to TWDB for review July 31, 2015, with the final report Due August 31, 2015. He also provided an outline of the team's report as specified in the TWDB contract.

d) Assessing the effects of freshwater inflows and other key drivers on the population dynamics of blue crab and white shrimp using a multivariate time-series modeling framework – Dr. Lindsay Scheef, Mission - Aransas National Estuarine Research Reserve (MANERR), University of Texas – Marine Science Institute (UTMSI)

Dr. Scheef presented on the status of the freshwater collaborative research project examining the population dynamics of blue crab and white shrimp. The deliverables of the project include
a comprehensive literature review and multivariate autoregressive (MAR) model. According to the study team’s timeline, the literature review is in the final stages of review. In addition, preliminary results for both blue crab and white shrimp models are supportive of known predator-prey dynamics and environmental variables that have been shown to affect the abundance of each species (i.e. blue crab populations are significantly negatively correlated with major predator populations such as red drum, black drum, and spotted sea trout as well as temperature at a lag of 0 years; while white shrimp populations are negatively correlated with salinity at a time lag of 0 years). Dr. Scheef indicated that because the variables were significant at a time step of 0 years that portioning the datasets further, such as by seasons, could provide more insight into the drivers of abundance for each species. Dr. Scheeff stated the next steps of the project include evaluating shorter time increments and adding additional data sets. A draft report is due to TWDB in June for review, with the final report due out August 31, 2015.

e) Strategy options for meeting attainment frequencies for the estuaries – James Dodson, San Antonio Bay Partnership (SABP) and Trungale Engineering & Science (TES)
Mr. Dodson, informed members of the progress to date on development of affordable, viable strategies to better manage water resources during droughts and meet freshwater inflow attainment frequencies for estuaries. The project’s approach is to identify voluntary strategy options to provide for estuary inflow needs and meet “Strategy Target Frequencies (STFs)” with a focus on the donation, purchase or lease of existing water right permit options and the use of Aquifer Storage and Recovery (ASR) to increase water available for environmental releases. He stated that a literature review on strategies had commenced as well as modeling and analysis of the volumes and timing of freshwater inflows needed to meet STFs. Preliminary modeling of the volumes and timings of freshwater inflows into the estuary suggests that supplemental supplies of 100,000 and 50,000 acre-feet in Spring and Summer, respectively could reduce or eliminate shortfalls to the goal STFs. Using the Region L WAM Baseline Run which includes effluent return flows Mr. Dobson evaluated the following three strategy options in the model: dedicated wastewater return flow, dry year option on irrigation water rights, and purchase/conversion of unused water rights which were all previously identified as strategies by the GSA BBASC. Mr. Dobson indicated that the final deliverables will include potential quantities of estuarine inflows necessary to achieve goal STFs and how those quantities can be generated by acquiring water rights and/or using ASR as well as cost estimates and steps to implement strategies. A draft report is due shortly to TWDB for review, with the final report due August 31, 2015. Members inquired as to whether joint projects between entities would affect strategy costs such as the Victoria 2018 project? Mr. Dobson indicated that joint projects would most likely lower the costs.
Next Steps / Future Environmental Flow Studies
Suzanne Scott suggested that contractors present their results to the BBASC upon completion of the studies in August/September 2015. Stakeholders present were supportive of this suggestion.

Nolan Ralphelt, TWDB, informed members that TWDB is seeking volunteers from the BBASC and BBEST groups to review the work plan funded project reports and handed out a guidance document outlining the reviewing process. He also stated that the focus of the review would be limited to within the context of the original scope of work (SOW), comments are expected to be submitted as one consolidated document in electronic format, and reviewers will have approximately a two week window to complete their review of the studies. Following discussion, stakeholders were in agreement to request volunteers to serve on a subcommittee to review the draft reports. Volunteers include Liz Smith, Debbie Magin, Greg Eckhardt, Sam Vaugh, and Tim Bonher. Additional BBEST members not present will be polled to provide them an opportunity to volunteer to review. In addition, once the final reports are submitted they will be posted on the TCEQ SB3 GSA basin website as well as distributed to all members.

In addition, Brian Mast, SARA, informed members that the TWDB had requested $2.0 million in legislative funding for the continued study of environmental flows and that no specific amounts were currently earmarked for any specific basins. He emphasized that the BBASC should consider moving forward with development of new SOWs for the next round of funding sooner rather than later.

Next Meeting Date, Time and Location
Members were in agreement to hold the next meeting this coming September in either Seguin or San Antonio. A poll will be sent out to determine the next meeting date.

Agenda Items for Future Consideration
- Action on Environmental Interest Vacancy
- SAWS Bed and Banks permit application and GBRA Reuse/Return Flows
- Membership Terms

Public Comment
James Dodson announced that a stakeholder group will be meeting to discuss strategy options for meeting attainment frequencies for the estuaries Thursday, June 4, 2015 at 2:30 p.m. in Victoria, TX.

Meeting Adjourned
V. Discussion and Appropriate Action Regarding Filling the Municipality Vacancy on Stakeholder Committee
VI. Discussion and Appropriation Action Regarding nominations for the Environmental Interests Vacancy on the Stakeholder Committee
Guadalupe, San Antonio, Mission and Aransas Rivers  
And Mission, Copano, Aransas, and San Antonio Bays  
Stakeholder Committee Member Nomination Form

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<tr>
<th>Nominee's contact information</th>
<th>Your contact details</th>
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</thead>
<tbody>
<tr>
<td><strong>Name:</strong> Jace Tunnell</td>
<td><strong>Name:</strong> Jennifer Ellis</td>
</tr>
<tr>
<td><strong>Address/City/State:</strong></td>
<td><strong>Address/City/State:</strong></td>
</tr>
<tr>
<td>Mission-Aransas National Estuarine Research</td>
<td>National Wildlife Federation</td>
</tr>
<tr>
<td>Reserve</td>
<td>44 East Ave, Suite 200</td>
</tr>
<tr>
<td>University of Texas at Austin Marine Science</td>
<td>Austin, TX 78701</td>
</tr>
<tr>
<td>Institute</td>
<td></td>
</tr>
<tr>
<td>750 Channel View Drive, Port Aransas, TX 78373</td>
<td></td>
</tr>
<tr>
<td><strong>Nominee's Basin of Residence:</strong> Nueces</td>
<td></td>
</tr>
<tr>
<td><strong>Title:</strong> Director, Mission-Aransas National</td>
<td><strong>Title:</strong> Sr. Project Coordinator,</td>
</tr>
<tr>
<td>Estuarine Research Reserve</td>
<td>Texas Living Waters Project</td>
</tr>
<tr>
<td><strong>Affiliation:</strong> Mission-Aransas National</td>
<td><strong>Affiliation:</strong> National Wildlife</td>
</tr>
<tr>
<td>Estuarine Research Reserve</td>
<td>Federation</td>
</tr>
<tr>
<td><strong>Phone:</strong> 361-749-3046</td>
<td><strong>Phone:</strong> 512-610-7756 (office), 512-</td>
</tr>
<tr>
<td><strong>Fax:</strong></td>
<td>468-5077 (cell)</td>
</tr>
<tr>
<td><strong>Email:</strong> <a href="mailto:Jace.Tunnell@austin.utexas.edu">Jace.Tunnell@austin.utexas.edu</a></td>
<td><strong>Fax:</strong> 512-476-9010</td>
</tr>
<tr>
<td></td>
<td><strong>Email:</strong> <a href="mailto:ellis@nwf.org">ellis@nwf.org</a></td>
</tr>
</tbody>
</table>

Is nominee willing to serve? Yes ☑  Don't know □

Identify interest group(s) nominee is recommended to represent (for full description of each interest group, see Texas Water Code, Section 11.02362):

- agricultural irrigation ☐
- free range livestock ☐
- concentrated animal feeding operation ☐
- recreational water users ☐
- municipalities ☐
- soil and water conservation districts ☐
- industrial refining ☐
- chemical manufacturing ☐
- electricity generation ☑
- production of paper products or timber ☐
- commercial fishermen ☐
- public interest groups ☐
- regional water planning groups ☐
- groundwater conservation districts ☐
- river authorities and others ☐
- environmental interests ☑

Please make a brief statement of the nominee's background and qualifications to represent the interest group:

Jace Tunnell is the Director of the Mission-Aransas National Estuarine Research Reserve (Reserve) at the University of Texas Marine Science Institute in Port Aransas, Texas. Before joining the Reserve, Jace was the Director for Research and Planning at the Coastal Bend Bays & Estuaries Program in Corpus Christi, Texas, where he had been working since 2006 focusing on large scale habitat restoration, freshwater inflows, water quality, and environmental planning initiatives. Prior to 2006 he was at the South Florida Water Management District in West Palm Beach, Florida, and leading the Isolated Wetlands Restoration Program in an overall effort to restore water quality flowing to the Everglades. Jace has numerous scientific publications on freshwater inflows and ecosystem services, and in spring 2015 published a book on archeological sites around the Coastal Bend region. Jace is currently a member of the Region N Water Planning Committee, member of the Nueces BBEST, and an alternate on the Nueces Estuary Advisory Council. He received a Bachelors of
Science degree in Vertebrate Biology and his Masters of Science in Marine Biology from Texas A&M University Corpus Christi.

Please submit your nominations by e-mail to Leslie.Patterson@TCEQ.Texas.gov
Guadalupe, San Antonio, Mission and Aransas Rivers
And Mission, Copano, Aransas, and San Antonio Bays
Stakeholder Committee Member Nomination Form

<table>
<thead>
<tr>
<th>Name: Ray Buck</th>
<th>Name: Mike Mecke</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address/City/State: UGRA; 125 Lehmann Drive, Suite 100; Kerrville, TX 78028</td>
<td>Address/City/State: 1701 Silver Saddle Dr Kerrville, TX 78028</td>
</tr>
<tr>
<td>Nominee’s Basin of Residence: Guadalupe</td>
<td></td>
</tr>
<tr>
<td>Title: General Manager</td>
<td>Title: Stakeholder</td>
</tr>
<tr>
<td>Affiliation: Upper Guadalupe River Authority</td>
<td>Affiliation: TX SWCD</td>
</tr>
<tr>
<td>Phone: 830-896-5445 Fax: 83-792-6763</td>
<td>Phone: 830.896.0805 Fax:</td>
</tr>
<tr>
<td>Email: <a href="mailto:rbuck@ugra.org">rbuck@ugra.org</a></td>
<td>Email:</td>
</tr>
</tbody>
</table>

Is nominee willing to serve? Yes ☒ Don’t know ☐

Identify interest group(s) nominee is recommended to represent (for full description of each interest group, see Texas Water Code, Section 11.02362):

- □ agricultural irrigation
- □ free range livestock
- □ concentrated animal feeding operation
- □ recreational water users
- □ municipalities
- □ soil and water conservation districts
- □ industrial refining
- □ chemical-manufacturing
- □ electricity generation
- □ production of paper products or timber
- □ commercial fishermen
- □ public interest groups
- □ regional water planning groups
- □ groundwater conservation districts
- □ river authorities and others
- □ environmental interests

Please make a brief statement of the nominee’s background and qualifications to represent the interest group:

Raymond L. Buck, Jr. is the current General Manager for the Upper Guadalupe River Authority (UGRA) where he has served since August 2005. Buck is a seasoned executive with a broad range of management and leadership experience in both the private and public sectors. Working more than 20 years in environmental and water resource management, Buck possesses significant experience relating to water rights, resources management, strategic planning, public relations, and negotiation. He is a former Board Director and Officer for the Texas Association of Groundwater Districts and currently serves as a Board Director for the Plateau Water Planning Group.
Please submit your nominations by e-mail to Leslie.Patterson@TCEQ.Texas.gov
VII. Briefings and Presentations from Science Teams awarded TWDB SB 3 Contracts

a. *Rangia* Clam Investigation in the Upper Guadalupe Bay System – SARA


c. Assessing the effects of freshwater inflows and other key drivers on the population dynamics of blue crab and white shrimp using a multivariate time-series modeling framework – UTMSI

d. Strategy Options for Meeting Attainment Frequencies for the Estuaries – San Antonio Bay Partnership

e. Texas Instream Flow Program Studies – SARA
Guadalupe Bayou Flow and Inundation Study

Final report to the BBASC

Richard Carothers, M.S.
Dr. Ben R. Hodges
Dr. Paola Passalacqua

Center for Research in Water Resources
University of Texas at Austin

September 30, 2015

Work accomplished

- Digital elevation model based on lidar data and detailed analyses.
- Inundation analysis using GIS tools.
- Field data collection for water levels, temperatures, and salinity.
- First stage of hydrodynamic modeling for connectivity in bayou.
Inundation Maps

Can be used to determine areas below any selected water height 1 and 2 ft above sea level shown.

Requires further analyses to evaluate connectivity between areas or to quantify areas at different water levels.

Digital Elevation Model

Calibration for hydrodynamic model was creating coarser grid that matches flow paths of finer grid.
Sensor names

Field Sensors Deployed

Deployments
March 18-20, 2015
May 20-22, 2015

Data recovery
May 20-22, 2015
Aug 19-20, 2015

Instrument recovery
Aug 19-20, 2015

Raw data – Water Level

Level [ft]

Day

- nHogS
- mGusS
- salDw
- CaN
- schN
- schS
- gGuardN
Hydrodynamic model results

Tracers to illustrate connectivity.

Initial tracers shown at right.

Flow rates tested:
- 140 cfs
- 280 cfs
- 560 cfs
- 1120 cfs
- 1680 cfs
- 2800 cfs
Limits of hydrodynamic model

Hydraulic representation of gates is not presently included – requires more data on sizes of openings and their installation.

Channels narrower than 15 m are widened, which affects the modeled flow rates.

Full calibration/validation not done (not part of contract).

Model does not include areas outside of lidar data, which includes substantial catchment flows.

Model is useful for qualitatively understanding connectivity – not for quantitatively predicting response.
Recommendations for future work

- Analyses of field data.
- Development of inundation maps at water surface elevations of interest to the BBASC.
- Addition of gate flow behavior to the hydrodynamic model.

Concluding points

- Major thrusts of projects accomplished.
- Field data not as extensive as originally planned due to logistics and weather (some funds returned to state).
- Hydrodynamic model is workable, but is close to the limits that can be accomplished without going to a supercomputer.
Acknowledgements

Funding provide by BBASC recommendations to TWDB.

We would like to thank numerous personnel within TWDB, GBRA.

Particular help with setting of the field work has been provided by:
Kevin Kriigel, TPWD
Dan Alonso, SABAY

salDiv = at diversion canal
salN = above diversion canal
salBar = at barrier
salS = below barrier
nHogS = upper Hog Bayou
35div = diversion canal at hwy 35
mGuadN = N on main stem
mGuadS = S on main stem
lGuadN = lower Guadalupe
sohN = N sensor on Schwings Bayou
schS = S sensor on Schwings Bayou
mmS = Mamie Bayou entrance
hogS = Hog Bayou entrance
goffS = Goff Bayou entrance
tc = planned, but not emplaced
GSA BBASC Study No. 5: Strategy Options for Meeting Attainment Frequencies for the Estuaries

James A. Dodson, San Antonio Bay Partnership
Joe Trungale, P.E., Trungale Engineering & Science
R. David C. Pyne, P.E., ASR Systems LLC

The Future of San Antonio Bay
The San Antonio Bay Partnership is Planning for It!

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.
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 "Regoogle\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).
DETERMINATION OF VOLUMES AND TIMING OF FRESHWATER INFLOWS NEEDED TO MEET STRATEGY TARGET FREQUENCIES

**Spring (March - May)**

**B&E Inflow Goal (for Rangita) = 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 I 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**

![Graph showing inflow shortfalls](chart)

- **Mar-May**

**Modeled Shortfalls for Spring Freshwater Inflow Targets**

Tringale Engineering & Science
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

Summer Shortfalls

Modeling Shortfalls for Summer Freshwater Inflow Targets
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 STP 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 SR3 Environmental Flow Standards for the Guadalupe River" by Inters. 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

<table>
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<th>Return Flow</th>
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<td>0</td>
<td>10,400</td>
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**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 STP goals.

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

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.
AQUIFIER 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

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 (CPESI)
ASR NEEDED TO FULLY SATISFY STF GOALS (5 Spring / 3 Summer Shortfalls)
RECHARGE RATE = 347 MGD  RECOVERY RATE = 39 MGD

ASR NEEDED TO FULLY SATISFY ALTERNATIVE GOALS (10 Spring / 3 Summer Shortfalls)
RECHARGE RATE = 283 MGD  RECOVERY RATE = 33 MGD
**Benefits of Specifically Sized ASR (Recharge Rate = 142 MGD Recovery Rate = 33 MGD)**

14 Spring / 1 Summer Shortfalls

---

**Benefits of Specifically Sized ASR**

Reduction in the Magnitude of Shortfalls

Spring PWI Pre and Post Project
Proposed Wellfields near Victoria, Texas:
ASR Wellfield Conceptual Plan and Profile

Proposed Wellfields near Victoria, Texas:
Typical Diagram for a Bank Filtration Collector Well
Proposed Wellfields near Victoria, Texas:
Bank Filtration – Effectively Inactivates Bacteria

Most ASR storage
is for months to years.

- Ochotren bacilli
- Enteroviruses
- Salmonella spp.
- Pathogens

Dr. Juan B. Rose
David E. Johns
University of South Florida
2002

Error bars reflect standard deviation of ratio
values observed in each temperature group.

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

Alphaviruses
- Hepatitis A
- Rotavirus
- Coxsackievirus

Dr. Juan B. Rose
David E. Johns
University of South Florida
2002
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

ASR WELLFIELD IMPLEMENTATION PLAN:
PHASED WELLFIELD DEVELOPMENT

<table>
<thead>
<tr>
<th>Implementation Plan, Phased Wellfield Development</th>
<th>Capital Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implementation Plan, Phased Wellfield Development:</td>
<td></td>
</tr>
<tr>
<td>1. Initial hydrogeologic investigations – Surficial Aquifer</td>
<td>$ 250,000</td>
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<tr>
<td>2. Initial hydrogeologic investigations – Evangeline Aquifer</td>
<td>$ 250,000</td>
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<tr>
<td>3. Bank Filtration and ASR Demonstration Testing</td>
<td>$ 12,000,000</td>
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<tr>
<td>(One Bank Filtration Well, 2 ASR wells)</td>
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</tr>
<tr>
<td>4. ASR Feasibility Assessment, Draft and Final</td>
<td>$ 300,000</td>
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<tr>
<td>5. Water Rights Acquisition and Related Startup Costs</td>
<td>$ 2,000,000</td>
</tr>
<tr>
<td>6. Purchase of Lands for Wellfield Facilities</td>
<td>$ 4,000,000</td>
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<tr>
<td>7. Complete Initial well cluster, 16 ASR wells, 32 MGD</td>
<td>$ 35,200,000</td>
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<tr>
<td>8. Remaining 9 well clusters, including all facilities</td>
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<tr>
<td>162 ASR wells, 324 MGD</td>
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<tr>
<td>9 Bank Filtration wells</td>
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<tr>
<td>Total</td>
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* Note: Total cost for Items 1-7 (full development of the Initial well cluster): $ 54,000,000
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. \[ \text{Total annual operating cost per well cluster} = \$500,000 \]  

This assumes no need for post-treatment other than aeration. Upon wellfield completion, the annual baseline operating cost is estimated at $3,900,000 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 $300/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 $3.4 million for 30 days of environmental flow augmentation. For most years in which ASR recovery occurs, the electrical power cost would be less than this.

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.
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.

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.
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.

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
Questions?
OVERVIEW

- Funded - Texas Water Development Board
- Project Team:
  - San Antonio River Authority
  - Texas State University - Department of Ecology
  - Baylor University - Environmental Science

- Coordination with SB3 Brazos River Project
OVERVIEW

• Project goals:
  • To enhance the understanding of flow-ecology relationships in the GSA basin
  • To initiate the process for developing a methodology for testing established flow standards
  • A key focus was how pulse flows affect the ecology of the river systems

OVERVIEW

• Project Development Science Workshops
  • July and October 2014
  • Hypothesis development and indicator selection
  • Site selection and methodologies
• Preliminary field work and observations
  • July through September 2014
• Environmental Flows Validation Project Study Methodologies Interim Report
  • Submitted to TWDB in November 2014
ECOLOGICAL COMPONENTS

- Aquatic
- Riparian
- Fish Recruitment
  - (Otoliths)
- Oxbow Connectivity

ENVIRONMENTAL FLOWS VALIDATION METHODOLOGY

- Two main objectives
  - To inform and refine validation methodologies with the goal of having a scientifically defensible approach for testing TCEQ environmental flow standards.
  - To provide the GSA BBASC with information on how application of these methodologies might validate or suggest refinement for existing TCEQ flow standards at select GSA basin sites.
SAMPLING ACTIVITIES AND RESULTS

AQUATICS

- Timothy Bonnor

PREDICTIONS

Flow Dependent Variable

Hydrograph

Time

High Flow Peaks

Substance: Base Flow, 2 per season, 1 per season, 1 per year, 1 per 2 years
<table>
<thead>
<tr>
<th>Basin</th>
<th>Season</th>
<th>Flow Tier</th>
<th>Science</th>
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<td>1/5Y</td>
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SUMMARY STATS

- 63 riffle habitats, 74 run habitats
- 51,000 macroinvertebrates
- 21,000 fishes

<table>
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<th>N</th>
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<tr>
<td>1 / season</td>
<td>12</td>
</tr>
<tr>
<td>1 / year</td>
<td>5</td>
</tr>
</tbody>
</table>
STATISTICAL METHODS

- Multivariate analyses (assess trends)
- Tested responses with a 3-factor ANOVA
  - Tier, Seasons, and Drainage
  - Site, habitat, species characterizations

Multivariate assessments (CCA) of macroinvertebrates and fishes

Parameter vs. Flow Tier And Discharge

Relative Abundance (%) Mollusk, Fishes

Flow Tier  Discharge (CFS)
CONCLUSIONS SO FAR...

- Among base, 2/season, 1/season, and 1/year events...
- Among 58 abiotic and biotic predictions tested...
  - ↑ Flow tiers  ↑ slackwater fishes
    - Opposite of predicted, but not too surprising
  - ↑ Flow tiers  ↓ N of darters
    - Opposite of predicted, surprising
  - "Failure to detect a difference doesn't mean a difference doesn't exist" - MORE LATER
SAMPLING ACTIVITIES AND RESULTS

RIPARIAN

- Jacquelyn Duke

RIPARIAN STUDY HYPOTHESES

Riparian responses to flow:

- **Seedlings**
  - Distributions correlate with TCEQ/BBEST flows
  - Distributions correlate with actual flows
  - Survival correlates with flows

- **Saplings**
  - Distributions correlate with TCEQ/BBEST flows
  - Distributions correlate with actual flows
  - Survival correlates with flows

- **Mature trees**
  - Distributions reflect TCEQ/BBEST flow coverage (80% or more)

- **Community**
  - Relative abundance reflects riparian dominance
  - Age distributions detect the effect of major anomalies in flow
HYPOXIC ZONE

- A - Low-flow conditions, little discharge to hypoxic zone

- B - Increased flow, expansion of hypoxic zone

Water stress is limiting factor to tree growth (Spurr and Barnes, 1980)

INDICATOR SPECIES

- Black Willow (Salix nigra)
  - Seed deposition early spring through summer

- Box Elder (Acer negundo)
  - Fall/overwinter

- Green Ash (Fraxinus pennsylvanica)
  - Spring and Fall/overwinter
SAMPLING EVENTS

- Summer 2014
  - Scouting, establishment, equipment installation, first counts taken, sapling collections, community characterization
- Fall 2014
  - Counts, download data, sapling collections, tree coring
- Winter 2014
  - Download data, map elevations
- Spring 2015
  - Counts, download data, tree coring, sapling collections
- Summer 2015
  - Counts, download data, community characterization, equipment removal

Goliad (San Antonio river at Goliad)

- 80% or more coverage - In green
- Elev  - Black willow  - Green ash

- Baseflow - 1.0m
- 1/Winter - 1.5m
- 1/Winter - 2.7m
- 3/Spring - 4.6m
- 2/Spring - 2.7m
- 1/Summer - 1.3m
- 1/Summer - 2.8m
- 2/Fall - 0.8m
- 1/Fall - 3.4m
- 2/Feb-April - 4.0m
- 2/July-Nov - 7.0m
- 1/yr (BEBEST) 7.0m
SUMMARY OF RESULTS

<table>
<thead>
<tr>
<th>Flow Tier</th>
<th>Number of All Species Covered* by</th>
<th>Number of Species at the Highest Elev Covered* by</th>
<th>Number That Occurred in 2014</th>
</tr>
</thead>
<tbody>
<tr>
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<td>3/Sp**</td>
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<td>2/Sp</td>
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<td>2/Jul-Nov**</td>
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<td>1/Yr</td>
<td>12/14</td>
<td>4/6</td>
<td>2/6</td>
</tr>
</tbody>
</table>

* Inundation of 80% or more of the species' distribution
** Galliation of large flow pulses
SAMPLING ACTIVITIES AND RESULTS

OXBOW CONNECTIVITY

- Brad Littrell
PRELIMINARY CONCLUSIONS

- **Aquatics**
  - Most aquatic hypotheses were "largely unsupported"
  - "Failure to detect a difference doesn't mean a difference doesn't exist"
  - More data needed
- **Riparian**
  - Excepting LSAR sites, larger pulses are generally needed to support the existing riparian communities
  - Timing also important
- **Oxbow Connectivity**
  - 6 of 7 sites tested were connected with existing TCEQ flow standards

ENVIRONMENTAL FLOWS
PROPOSED VALIDATION METHODOLOGY

- Standardized approach
- Incorporates multiple ecological components
- Agreed upon upfront – BBASC and TCEQ
- Simplified field and desktop activities
- Tiered approach
  - Tier I – Floodplain Connectivity
  - Tier II – Riparian Assessment
  - Tier III – Aquatic Assessment
  - Tier IV - ???
ENVIRONMENTAL FLOWS
PROPOSED VALIDATION METHODOLOGY

• POTENTIAL APPLICATION
  • Tier I and II can be conducted right now
    • Examples provided in Section 4.3
  • Tier III – premature to evaluate
  • Additional Tiers – to be developed via additional studies and expert workshops

ENVIRONMENTAL FLOWS
FUTURE RESEARCH AND MONITORING RECOMMENDATIONS - SECTION 5

• Applied Research
  • Each component with different focus
    • Aquatics – major emphasis
    • Riparian and Oxbows – more site specific as needed
    • New ecological components?
• Long-term Monitoring
  • Limited initiation for each component
• Expert Panel Workshops
  • To refine methodology
QUESTIONS / COMMENTS?

- Acknowledgements
- Landowners
- BBASC
- TWDB
- TPWD and TCEQ
- BBEST
- Volunteers
VIII. TWDB Next Steps / Future Environmental Flow Studies
IX. Set Next Meeting Date, Time and Location
X. Agenda Items for Future Consideration
XI. Public Comment
XII. Adjourn