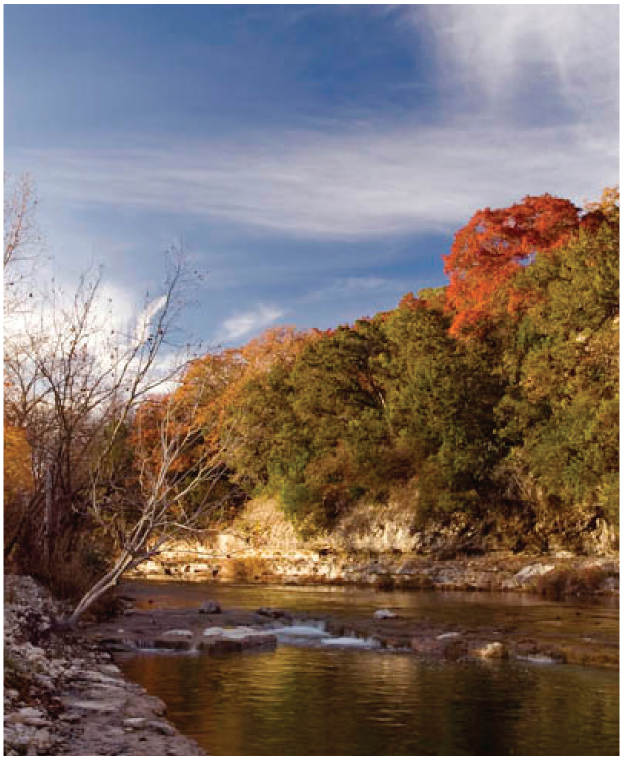
Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Area Stakeholders Committee Recommendations Report



September 1, 2011

Environmental Flows Standards and Strategies Recommendations Report

Prepared by

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

With Technical Support from

HDR Engineering, Inc.
BIO-WEST, Inc.
Kennedy Resource Company
and the
Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Expert Science Team (GSA BBEST)

With Administrative Support from

San Antonio River Authority
The Rozelle Group
Intrinsic Consulting

September 1, 2011

September 1, 2011

The Honorable Troy Fraser, Co-Presiding Officer
The Honorable Allan Ritter, Co-Presiding Officer
Environmental Flows Advisory Group (EFAG)

Mr. Mark R. Vickery, P.G.; Executive Director
Texas Commission on Environmental Quality (TCEQ)

Dear Chairman Fraser, Chairman Ritter, and Mr. Vickery:

It is with honor that we submit to you the Environmental Flows Standards and Strategies Recommendations Report from the Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Area Stakeholders Committee (GSA BBASC). Since its first meeting in December 2009, the GSA BBASC has met 29 times and committed countless hours toward its charge to produce the recommendations presented within this report.

The GSA BBASC, in reviewing its charge as outlined in Senate Bill 3 (SB3) of the 80th Texas Legislature, established the following purpose statement to further guide its work: "The purpose of GSA BBASC is to balance the environmental flow regime presented by the BBEST with water supply needs across stakeholder groups to reach consensus on recommendations to TCEQ for future flow requirements that will protect the ecology of the rivers and bays/estuaries. These recommendations, within the confines of SB3, will also offer standards and strategies to TCEQ."

We are pleased to report that most recommendations of the GSA BBASC were supported by consensus. The committee recognized that consensus does not necessarily mean unanimity, but members understood that by supporting consensus they weigh the combination of gains and trade-offs and then agree to support the decision. There were a few very difficult decision points where consensus could not be reached and votes were taken in accordance with our adopted meeting rules. A tabular record of these votes is included in our report. The formal Recommendations Report was approved for submittal to the TCEQ and the EFAG by a vote of 21 – 3. The expectation is that, during the rulemaking process, comments from the stakeholder interests will be submitted to the agency to further detail issues of concern.

We are proud of the accomplishments of the GSA BBASC. It is important to recognize that although the SB 3 Environmental Flows process is a significant and welcomed improvement in the State's process to establish Environmental Flow standards, the time constraints and gaps in available science and data were noted time and time again by GSA BBASC members as significant challenges during the committee's decision-making process. Water issues are complicated. Better science on the environmental needs of the rivers and bays as well as more complete data on water uses and water availability can only improve the reliability and the ultimate results of this process. To that end, the GSA BBASC members are dedicated to completing our next task, the development of the Work Plan.

The following Recommendations Report is complete; however, there are several sets of meeting minutes that have been drafted but not yet formally approved by the GSA BBASC. The group decided, at its final meeting prior to submitting the Recommendations Report, to omit the draft minutes from Appendix A and to forward them to TCEQ and EFAG once approved. Meeting minutes to be forwarded at a later date are for meetings which occurred on July 18, 19 and 28, and August 2, 3, 16 and 29.

Thank you for this opportunity to serve the State of Texas. We both make ourselves available to answer questions you may have on this report.

Respectfully Submitted,

Suzanne B Scott

Dianne H. Wassenich

Suzanne Scott	Dianne Wassenich
GSA BBASC Chair	GSA BBASC Vice-Chair

BBASC Final Votes on E-Flow Recommendations			
Streamgage and other Environmental Flow Recommendations	**Consensus**	**Vote to Suspend Consensus (for-against-abstain)**	**Supermajority Vote 75% of the entire voting membership (for-against-abstain)**
Guadalupe River @ Comfort	✓		
Guadalupe River near Spring Branch	✓		
Blanco River @ Wimberley	✓		
San Marcos River @ Luling	✓		
Plum Creek near Luling	✓		
Guadalupe River @ Gonzales w/ 10% dedication for bays & estuaries		22 - 0 - 0	19 - 3 - 0
Sandies Creek near Westhoff	✓		
Guadalupe River @ Cuero w/ 10% dedication for bays & estuaries		22 - 0 - 0	19 - 3 - 0
Guadalupe River @ Victoria w/ 10% dedication for bays & estuaries		22 - 0 - 0	19 - 3 - 0
Medina River @ Bandera	✓		
Medina River @ San Antonio River	✓		
San Antonio River near Elmendorf	✓		
San Antonio River near Falls City	✓		
Cibolo Creek near Falls City	✓		
San Antonio River @ Goliad	✓		
Mission River @ Refugio	✓		
GSA BBASC Pulse Exemption Rule	✓		
10% dedication to environmental flows for new appropriations greater than 200 acft/yr		22 - 0 - 0	19 - 3 - 0
Adopt GSA BBEST Bay & Estuary inflow volume recommendations		21 - 1 - 2	21 - 1 - 2
TCEQ evaluate permit applications via a modeling process as the BBEST recommended		24 - 0 - 0	21 - 1 - 2
TCEQ, through rulemaking, will form a consensus-based stakeholder advisory group to advise TCEQ on the 10% dedication regarding new appropriations		24 - 0 - 0	23 - 1 - 0
Adoption of GSA BBASC narrative regarding the Strategies Addressing Environmental Flow Standards		24 - 0 - 0	23 - 1 - 0
Data Tools Needed for Achieving Environmental Flow Standards	✓		
Strategy Options for Achieving Environmental Flow Standards	✓		
GSA BBASC recommends TCEQ provide a mechanism to allow 10% dedication to reach Guadalupe Estuary		24 - 0 - 0	22 - 2 - 0
GSA BBASC recommends additional support and funding for the TCEQ South Texas Watermaster Program		24 - 0 - 0	21 - 3 - 0
GSA BBASC recommends Web-based Technology be developed to Facilitate Compliance with Environmental Flow permit Conditions	✓		
Adoption of GSA BBASC Recommendation Report		24 - 0 - 0	21 - 3 - 0

ACKNOWLEDGEMENTS

The Stakeholders Committee wishes to acknowledge the contributions of many people and organizations that made the successful completion of the committee's task possible. First, and foremost, we wish to recognize the dedication and commitment of all committee members and alternates. The full committee met 29 times with additional commitments to conference calls and workgroup meetings. Many of the members not only contributed their valuable time and energy, but took uncompensated time away from work and absorbed their own travel costs, to complete this assigned task.

The Committee is especially grateful to the members of the Bay and Basin Expert Science Team for their diligent efforts in developing and presenting a set of comprehensive recommendations and in providing invaluable support to the committee throughout deliberations. The committee would like to thank the staff members of the Texas Commission on Environmental Quality; the Texas Parks and Wildlife Department; and the Texas Water Development Board for their significant assistance to the committee.

We owe much of our success to the support of our professional technical consultants, HDR Engineering, Inc. with support from BIO-WEST, Inc. and Kennedy Resource Company and our facilitators The Rozelle Group with support from Intrinsic Consulting. Recognizing that our committee had limited funding available, they agreed to provide their services at a reduced rate to make it affordable. We would also like to express our appreciation to the National Wildlife Federation and San Marcos River Foundation, in association with Intera Geosciences and Engineering, for funding and conducting preliminary evaluations of potential strategies.

The technical and facilitation support, which was instrumental in guiding the committee to a successful conclusion, was made possible due to the generosity of several members of the Committee and their organizations in voluntarily contributing funds to pay for their services. Contributions were provided by the City of Victoria, CPS Energy, Edwards Aquifer Authority, Guadalupe-Blanco River Authority, National Wildlife Federation, New Braunfels Utilities, San Antonio Water System, and San Antonio River Authority.

The Committee also benefited greatly from the willingness of organizations to host our meetings. The San Antonio Water System, Guadalupe-Blanco River Authority, Chisholm Trail Heritage Museum in Cuero, Texas, San Antonio River Authority, San Marcos River Foundation, New Braunfels Utilities, City of Victoria, City of Refugio, INVISTA, and others all graciously hosted our meetings. In addition, the committee thanks The National Wildlife Federation and the Cibolo Creek Nature Center for their participation in and invaluable assistance with the Committee tour of riparian zones on and near the Cibolo Creek Nature Center and Guadalupe Estuary.

The committee thanks Suzanne Scott as the Chair of the GSA BBASC and Dianne Wassenich as Vice-Chair. The committee benefited greatly from their dedication and leadership.

The Committee also wishes to acknowledge Mr. Brad Groves' contributions as a GSA BBASC member. Brad proudly served the Texas water community by lending his technical expertise, knowledge and passion for the protection of the state's natural resources on the GSA BBASC. His appointment to the GSA BBASC by the Texas Environmental Flows Advisory Group to represent Groundwater Conservation Districts was a testament to the value of his knowledge, insight and commitment to a public process aimed at achieving workable recommendations that

balance the water supply and environmental needs for water from the rivers, bay and estuaries in our basin. Brad served on the committee until his untimely passing in November 2010.

There were many others - too many to list here - who aided, including the citizens who attended the meetings, the Committee throughout the environmental flows recommendation process. Thank you to all who have participated in and assisted with the Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Area Stakeholders Committee.

Cover Photographs courtesy (clockwise from beginning with top left): Mission River photo by John W. Davis, Guadalupe River courtesy of Guadalupe-Blanco River Authority (GBRA), San Antonio Bay courtesy Guadalupe-San Antonio Basin and Bay Expert Science Team (GSA BBEST), and San Antonio River courtesy San Antonio River Authority (SARA)

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Appendices

(Electronic)

Appendix A – Approved Minutes of GSA BBASC Meetings

Appendix B – Science Advisory Committee Review and Comments Regarding the GSA BBEST Environmental Flows Recommendations Report

Appendix C – Texas Parks and Wildlife Department Staff Perspectives on the GSA BBEST Report and Supporting Documentation

Appendix D – Texas Instream Flows Program Interim Recommendations for the Lower San Antonio River

Appendix E – Summary Information from Simulations Made by GSA BBASC in Development of Recommendations Report

Appendix E1 – Hydrology and Instream Summary Information
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Appendix F – "Evaluation of Aquatic Habitat Relationships in the Guadalupe River at the Gonzales and Victoria Study Sites," Report by Dr. Thom Hardy

Appendix G – "Biological and Ecological Implications of Non-Attainment of the BBEST Guadalupe Estuary Criteria," Report by the GSA BBEST Estuary Sub-Committee

Appendix H – Report on Strategies to Meet Environmental Flow Standards by National Wildlife Federation

Appendix I – GSA BBEST Chair / Vice-Chair Response to GSA BBASC Member Written Questions Submitted to TCEQ

Appendix J – Technical Presentations Presented to the GSA BBASC Between March 1, 2011 and September 1, 2011

Common Abbreviations

acft	acre-feet
acft/yr	acre-feet per year
ASR	Aquifer Storage and Recovery
cfs	cubic feet per second
BBASC	Basin and Bay Area Stakeholders Committee
BBEST	Basin and Bay Expert Science Team
BMA	Bexar-Medina-Atascosa Counties Water Control and Improvement District #1
CCEFN	Consensus Criteria for Environmental Flow Needs
CCM	Comparative Cross-Section Methodology
CCMA	Cibolo Creek Municipal Authority
CPS	City Public Service
CRWA	Canyon Regional Water Authority
DFC	Desired Future Conditions
D&L	Domestic and Livestock
EAA	Edwards Aquifer Authority
EARIP	Edwards Aquifer Recovery Implementation Program
EFAG	Environmental Flows Advisoru Group
EQIP	Environmental Quality Incentives Program
FRAT	Flow Regime Application Tool
GBRA	Guadalupe-Blanco River Authority
GCD	Groundwater Conservation District
GAM	Groundwater Availability Model
GMA	Groundwater Management Area
GSA	Guadalupe–San Antonio
HCP	Habitat Conservation Plan
HEFR	Hydrology-based Environmental Flow Regime
kacft	thousand acre-feet
kacft/yr	thousand acre-feet per year
LSAR	Lower San Antonio River
MBP	Mid-Basin Project
NBU	New Braunfels Utilities
NWF	National Wildlife Federation
PHABSIM	Physical Habitat Simulation
SAC	Science Advisory Committee
SARA	San Antonio River Authority
SARP	San Antonio River Project
SAWS	San Antonio Water System
SB 2	Senate Bill 2
SB 3	Senate Bill 3
SCTRWP	South Central Texas Regional Water Plan
TCEQ	Texas Commission on Environmental Quality
TIFP	Texas Instream Flow Program
TPWD	Texas Parks and Wildlife Department
TWDB	Texas Water Development Board
UGRA	Upper Guadalupe River Authority
USGS	United States Geological Survey
WAM	Water Availability Model
WUA	Weighted Usable Area
Q95	Daily average flow rate exceeded 95 percent of the time
7Q2	Annual lowest mean discharge for seven consecutive days with a two-year recurrence interval

1.0 Preamble

1.1 Senate Bill 3 Environmental Flows Process

Senate Bill 3 (SB3) of the 80th Texas Legislature[1] established a process for the development and implementation of environmental flow standards applicable to new appropriations for surface water use in each of the major river basins and estuarine systems across the State of Texas. As summarized in Figure 1.1-1, this process began with selection of the Environmental Flows Advisory Group (EFAG). It reaches an interim conclusion for each river basin and associated estuarine system with Texas Commission on Environmental Quality's (TCEQ) adoption of rules implementing environmental flow standards. This Recommendations Report, which is the primary deliverable of the Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Area Stakeholders Committee (GSA BBASC), is one of the two recommendations reports that will inform TCEQ rule-making. After submittal of this report, the GSA BBASC will also prepare and submit a Work Plan.

1.1.1 Environmental Flows Advisory Group (EFAG)

The EFAG is comprised of nine members including three state Senators, three state Representatives, and three commissioners or board members respectively representing the TCEQ, Texas Parks and Wildlife Department (TPWD), and Texas Water Development Board (TWDB). Key responsibilities of the EFAG include appointment of the Basin and Bay Area Stakeholder Committees (BBASC) and Science Advisory Committee (SAC).

1.1.2 Science Advisory Committee (SAC)

The SAC is comprised of nine technical experts from diverse areas relevant to the evaluation of environmental flows that has provided documented guidance to both Bay and Basin Expert Science Teams (BBEST) and BBASCs since 2009. Guidance provided by the SAC regarding environmental flows has addressed geographic scope; use of hydrologic data; fluvial sediment transport (geomorphology); methodologies for establishing freshwater inflow regimes for estuaries; biological overlays; nutrient and water quality overlays; moving from flow regimes to flow standards; lessons learned from early BBESTs; work plans for adaptive management; methods for evaluating inter-relationships between environmental flow regimes and water supply projects; and consideration of attainment frequencies and hydrologic conditions. In accordance with the SB3 statute and in support of the EFAG, the SAC provides review and comments regarding BBEST environmental flows recommendations reports. SAC review and comments regarding the Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays BBEST (GSA BBEST) Environmental Flows Recommendations Report are included as Appendix B.

[1] http://www.capitol.state.tx.us/BillLookup/Text.aspx?LegSess=80R&Bill=SB3

1.1.3 Basin and Bay Area Stakeholders Committee (BBASC)

BBASC members are appointed by the EFAG and represent a broad base of stakeholder groups as defined in SB3. Pursuant to Section §11.02362(o) of the Texas Water Code, the initial charge of a BBASC is summarized as follows:

> *Each basin and bay area stakeholders committee shall review the environmental flow analyses and environmental flow regime recommendations submitted by the committee's basin and bay expert science team and shall consider them in conjunction with other factors, including the present and future needs for water for other uses related to water supply planning in the pertinent river basin and bay system. ………… The basin and bay area stakeholders committee shall develop recommendations regarding environmental flow standards and strategies to meet the environmental flow standards and submit those recommendations to the commission and to the advisory group in accordance with the applicable schedule specified by or established under Subsection (c), (d), or (e). In developing its recommendations, the basin and bay area stakeholders committee shall operate on a consensus basis to the maximum extent possible.*

Each BBASC appoints a BBEST charged with developing environmental flow analyses and recommended environmental flow regimes for river basin and bay systems based solely on the best science available and without regard to the needs for water for other uses. The BBASC is charged with balancing the BBEST flow recommendations with consideration for water supply needs such as water supply development, economic development, recreation, agriculture and other uses. In addition, BBASCs are charged with development of a work plan that addresses periodic review of environmental flow standards, prescribes necessary monitoring and studies, and establishes a schedule for continuing validation or refinement of environmental flow standards.

Detailed information regarding the GSA BBASC is presented in Section 1.2 of this report.

1.1.4 Basin and Bay Expert Science Team (BBEST)

As mentioned in Section 1.1.2, a BBEST is appointed by the BBASC for each basin and bay area and is initially charged as follows (emphasis added):

> *Each basin and bay expert science team shall develop <u>environmental flow analyses</u> and a recommended <u>environmental flow regime</u> for the river basin and bay system for which the team is established through a collaborative process designed to achieve a consensus. In developing the analyses and recommendations, the science team must consider all reasonably available science, without regard to the need for the water for other uses, and the science team's recommendations must be based solely on the best science available.*

SB3 of the 80th Texas Legislature offers the following definitions pertinent to the BBEST initial charge (emphasis added):

> *"<u>Environmental flow analysis</u>" means the application of a scientifically derived process for predicting the response of an ecosystem to changes in instream flows or freshwater inflows.*

"Environmental flow regime" means a schedule of flow quantities that reflects seasonal and yearly fluctuations that typically would vary geographically, by specific location in a watershed, and that are shown to be adequate to support a sound ecological environment and to maintain the productivity, extent, and persistence of key aquatic habitats in and along the affected water bodies.

Each BBEST is also charged with providing assistance to the pertinent BBASC as the BBASC prepares its environmental flows recommendations report and Work Plan.

The GSA BBEST is comprised of 11 members appointed by the GSA BBASC. From its first meeting on April 7, 2010, through timely submittal of its environmental flows recommendations report on March 1, 2011, the GSA BBEST was represented by at least one member at each meeting of the GSA BBASC. The GSA BBEST supported the GSA BBASC by providing "robust interaction with the stakeholders as they undertake development of recommended Standards and Strategies."

1.1.5 Texas Commission on Environmental Quality (TCEQ)

With due consideration of all relevant information available, including BBASC and BBEST recommendations, the TCEQ will adopt environmental flow standards for each river basin and bay system through an established, public rule-making process.

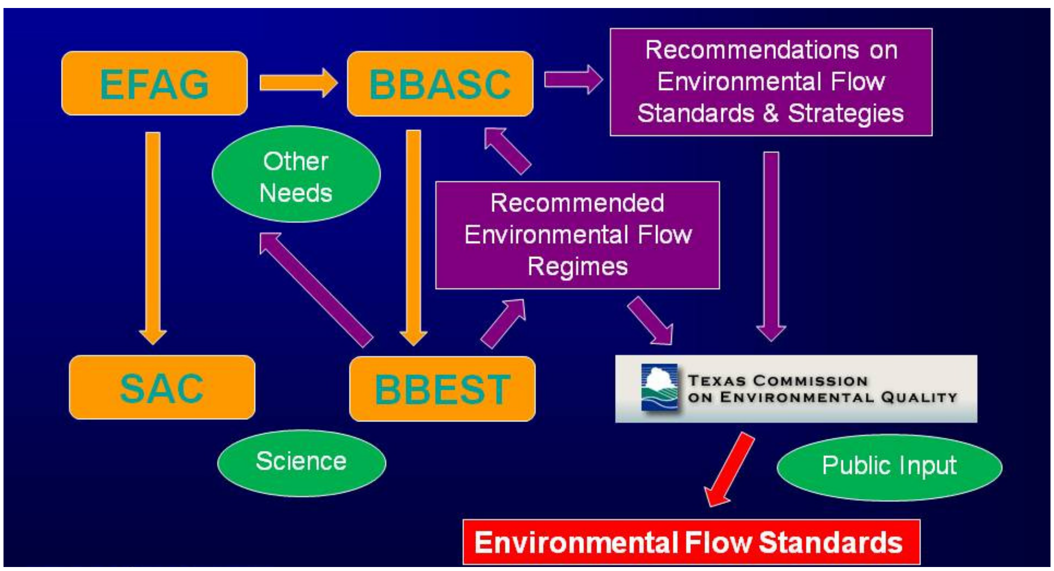

Figure 1.1-1. SB3 Environmental Flows Process

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

The GSA BBASC reflects interest groups concerned with particular river basins and bay systems. Interest groups represented on GSA BBASC include: agricultural irrigation, free range livestock, and concentrated animal feeding operations), recreational water users, municipalities, soil and water conservation districts, refining industry, chemical manufacturing, electric generation, commercial fishing, public interests, regional water planning, groundwater conservation districts, river authorities, and environmental interests.

The GSA BBASC facilitated the nomination of members to the GSA BBEST; reviewed the credentials of the nominated science team members; and finalized the appointment of the GSA BBEST by March 2010.

1.2.1 GSA BBASC Membership and Meetings

The GSA BBASC is comprised of 25 members, representing 15 interest groups concerned with the Guadalupe–San Antonio River Basin, San Antonio–Nueces Coastal Basin, and the Mission, Aransas, Copano, and San Antonio Bays. Active membership of the GSA BBASC at the time of the completion of this report is listed below in Table 1.2-1.

Table 1.2-1. Membership of the GSA BBASC

BBASC Member	Interest Group	Alternate(s)
Suzanne Scott (Chair)	River Authority	Steve Graham, Steve Raabe
Dianne Wassenich (Vice-Chair)	Public Interest	Tom Wassenich
Bill Braden	Agricultural Irrigation	Bob McCan, Dick Fritz
Tyson Broad	Environmental	Myron Hess
Jack Campbell	Commercial Fishermen	Nicole Davis
Thurman S. Clements Jr.	Groundwater Conservation District	Tim Andruss
David Crow	Free-Range Livestock	Bob McCan, Jay Gray
Paula DiFonzo	Municipality	Roger Biggers
Karl Dreher	Groundwater Conservation District	Rick Illgner
Ken Dunton	Environmental	James Dodson
Jennifer Ellis	Recreational Water User	
Garrett Engelking	Public Interest	Elizabeth Smith
Stephen Fotiades	Chemical Manufacturing	
Jay Gray	Concentrated Animal Feeding Operation	Josh Gray
Chris Hale	Public Interest	
Jerry James	Municipality	Gary Middleton
Everett Johnson	Recreational Water User	Dr. Earl Matthews, Dick Fritz
Mike Mecke	Soil & Water Conservation District	Eddie Seidensticker
Con Mims	Regional Water Planning Group	Steve Raabe
James Lee Murphy	River Authority	Tommy Hill
Mike Peters	Refining	Brad Bredesen
Robert Puente	Municipality	Steve Clouse, Hope Wells
Kimberly Stoker	Electric Generation	Doris Cooksey
Walter Womack	Regional Water Planning Group	
Jennifer Youngblood*	Groundwater Conservation District	Micah Voulgaris

** The stakeholders committee wishes to acknowledge Mr. Brad Groves' contributions as a GSA BBASC member*

Since its first meeting on December 15, 2009[2], the GSA BBASC has met a total of 29 times and worked with great determination to accomplish the tasks with which it is charged. Many members have taken time away from their jobs to attend stakeholder meetings and have not been reimbursed for their travel expenses. It should also be noted there was an excellent attendance record throughout the year-and-a-half of stakeholder meetings. The GSA BBASC spent March 2010 through November 2010, while the GSA BBEST was producing its report, becoming

[2] Approved minutes from all GSA BBASC Meetings through June 1, 2011 can be found in Appendix A

familiar with the environmental and water supply needs of the bay and basin area. The presentations provided to the GSA BBASC are listed below:

Topics presented to the GSA BBASC:

March 1, 2010

- Overview of Water in the San Antonio Area – Steve Clouse, SAWS

April 7, 2010

- Update on the Texas Instream Flow Program – TCEQ, TPWD, TWDB
- Previous BBEST Experience, Sabine-Neches – Sam Vaugh

May 2010

- Regions L and N regional water plans including analyses of cumulative effects on the environment of the plans – Brian Perkins, HDR Engineering
- Chemical Industry Water Usage – Dale Duhon, INVISTA
- Electrical Generation Water Usage – Sam Helmle, CPS Energy
- Bay and Estuary Presentation – Norman Boyd, TPWD

June 2, 2010

- Overview of Estuaries – George Ward, University of Texas
- Water 101: Review of basic water quantity and quality terminology – Brian Perkins, HDR Engineering
- Follow-up on Region L and N Water Plans – Brian Perkins, HDR Engineering
- South Texas Watermaster operations – Albert Garces, TCEQ

July 7, 2010

- Water Resources of the Guadalupe-San Antonio River Basin – Tommy Hill, GBRA and Steve Raabe, SARA
- Water Resources of the Upper Guadalupe River Basin – Ray Buck, UGRA
- Region J Initially Prepared Plan – Jonathon Letz, Region J
- Groundwater-Surface Water Interaction Studies in the Guadalupe-San Antonio River Basin – Darwin Ockerman, USGS
- Hydrology-based Environmental Flow Regime (HEFR) – Dan Opdyke, TPWD

August 4, 2010

- Municipal Water Use
  - San Antonio Water System – Steve Clouse
  - City of San Marcos – Tom Taggart
  - New Braunfels Utilities – Roger Biggers

  - GBRA Mid-Basin – GBRA
  - GBRA Lower Basin – GBRA
- Guadalupe River Operations 101 – GBRA
- Follow-up Questions regarding Upper Guadalupe presentations – Tara Bushnoe, UGRA

September 1, 2010

- State Methodology for Estimating Bay and Estuary Inflow – Cindy Loeffler, TPWD
- Coastal Activities – Rhonda Cummins, Calhoun County Marine Extension Agent
- Municipal Water Usage
  - City of Victoria – Jerry James
- Mission-Aransas Rivers – Liz Smith, Texas A&M-Corpus Christi
- Mission-Aransas National Estuarine Research Reserve – Ed Buskey, University of Texas Marine Science Institute
- San Antonio Bay Partnership – James Dodson
- Coastal Bend Bays and Estuaries Program – Ray Allen, Executive Director

October 6, 2010

- Edwards Aquifer Recovery Implementation Program – Robert Gulley, Program Manager
- Texas Instream Flow Program Lower San Antonio River Study – Ed Oborny
- Guadalupe-Blanco River Trust – Janae' Reneaud, Executive Director
- Medina River
  - Bandera County River Authority and Groundwater District - David Jeffrey, General Manager
  - Bexar-Medina-Atascosa WCID #1 – Will Carter, Board President and Ed Berger, Business Manager
- Municipal Water Usage
  - Bexar Metropolitan Water District – Humberto Ramos

November 3, 2010

- Science Advisory Committee (SAC) Resource Document "Lessons Learned From Initial SB3 BBEST Activities" – Bob Huston, Science Advisory Committee
- SAC Resource Document "Moving From Instream Flow Regime Matrix Development to Environmental Flow Standard Recommendations" – Bob Huston, Science Advisory Committee

As a result of monthly meetings of the full GSA BBASC, focused subcommittee efforts, supplemental meetings since March 2011 and the individual and collective efforts of members, the GSA BBASC is pleased to submit this report summarizing our recommendations regarding environmental flow standards and strategies to meet them.

1.2.2 Technical and Facilitation Consultants

The GSA BBASC in anticipation of the publication of the March 1, 2011 GSA BBEST Recommendation Report, chose to seek technical and facilitation support. The GSA BBASC recognized that in addition to the GSA BBEST members' technical expertise, they would benefit from hiring a technical consultant to complete additional modeling runs and professional facilitators to assist in reaching consensus-based decisions. The GSA BBASC asked the San Antonio River Authority (SARA) to act as the contracting agent in issuing the technical and facilitation Request for Proposals (RFP). As the RFPs were drafted, the GSA BBASC appointed a subcommittee that was responsible for reviewing the RFP solicitation, score received proposals, conduct interviews as necessary, and ultimately make hiring recommendations to the full GSA BBASC.

The scope of work for the prospective technical consultants was presented as an iterative process requiring multiple model runs to determine the impacts of GSA BBEST environmental flow recommendations on water projects and water projects' potential impacts on the health of the rivers' and bays' ecology. The technical consultant scope of work included:

- analyzing the potential impact of full implementation of the GSA BBEST recommendations on large-scale water supply project firm yields;
- analysis of the availability of new run-of-river surface water permits for municipal, industrial, steam-electric power generation, and/or agricultural uses up to 10,000 acre-feet per year (10 kacft/yr);
- additional modeling of potential GSA BBASC environmental flow standards that were being considered;
- assistance with the development of the GSA BBASC Work Plan especially summarizing stakeholder-identified areas of concern;
- participation in GSA BBASC meetings; and
- drafting of the Recommendation Report due on September 1, 2011.

The scope of work for prospective facilitator consultants specifically sought to identify an individual or team with experience in facilitating consensus-based decision-making processes involving large stakeholder groups engaged in complex technical and scientific issues. The scope of work also included:

- assisting the GSA BBASC in clearly identifying its goals;
- participating in the evaluation of the GSA BBEST recommendations with an eye towards successfully navigating any disputes or conflicts that may arise in the future;
- development of a decision process schedule;
- facilitation of six to eight meetings; and
- organizing all meeting preparatory and follow-up work to ensure the consensus-based decision-making process moved forward efficiently.

The technical and facilitation RFPs were issued on January 24, 2011 with all proposals due by 12:00 noon Central Standard Time on February 7, 2011. Three technical consultant firms submitted bids for the GSA BBASC subcommittee to consider and five facilitation firms or individuals submitted proposals as well. A GSA BBASC subcommittee scored the bid proposals, conducted interviews and, ultimately, made a recommendation to the full GSA BBASC. Following this process, the GSA BBASC hired HDR Engineering, Inc. team as the technical consultant and The Rozelle Group team as the facilitation consultant.

1.3 Introduction

The Recommendations Report of the GSA BBASC is comprised of six major sections, plus supporting appendices. Section 1 provides a general overview of the SB3 environmental flows process. Section 2 describes the resources of interest throughout the region. Information and technical analyses relevant to development of the GSA BBASC recommendations are summarized in Section 3. GSA BBASC recommendations regarding environmental flow standards are provided in Section 4. GSA BBASC recommendations regarding strategies to meet environmental flow standards are summarized in Section 5. Status of the Work Plan at the time of this report is briefly discussed in Section 6.

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2.0 Resources of Interest within the Basin and Bay Area

Resources of interest within the Guadalupe–San Antonio River Basin, the San Antonio–Nueces Coastal Basin and the associated bays and estuaries are multitude and perhaps best summarized in documents readily available on the internet including, but not limited to, the following:

a. 2011 South Central Texas, Plateau, and Coastal Bend area regional water plans[3];
b. Annual reports under the Texas Clean Rivers Program[4];
c. Texas Commission on Environmental Quality assessments of water availability[5];
d. Texas Parks and Wildlife Department data regarding stream segments they have identified as ecologically significant[6];
e. Freshwater Inflows to Texas Bays and Estuaries[7]; and
f. Environmental Flows Recommendations Report of the GSA BBEST (Section 2)[8].

For convenient reference of readers and the GSA BBASC, the following sub-sections provide limited summary information regarding the relative magnitudes and geographical distributions of streamflows and freshwater inflows to bays and estuaries, surface water rights, and discharges of treated effluent affecting this basin and bay area. A map of the area is presented in Figure 2.0-1.

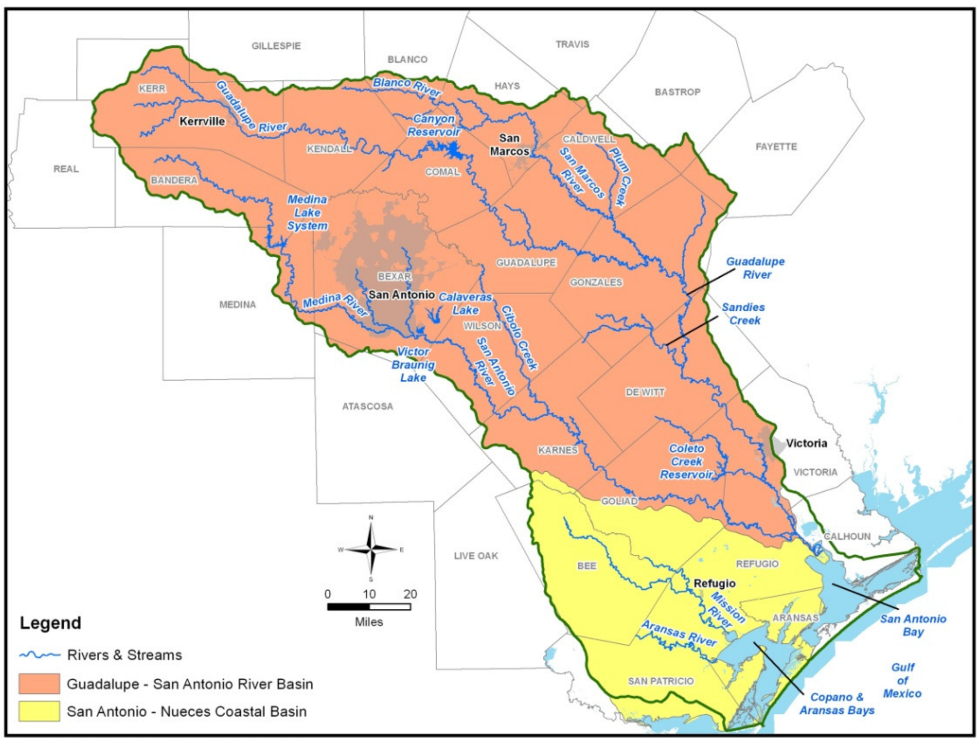

Figure 2.0-1. Location of the GSA BBASC Area

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3 http://www.twdb.state.tx.us/wrpi/rwp/3rdround/2011RWP.asp
4 http://www.tceq.texas.gov/waterquality/clean-rivers/index.html
5 http://www.tceq.texas.gov/permitting/water_supply/water_rights/wam.html
6 http://www.tpwd.state.tx.us/landwater/water/environconcerns/water_quality/sigsegs/
7 http://midgewater.twdb.state.tx.us/bays_estuaries/b_nEpage.html
8 http://www.tceq.state.tx.us/permitting/water_supply/water_rights/eflows/guadalupe-sanantonio-bbsc

2.1 Streamflow and Freshwater Inflow to Bays and Estuaries

The magnitudes of long-term average historical streamflows and freshwater inflows at locations throughout the Guadalupe–San Antonio River Basin and the San Antonio–Nueces Coastal Basin are shown numerically and as approximately scaled arrows in Figure 2.1-1. Observations of interest upon review of long-term average flows shown in Figure 2.1-1 include the following:

a. Contributions of Edwards Aquifer discharge at Comal Springs (213 kacft/yr) and streamflow (248 kacft/yr) to the Guadalupe River above the springs are comparable in Comal County.
b. Contributions of Edwards Aquifer discharge at San Marcos Springs (98 kacft/yr) and streamflow above the springs (95 kacft/yr) to the San Marcos River are comparable in Hays County.
c. Sources of freshwater inflows to San Antonio Bay may be approximately attributed as 64 percent from the Guadalupe River, 23 percent from the San Antonio River, and 13 percent from flows originating below Victoria and Goliad.
d. Sources of freshwater inflows to Copano and Aransas Bays may be approximately attributed as 19 percent from the Mission River and 81 percent from flows originating below Refugio.

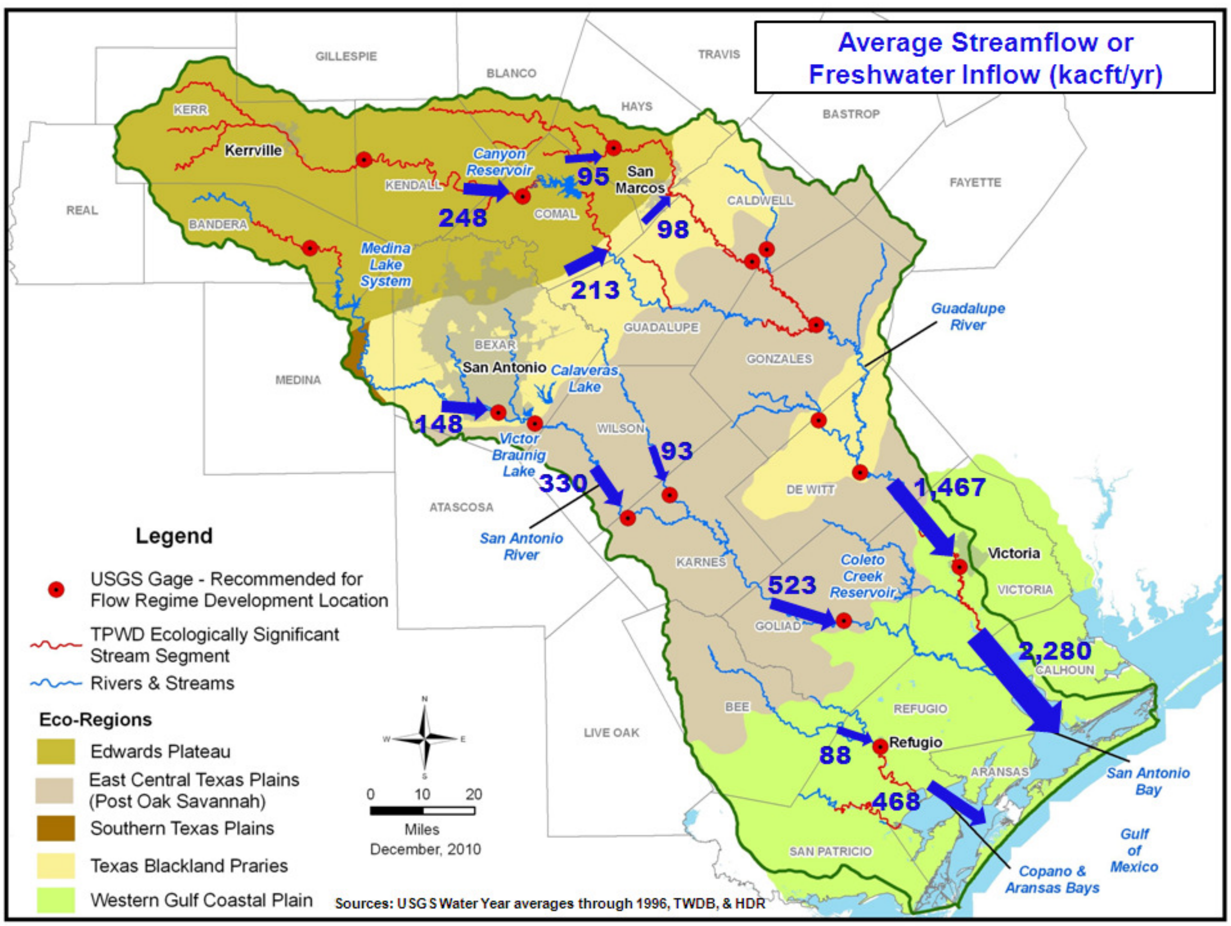

Figure 2.1-1. Average Streamflow or Freshwater Inflow

As flows are of particular importance for both water supply and environmental uses during severe drought, historical streamflows and freshwater inflows for calendar year 1956 are shown numerically and as approximately scaled arrows in Figure 2.1-2. Observations of interest upon review of 1956 flows shown in Figure 2.1-2 include the following:

a. Edwards Aquifer discharges from Comal Springs (28 kacft/yr) and San Marcos Springs (48 kacft/yr) represent a significant component of total flow in the Guadalupe River.
b. Sources of freshwater inflows to San Antonio Bay may be approximately attributed as 48 percent from the Guadalupe River, 46 percent from the San Antonio River, and 6 percent from flows originating below Victoria and Goliad.
c. Sources of freshwater inflows to Copano and Aransas Bays may be approximately attributed as 27 percent from the Mission River and 73 percent from flows originating below Refugio.

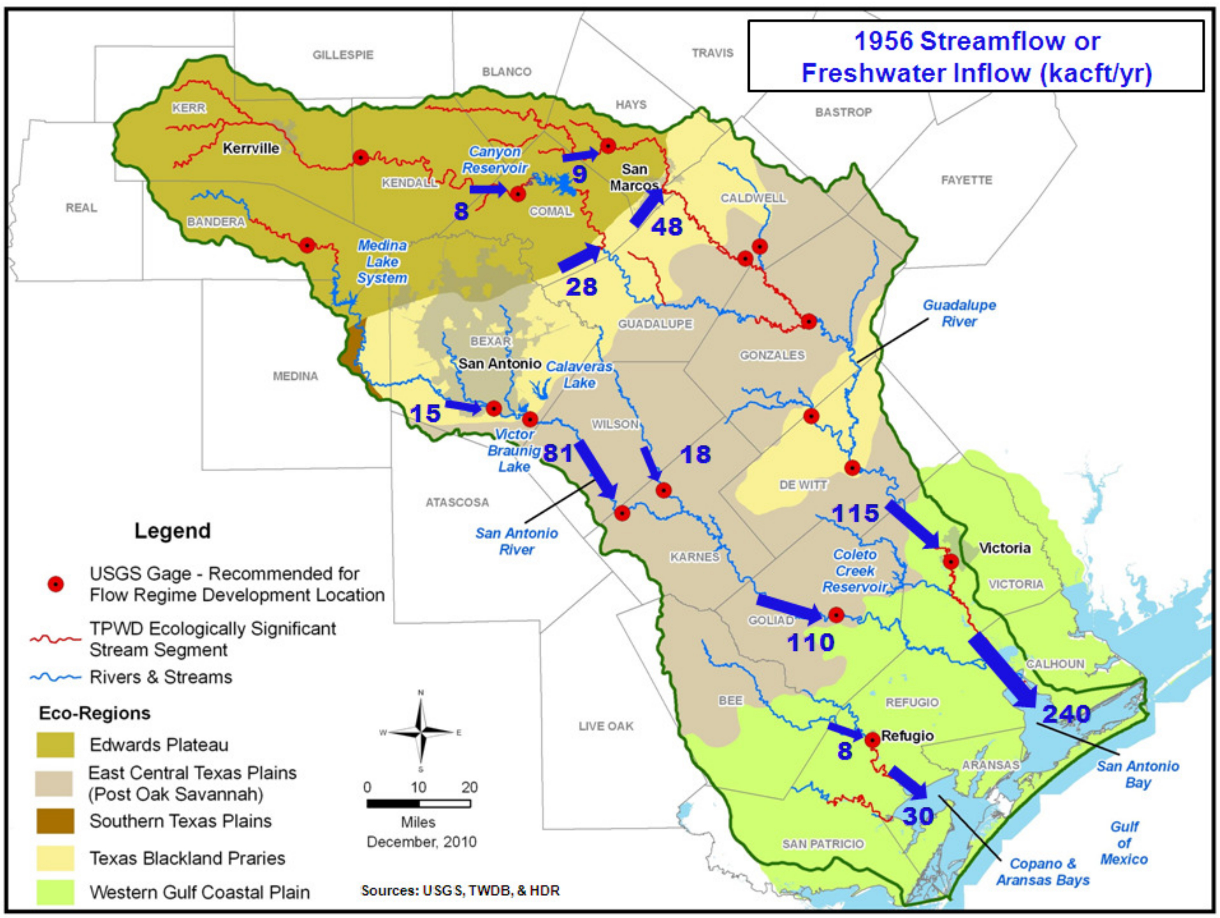

Figure 2.1-2. Drought (1956) Streamflow or Freshwater Inflow

2.2 Surface Water Rights

Consumptive uses of surface water authorized by certificate of adjudication or permit in the Guadalupe–San Antonio River Basin total approximately 600 kacft/yr while maximum historical consumptive use has been less than 270 kacft/yr. The locations and magnitudes of major surface water rights (water rights with an authorized annual diversion of 20 kacft/yr or greater) and their authorized consumptive uses in the Guadalupe–San Antonio River Basin are shown numerically and as approximately scaled arrows in Figure 2.2-1. There are no major water rights in the San Antonio–Nueces Coastal Basin. The major water rights shown in Figure 2.2-1 represent more than 75 percent of the authorized consumptive use of all existing water rights in the Guadalupe–San Antonio River Basin. Observations of interest upon review of existing water rights shown in Figure 2.2-1 include the following:

a. Major water rights are associated with each of the five major existing reservoirs in the Guadalupe–San Antonio River Basin:
    i. The Guadalupe-Blanco River Authority (GBRA) holds water rights to consume a five-year average of 90 kacft/yr from Canyon Reservoir for municipal and industrial purposes.
    ii. The Bexar-Medina-Atascosa Counties WCID#1 (BMA) holds water rights to annually consume approximately 67 kacft/yr from the Medina Lake System for irrigation and municipal purposes.
    iii. The City Public Service Board of San Antonio (CPS) holds water rights to consume 49 kacft/yr from Braunig and Calaveras Lakes for steam-electric power generation purposes.
    iv. Coleto Creek Power holds water rights to consume approximately 24 kacft/yr from Coleto Creek Reservoir for steam-electric power generation purposes.
b. The largest single group of water rights authorized to divert at one location totals 175 kacft/yr and is held jointly by GBRA and the Dow Chemical Company (with the exception of 3 kacft/yr held by GBRA alone).

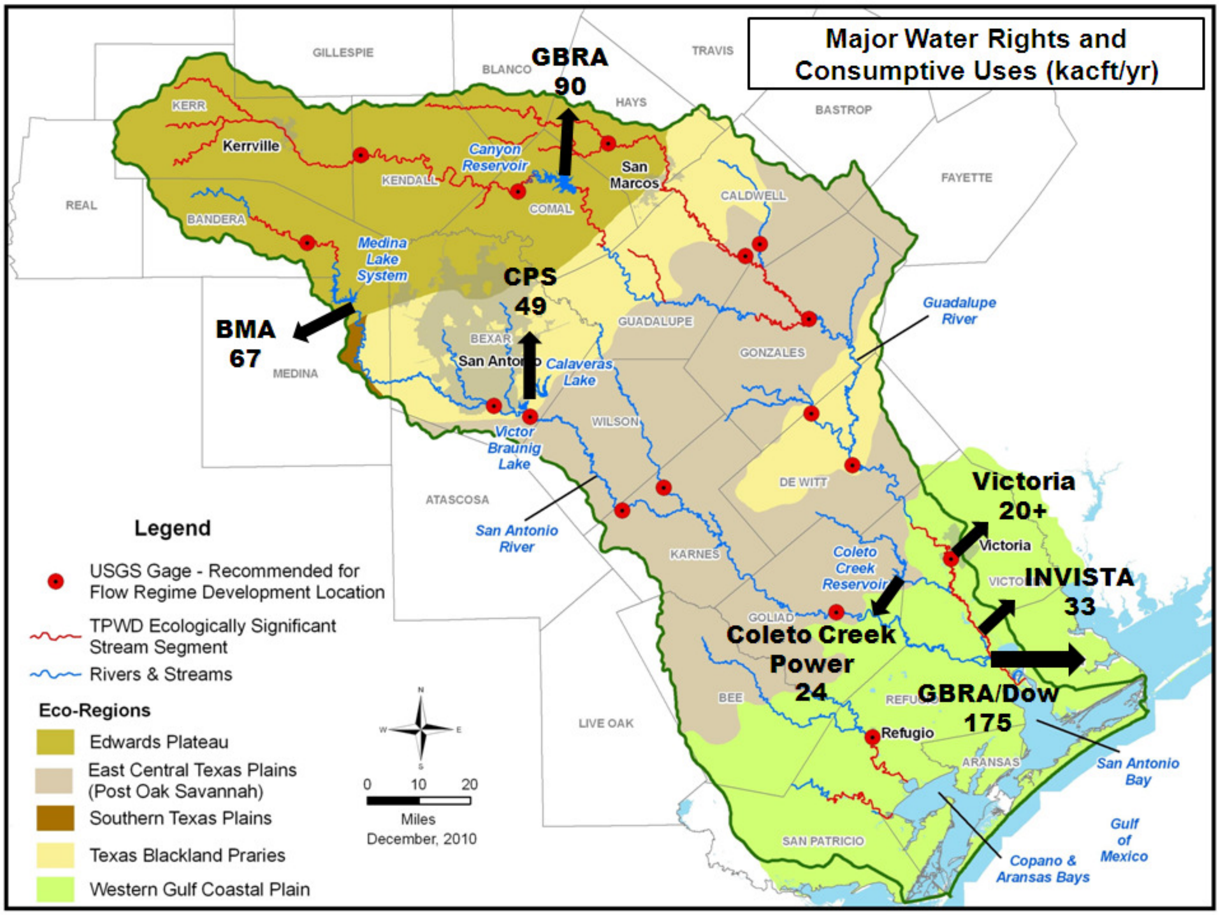

Figure 2.2-1. Major Water Rights and Consumptive Uses

2.3 Treated Effluent

The locations and magnitudes of major discharges of treated effluent in calendar year 2006 in the Guadalupe–San Antonio River Basin are shown numerically and as approximately scaled arrows in Figure 2.3-1. There are no major discharges in the San Antonio–Nueces Coastal Basin. Observations of interest upon review of treated effluent volumes shown in Figure 2.3-1 include the following:

a. More than 75 percent of treated effluent originated in Bexar County and was discharged by the San Antonio Water System (SAWS), San Antonio River Authority (SARA), and the Cibolo Creek Municipal Authority (CCMA). Note that the amount of 116 kacft/yr shown for SAWS is the result of an adjustment to the total effluent volume (126 kacft/yr) to account for contracted direct reuse. SAWS' actual effluent discharge to receiving streams (119 kacft/yr) was greater than 116 kacft/yr because all direct reuse contracts were not exercised in 2006.
b. Approximately 15 percent of treated effluent was associated with industrial facilities discharging to the lower Guadalupe River or to San Antonio Bay via the Victoria Barge Canal.

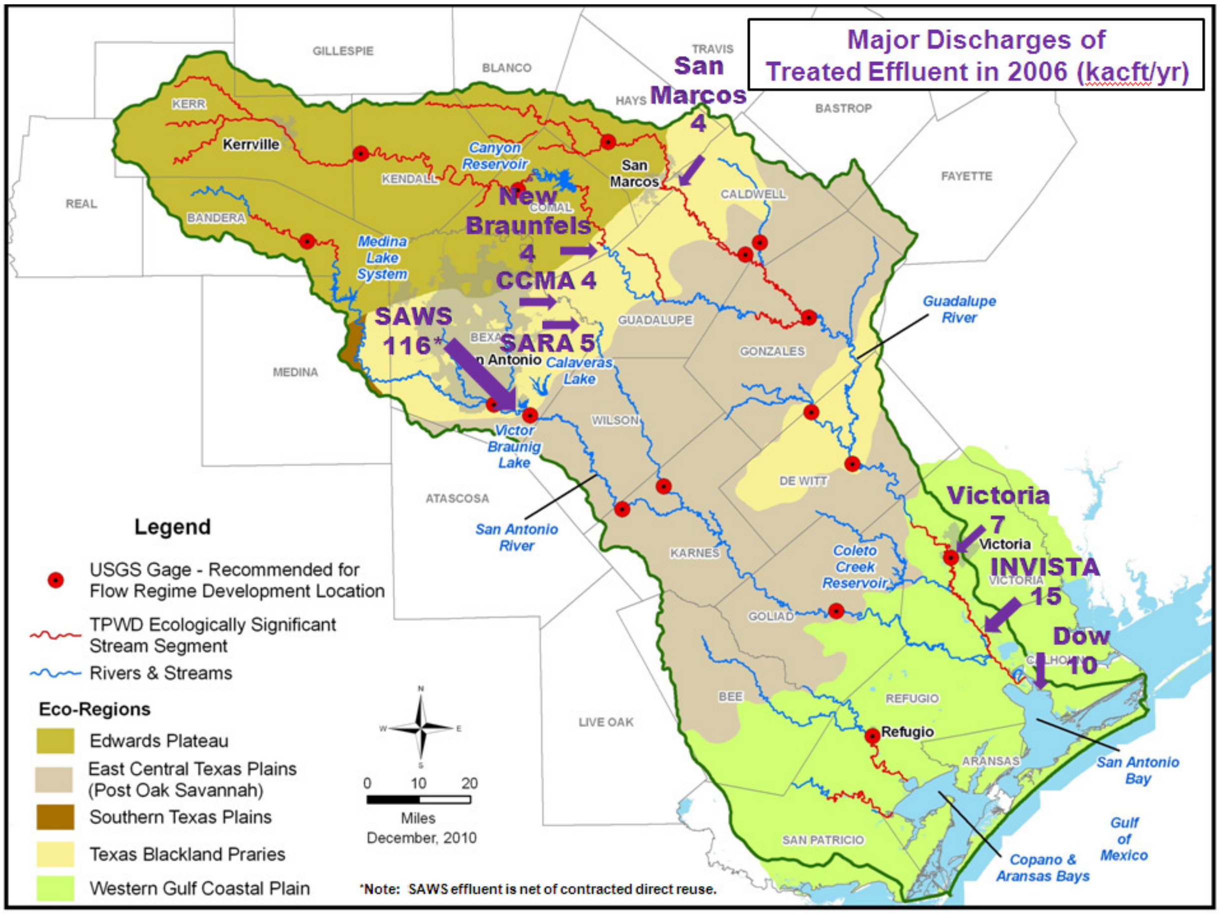

Figure 2.3-1. Major Discharges of Treated Effluent in 2006

3.0 Development of GSA BBASC Recommendations

3.1 General Comments on the GSA BBEST Recommendations Report

3.1.1 Comments from GSA BBASC Members

The Environmental Flows Recommendations Report prepared by the GSA BBEST was submitted to the EFAG, TCEQ, and GSA BBASC on March 1, 2011. The GSA BBEST presented its recommendations to GSA BBASC on March 2, 2011; returned for interactive discussion of the recommendations at the March 15, 2011 GSA BBASC meeting; and engaged with and responded to the GSA BBASC in the ensuing months. GSA BBASC comments, questions, and concerns regarding the GSA BBEST recommendations have been offered and considered, beginning even before the March 1, 2011 submittal and continuing to-date. This section includes a brief summary of such GSA BBASC comments, questions, and concerns, focusing on, but not limited to, those expressed during a June 1, 2011 facilitated discussion regarding members' thoughts on the GSA BBEST Environmental Flows Recommendation Report. In this facilitated discussion, two questions were asked of the GSA BBASC:

1) What did you like best or appreciate most about the GSA BBEST recommendations?
2) What are your concerns regarding the GSA BBEST report?

Member input to these questions, provided individually and sometimes collectively, is summarized in the following paragraphs.

The stakeholders expressed confidence in the GSA BBEST members and their recommendations report. The report was praised as being the closest effort to-date in describing conditions for a sound ecological environment in streams, rivers, bays, and estuaries. The GSA BBEST recommendations reflect a good basis from which the GSA BBASC can make instream flow recommendations considering supplemental information from its consultants and the GSA BBEST. A number of GSA BBASC members expressed that the information on pulses and geomorphology and their importance to the river and bay systems with regard to nutrient flows throughout the system was a positive step forward in understanding the rivers, bays and estuaries. Several other stakeholders mentioned their general approval of the 50 percent rule pertaining to withdrawals during dry periods when streamflows are approaching subsistence levels. The GSA BBEST took a good approach on the estuaries and provided a fresh look at the environmental needs of the basin.

While the GSA BBASC was generally pleased with the GSA BBEST efforts and findings, there were concerns expressed by the stakeholders including the very tight, legislatively imposed timelines, the amount of available scientific data for the Guadalupe and San Antonio Rivers, and to concerns regarding the limited number of indicator species used to determine the health of the bays and estuaries. The aggressive legislative timelines imposed in Senate Bill 3 (SB 3) were a concern to some members as they noted that such timelines could result in inadequate time for the GSA BBEST to understand, evaluate, and debate its recommendations potentially resulting in recommendations that are more restrictive than necessary. It was also mentioned that the stakeholder group did not know how TCEQ's future permit process would eventually address estuarine and lower basin needs for freshwater inflows.

Since the amount of scientific data available to the BBESTs is variable from basin to basin, and also from river to river within a basin, the SB 3 process can be difficult for BBESTs and

BBASCs to navigate. Within the Guadalupe–San Antonio River Basin, there is little information, for example, on the headwaters of the Guadalupe River regarding groundwater – surface water interaction. In the lower San Antonio River Basin, the SB 2 instream flows study was nearly completed such that the GSA BBEST, and later the GSA BBASC, could benefit from those on-the-ground and in-the-river scientific observations. Similar data, though less comprehensive and advanced, for the lower Guadalupe River was available to the GSA BBEST from unpublished studies by TPWD. The lack of apparent linkage between GSA BBEST recommended flows and available habitat curves was identified as a concern. There was also concern regarding the TPWD comments pertaining to some GSA BBEST subsistence flow recommendations being too low to maintain a sound ecological environment.

Several members expressed concerns regarding the GSA BBEST bay and estuary recommendations, particularly how they were derived. Several members expressed disappointment that white shrimp and blue crab or other mobile species were not utilized in determining the ecological soundness of the current bay and estuary habitat. Another member felt the flow requirements of the bay were not well-linked to the system as a whole. Concerns were expressed that the effects of the GBRA Saltwater Barrier and Diversion Dam, Calhoun Canal System, Traylor's Cut, and Cedar Bayou were not addressed by the GSA BBEST. There were also concerns that bay and estuary recommendations only explicitly addressed 8 of 12 months of the year and that protecting instream flow standards to the bay might not be sufficient protections for the bay. In addition, concern was expressed that the GSA BBEST was unable to complete time series analyses of freshwater inflows and associated effects on species of interest prior to issuing its environmental flow regime recommendations.

Many members of the GSA BBASC expressed concerns regarding the complexity of both the instream flow and estuarine inflow regime recommendations of the GSA BBEST recognizing the administrative, operational, and legal challenges associated with real-time management of individual or multiple water rights, and water supply facilities subject to water rights permit conditions based on the GSA BBEST recommendations. Members of the GSA BBASC did comment that operators of larger diversions, specifically municipal and industrial users, may be better equipped to use technology to assist in the operation of a water right permit with multi-tiered flow requirements; however operators of smaller diversions may not have the ability to effectively manage the complexities of the flow standards.

In response to a solicitation for written follow-up questions from the GSA BBASC members regarding the GSA BBEST recommendations report, the GBRA submitted an April 8, 2011 letter to the GSA BBEST through TCEQ. The letter, along with a response from the GSA BBEST Chair and Vice-Chair, are in Appendix I.

3.1.2 Comments from Science Advisory Committee (SAC)

The SAC issued a memorandum to the Environmental Flows Advisory Group (EFAG) on May 3, 2011 entitled "Review comments on Guadalupe and San Antonio Rivers, San Antonio Bay and Aransas-Copano Bay Basin and Bay Expert Science Team (BBEST) Environmental Flow Recommendations Report dated March 1, 2011" (Appendix B). In this memorandum, the SAC systematically reviewed and offered comment on the GSA BBEST Environmental Flows Recommendations Report. It is noted that the SAC met with GSA BBEST leadership on April 13, 2011 to receive further explanation of their work.

In their summary, the SAC concluded that the GSA BBEST "achieved excellence in its report" with the exceptions of the following major items of concern. The SAC observed that the GSA BBEST relied heavily on historical flow values to develop environmental flow recommendations. The SAC identified the GSA BBEST as the "best-equipped BBEST thus far," and then criticized it for being unable to "make a quantifiable recommendation founded upon a clear connection between levels of flow and metrics of the ecosystem health" and "instead recommended little, if anything, more than the default HEFR flow regimes based on historical hydrology." Furthermore, the SAC added that, with regards to the instream flow recommendations, there was no logical connection presented between Weighted Usable Area curves and default HEFR flows ultimately recommended. As for the estuary inflow recommendations, the SAC recognized "a convincing presentation of the dependence of preferable salinities within key habitat zones on the inflows" for the indicator species *Rangia* and oysters, but expressed concern regarding the use of historical statistics in specifying the attainment frequencies for inflow classes.

3.1.3 Comments from Texas Parks and Wildlife Department (TPWD)

In a letter dated April 21, 2011, TPWD provided comments on the GSA BBEST Environmental Flows Recommendations Report of March 1, 2011. The TPWD letter is included in Appendix C of this report. Further supporting documentation from TPWD regarding their comments on the GSA BBEST recommended subsistence flows is also included in Appendix C.

In general, the TPWD commended the GSA BBEST for its use of best available science and supported the GSA BBEST Instream Flow Regime Recommendations. TPWD expressed some concerns with regard to the subsistence flows chosen by the GSA BBEST and suggested use of the greater of the Q95, TCEQ's critical low flow (generally 7Q2), or default HEFR subsistence flow calculation to support critical water quality and habitat needs during very dry times. TPWD additionally noted the value of the 50% rule helped to address some, but not all, concerns with subsistence flow recommendations being too low for adequate protections. TPWD also encouraged the GSA BBEST to make a comparison of the Comparative Cross-Section Methodology (CCM), Physical Habitat Simulation (PHABSIM), and preliminary Texas Instream Flow Program (TIFP) results in order to help guide the GSA BBASC in setting priorities in their work plan.

TPWD supported the efforts of the GSA BBEST in advancing the state of science with regard to the salinity zone approach used for the Guadalupe and Mission-Aransas Estuaries. However, TPWD criticized the GSA BBEST for focusing on two species – *Rangia* and oysters – in their recommendations, which resulted in a lack of freshwater inflow recommendation for certain months of the year. TPWD mentioned the lack of nutrient and sediment delivery analyses in developing the GSA BBEST recommendations, which led to a perceived lack of high flow pulse recommendations to the estuary. TPWD supported the extension of the GSA BBEST instream flow recommendations to the bay in all months and TPWD also stated that an annual schedule of beneficial inflows should be considered for oysters. TPWD stated that, contrary to the GSA BBEST opinions, they believe that salinity does significantly influence white shrimp abundance and suggested that further investigation of relationships between white shrimp abundance and freshwater inflows be prioritized in the GSA BBASC Work Plan.

3.1.4 GSA BBASC Responses and Requests on the GSA BBEST Report

In response to comments received from members of the GSA BBASC, SAC, and TPWD, the GSA BBASC made suggestions and/or took actions including, but not limited to, the following:

- Members suggested that initiating TIFP instream flow studies on the Guadalupe River and fully completing the TIFP studies on the San Antonio River would increase and enhance available scientific data for the basin.
- Another member suggested that monitoring and gathering spring flow data in the headwaters region (Bandera, Spring Branch, Kerrville, and Comfort areas) would allow for a more complete understanding of surface water – groundwater interactions and the headwaters contributions to the system (see Section 3.3.3).
- As there is uncertainty due to limited available science in some areas of the riverine and estuarine systems, some suggested that uncertainty be acknowledged in the GSA BBASC recommendations report and that the need for specific additional science be identified and prioritized in the Work Plan, then undertaken over the next few years in the adaptive management phase (see Section 6).
- In the near term, the group urged completion of the GSA BBASC consultants' planned work including applications of the Water Availability Model (WAM) to examine hypothetical and proposed surface water projects subject to the GSA BBEST criteria. These model runs were performed by the GSA BBASC consultant team and the results reported back to the committee at several later meetings (see Sections 3.3.1 and 3.3.2).
- It was recognized that existing permitted water rights are not the focus of the SB 3 environmental flows process; however, there could be measures proposed by the GSA BBASC that existing permit holders could voluntarily adopt should they wish to increase freshwater inflows to the bays and estuaries. The GSA BBASC has included a list of voluntary measures in this report in Section 5.0 – GSA BBASC Recommendations for Potential Strategies to Meet Environmental Flow Standards.
- Considering concerns expressed prior to or during the June 1, 2011 facilitated discussion, the GSA BBASC has begun to identify how its concerns may be addressed in both the near and long terms. The GSA BBASC believes that many of the problematic issues it identified can be addressed and improved over time if policy suggestions to the TCEQ and activities pursuant to the GSA BBASC Work Plan are implemented (see Sections 4.4 and 6).
- The SAC speculated that the work of the GSA BBEST may have been more complete than its report would suggest and encouraged the GSA BBEST membership to engage in robust interaction with the GSA BBASC as it undertook development of recommended environmental flow standards and strategies. Such interaction has, in fact, occurred as members of GSA BBEST have provided significant technical support to the GSA BBASC in the form of reports and active participation in meetings. Two of these reports, "Evaluation of Aquatic Habitat Relationships in the Guadalupe River at the Gonzales and Victoria Study Sites" and "Biological and Ecological Implications of Non-Attainment of the BBEST Guadalupe Estuary Criteria" are included as Appendix F and Appendix G, respectively, to the GSA BBASC Recommendations Report.
- The GSA BBASC expressed interest in obtaining a better understanding of the TPWD comments on subsistence flows which resulted in TPWD explaining their comments at subsequent meetings and providing additional technical insight (see Appendix C).

- The GSA BBASC responded to some of the TPWD comments by including Bay & Marsh Salinity & Water Level Data Collection & Monitoring and the development of Habitat Suitability Models for Oysters, Blue Crabs, and White Shrimp as specific subjects to be further addressed in Work Plan development (see Section 6).
- The GSA BBASC requested that the GSA BBEST perform time series analyses to assess how freshwater inflows to the Guadalupe Estuary compare to GSA BBEST Recommendations attainment frequencies and affect species (Section 3.3).

3.2 Consideration of Present and Future Water Needs Related to Water Supply Planning

Pursuant to its charge, the GSA BBASC was required to *consider the present and future needs for water for other uses related to water supply planning in the pertinent river basin and bay system* during the process of developing its recommendations regarding environmental flow standards and strategies to meet them. Section 3.2 provides summaries of relevant information from the approved 2011 regional water plans for the South Central Texas (Region L), Plateau (Region J), and Coastal Bend (Region N) planning areas and other sources with the intent of establishing a quantitative frame of reference for consideration of water needs for municipal, industrial, steam-electric, mining, irrigation, and livestock uses along with water needs for environmental purposes in the Guadalupe–San Antonio River Basin, San Antonio–Nueces Coastal Basin, and the associated bays and estuaries. Summaries in the following sections are compiled from county-level data as river and coastal basin boundaries do not typically coincide with county boundaries.

3.2.1 Regional Economies Dependent on Water

The regional economies of the Guadalupe–San Antonio River Basin and San Antonio–Nueces Coastal Basin may be classified into five major sectors: Trades and Services, Manufacturing, Livestock, Agricultural Production, and Oil & Gas (mining). To varying degrees, each of these sectors is dependent on reliable water supply. Such dependence may range from direct uses in crop irrigation, watering livestock, product manufacturing, power generation, and/or hydraulic fracturing for oil & gas recovery to less direct uses for residential purposes, cooling, and domestic consumption and sanitation supporting commercial establishments. Table 3.2-1 provides a county-by-county summary of estimated annual economic contribution values for each of the five major economic sectors. Observations upon consideration of Table 3.2-1 include the following:

a. Based on data for the five major economic sectors, the regional economy is estimated at more than $87.2 billion per year.
b. Trades and Services is by far the largest sector of the regional economy as it accounts for 75.4 percent of the total tabulated annual economic contribution value.

c. Manufacturing accounts for an additional 20.4 percent[9] of the total tabulated annual economic contribution value with the remaining 4.2 percent being associated with Oil & Gas recovery, Livestock, and Agricultural Production.

d. Approximately 83 percent of the total tabulated annual economic contribution value is associated with Bexar, Comal, Guadalupe, and Hays Counties.

Table 3.2-1. Regional Economic Data Summary[10]

County	Trades & Services Economic Activity (million dollars)[1]	Manufacturing Economic Activity (million dollars)[2]	Market Value of All Livestock (million dollars)[3]	Market Value of All Crops (million dollars)[3]	Value of Oil Production (million dollars)[4]	Value of Gas Production (million dollars)[5]	Total (million dollars)
Aransas	$429	$0	$2	$0	$37	$101	**$569**
Bandera	$187	$0	$6	$1	$0	$0	**$194**
Bee	$396	$0	$20	$19	$35	$276	**$746**
Bexar	$47,503	$12,361	$20	$64	$8	$0	**$59,956**
Caldwell	$484	$92	$40	$7	$57	$3	**$683**
Calhoun	$426	(D)	$9	$20	$31	$95	**$581**
Comal	$3,004	$1,103	$4	$3	$0	$0	**$4,114**
DeWitt	$297	$111	$34	$7	$40	$270	**$759**
Goliad	$60	$0	$15	$5	$48	$454	**$582**
Gonzales	$278	$446	$389	$15	$15	$8	**$1,151**
Guadalupe	$1,757	$2,160	$22	$19	$78	$1	**$4,037**
Hays	$3,302	$1,088	$7	$5	$0	$0	**$4,402**
Karnes	$156	$0	$14	$11	$23	$57	**$261**
Kendall	$1,261	$183	$7	$1	$0	$0	**$1,452**
Kerr	$1,521	$165	$12	$1	$0	$0	**$1,699**
Medina	$535	$78	$38	$43	$6	$1	**$701**
Refugio	$99	$0	$9	$20	$244	$289	**$661**
San Patricio	$966	(D)	$20	$90	$65	$162	**$1,303**
Victoria	$2,768	(D)	$20	$23	$49	$103	**$2,963**
Wilson	$340	$0	$37	$16	$18	$0	**$411**
Total	**$65,769**	**$17,787**	**$725**	**$370**	**$754**	**$1,820**	**$87,225**

1. 2007 Economic Census, U.S. Department of Commerce. This value only includes trade and service sectors for which data was not withheld and includes employer sales, shipments, receipts, revenue, or business done.
2. 2007 Economic Census, U.S. Department of Commerce. (D) - data withheld to avoid disclosing data for individual companies. Includes employer sales, shipments, receipts, revenue, or business done.
3. 2007 Census of Agriculture, Volume 1 Geographic Area Series, "Table 1. County Summary Highlights: 2007."
4. Value of production derived from production records obtained from the Railroad Commission of Texas and an assumed price of $64.20/bbl (approx. average for 2007).
5. Value of production derived from production records obtained from the Railroad Commission of Texas and an assumed price of $7/1,000 cf (approx. average for 2007).

The GSA BBASC has expressed particular interest in the health of the bays and estuaries receiving freshwater inflows from the Guadalupe–San Antonio River Basin and the San Antonio–Nueces Coastal Basin. Although data are readily available regarding the economic impacts of bay and estuary related recreational activities and commercial fishing for the entire Gulf Coast of Texas, only limited data are available specifically for the Guadalupe Estuary. To some degree, such impacts are included in the economic sector identified as Trades and Services, but the source of information does not break out all such businesses specifically. Apportioning

[9] Manufacturing actually accounts for more than 20.4 percent of the total tabulated annual production value because data has been withheld for Victoria, Calhoun, and San Patricio Counties by the U.S. Department of Commerce to avoid disclosures for individual companies.

[10] As U.S. Department of Commerce Economic Census data is published every five years, 2007 data was used for all economic sectors to facilitate comparisons.

Texas Gulf Coast data from the National Marine Fisheries Service[11] in accordance with estuary-specific data from Texas A&M University[12], one may estimate that the statewide economic impacts of bay and estuary related recreational fishing activities for the Guadalupe Estuary is about $24 million per year. Similarly, the statewide economic impacts of the Texas seafood industry attributable to the Guadalupe Estuary are estimated to be $162 million per year. In addition, the economic impact of wildlife viewing activities in or near the Guadalupe Estuary is estimated to be $29 million per year. While these three economic subsectors represent about one quarter of one percent of the regional economy, they are locally quite significant.

3.2.2 Regional Water Demand Projections

The Texas Water Development Board (TWDB) prepares long-range projections of dry year water demand by usage type, county, and river basin to support regional water plan development, which, in turn, supports state water plan development. Dry year demand projections for six sectors of water use during the next several decades are summarized in Figure 3.2-1. Observations upon consideration of Figure 3.2-1 include the following:

a. Water demands are expected to increase by more than 374,000 acft/yr (51 percent) from year 2010 to 2060.
b. Municipal and industrial uses of water are expected to steadily increase and together represent a minimum of 70 percent of water demands in the coming decades.
c. Water demands for steam-electric power generation are expected to increase dramatically while irrigation demands decrease and other uses (mining and livestock) remain relatively stable in the coming decades.

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[11] National Marine Fisheries Service. 2010. Fisheries Economics of the United States, 2007. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-F/SPO-104, 180 p. Available at: https://www.st.nmfs.noaa.gov/st5/publication/index.html.

[12] Jones, Lonnie L. and Tanyeri-Abur, Aysen. 2001. Impacts of Recreational and Commercial Fishing and Coastal Resource-Based Tourism on Regional and State Economies. Department of Agricultural Economics, Texas Agricultural Experiment Station, Texas A&M University System, Texas Water Resources Institute, TR-184, 22 p.

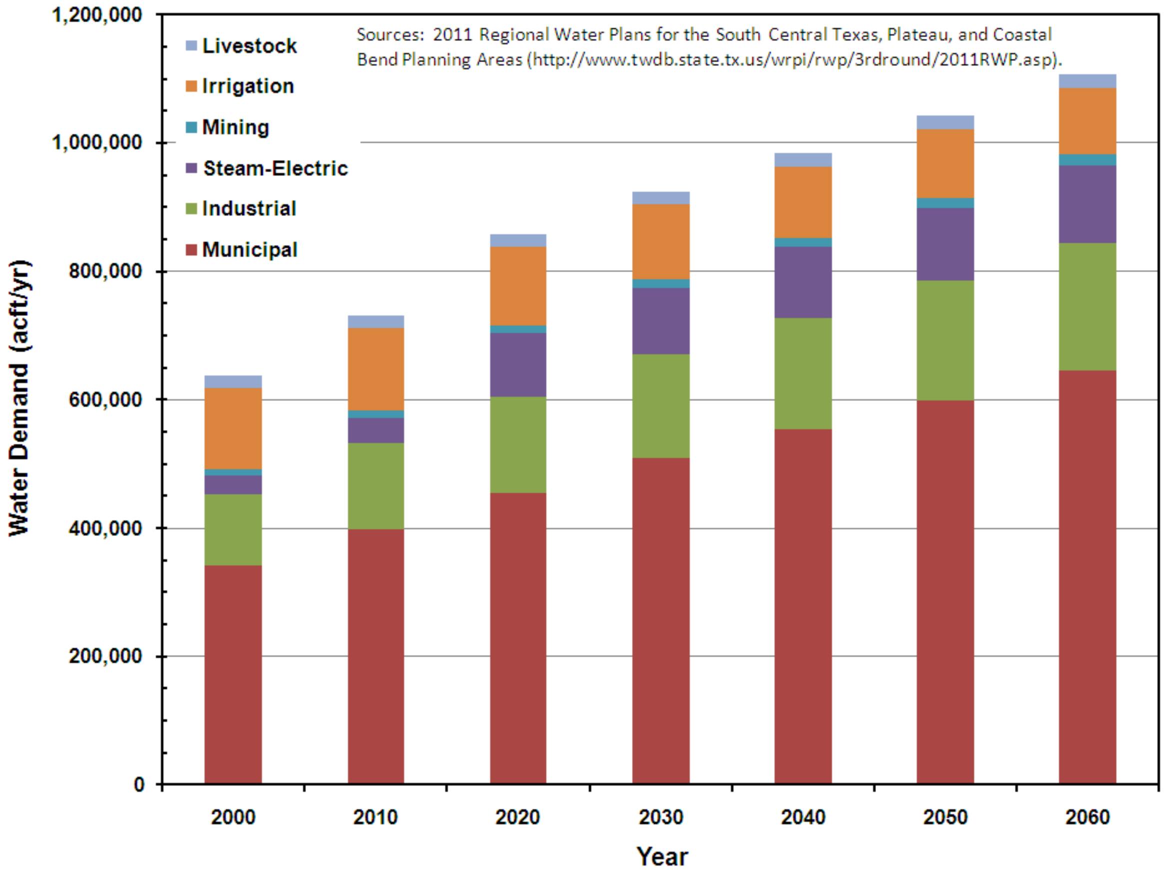

Figure 3.2-1. Water Demand Projections for Counties in the Guadalupe–San Antonio River Basin and/or the San Antonio–Nueces Coastal Basin by Type of Use[13]

Needs for additional water supply are quantified in the regional water planning process by comparing projected dry year demands to reliable or firm existing supplies. Any apparent shortages resulting from these comparisons are identified as needs for additional water supply or simply needs. Figure 3.2-2 presents calculated needs for additional water supply through the year 2060. Observations upon consideration of Figure 3.2-2 include the following:

a. The need for additional reliable water supply is expected to grow from the year 2010 level of about 115,000 acft/yr to more than 405,000 acft/yr by 2060.
b. Approximately 90 percent of projected needs for additional water supply are in Bexar, Victoria, Comal, and Hays Counties of the Guadalupe–San Antonio River Basin.

[13] See Table 3.2-1 for a list of counties included.

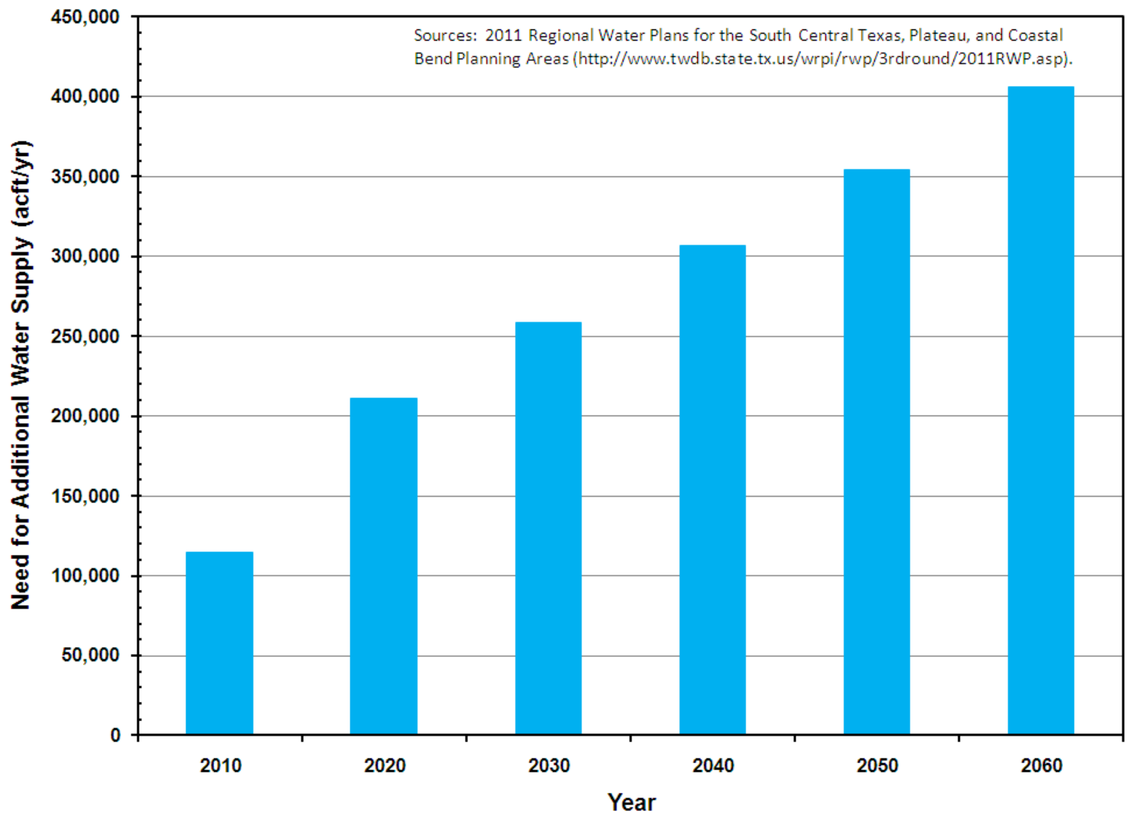

Figure 3.2-2. Needs for Additional Water Supply for Counties in the Guadalupe–San Antonio River Basin and/or the San Antonio–Nueces Coastal Basin[14]

3.2.3 Regional Water Plan Strategies and Costs

A number of water management strategies are recommended for implementation in the 2011 South Central Texas (Region L), Plateau (Region J) and Coastal Bend (Region N) Regional Water Plans to meet projected needs for additional water supply in the coming years. Among these recommended strategies are those directly, potentially, or not affected by the new environmental flow standards to be adopted by TCEQ. Strategies directly or potentially affected are identified in the following two paragraphs. Recommended water management strategies not affected by the environmental flow standards are generally associated with development of groundwater supplies and are not listed herein. In addition, these regional water plans include recommended strategies identical or very similar to some of those recommended by the GSA BBASC to help achieve the environmental flow standards ultimately adopted. These common strategies are in a third paragraph below.

Recommended water management strategies in a 2011 regional water plan expected to be directly affected by TCEQ adopted environmental flow standards in the basins assigned to the GSA BBASC include the following (listed along with the associated firm yield, unit costs for water, and planning region:

[14] See Table 3.2-1 for a list of counties included.

a) GBRA Mid-Basin (Surface Water); 25,000 acft/yr; $1879 - $2204/acft/yr; Region L.
b) GBRA New Appropriation (Lower Basin); 11,300 acft/yr; $1953/acft/yr; Region L.
c) Storage Above Canyon Reservoir (ASR); 3140 acft/yr; $1772/acft/yr; Region L.
d) Canyon Regional Water Authority (CRWA) Siesta Project; 5042 acft/yr; $1421/acft/yr; Region L.
e) Edwards Aquifer Recharge – Type 2 Projects; 21,577 acft/yr; $2005/acft/yr; Region L.
f) Surface Water Acquisition, Treatment, & ASR; 10,314 acft/yr; $1416 - $2079/acft/yr; Region J.
g) Surface Water Storage; 1121 acft/yr; $581/acft/yr; Region J.

These seven recommended water management strategies are identified as being directly affected by adopted environmental flow standards because they involve new appropriations of surface waters of the state, and permits for diversion and/or impoundment must be obtained from the TCEQ. Although a permit application for the GBRA Mid-Basin (Surface Water) project was administratively complete and a permit application for the GBRA New Appropriation (Lower Basin) project was pending at TCEQ at the time of adoption of the 2011 Region L Regional Water Plan, it is expected that both of these strategies will be permitted in accordance with environmental flow standards as adopted pursuant to SB3 of the 80th Texas Legislature. Pursuant to discussions during three meetings of a Guadalupe Basin Water Needs Workgroup, November 5, 2009 action of the Region L Planning Group, and agreement of GBRA, two recommended water management strategies identified as the GBRA New Appropriation (Lower Basin) and GBRA Mid-Basin Project (Surface Water) are subject to senior water rights, the full application of environmental flow standards adopted pursuant to Section 11.1471 of the Texas Water Code, and the TCEQ permitting process.

Recommended water management strategies in a 2011 regional water plan potentially affected by TCEQ adopted environmental flow standards in the basins assigned to the GSA BBASC include the list below (listed along with planning region). As each of these water management strategies relies on existing surface water rights and may not require a new appropriation of surface water, it is assumed by the GSA BBASC that such strategies will not be affected by environmental flow standards adopted pursuant to SB3 of the 80th Texas Legislature.

a) GBRA-Exelon Project; Region L.
b) GBRA Lower Basin Storage (100 acre site); Region L.
c) Medina Lake Firm-Up (ASR); Region L.
d) Surface Water Rights; Region L.

Recommended water management strategies in a 2011 regional water plan potentially relevant to GSA BBASC recommendations regarding strategies to meet environmental flow standards potentially include all of those listed above as well as the following:

a) Conservation (Municipal, Industrial, and Agricultural).
b) Drought Management.
c) Recycled Water Programs.
d) Edwards Transfers.
e) Brackish Wilcox Groundwater.

f) Seawater Desalination.

For additional information regarding GSA BBASC recommendations regarding strategies to meet environmental flow standards, please refer to Section 5 of this report. In addition, the Edwards Aquifer Recovery Implementation Program (EARIP) is formulating a Habitat Conservation Plan (HCP) including several of these recommended strategies. This HCP is expected to be under consideration for approval by the U.S. Fish & Wildlife Service in the near future.

3.3 Analyses Performed for the GSA BBASC

HDR Engineering (HDR), along with Kennedy Resource Company and BIO-WEST, performed technical evaluations to assist the GSA BBASC in evaluating the effects of potential environmental flow recommendations on water supply projects in the Guadalupe–San Antonio River Basin. The HDR team was scoped to evaluate two potential large-scale firm yield water supply projects and six hypothetical run-of-river diversions. The GSA BBASC enlisted the help of GSA BBEST member Dr. Norman Johns to perform "time series" analyses for various inflow scenarios to determine whether they meet the GSA BBEST estuary recommendations. The rest of the GSA BBEST Estuary Sub-Committee was also enlisted to evaluate the biological and ecological effects of several inflow scenarios on the Guadalupe Estuary.

3.3.1 Large-Scale Firm Yield Projects

The GSA BBASC chose to evaluate the GBRA Mid-Basin Project from the 2011 Region L Regional Water Plan as one of the potential large-scale firm yield projects. The other choice was a hypothetical run-of-river project with off-channel storage on the San Antonio River near Goliad, known as the San Antonio River Project. Details for each project are summarized below. Cost estimates associated with the projects are consistent with the methodology and assumptions of the 2011 Region L Regional Water Plan.

Mid-Basin Project

The Mid-Basin Project is a recommended water management strategy in the 2011 Region L Regional Water Plan sponsored by GBRA for the development of 25,000 acft/yr of firm water for use in Caldwell, Comal, and/or Hays Counties utilizing a new diversion from the Guadalupe River near Gonzales in conjunction with an off-channel reservoir (see Figure 3.3-1). The Mid-Basin Project, as recommended in the 2011 Region L Regional Water Plan, includes two variations of the project. One variation consists of the new diversion with a maximum instantaneous diversion rate of 800 cubic feet per second (cfs) subject to the Consensus Environmental Criteria required for regional water planning, off-channel storage of 188,800 acft and delivery, water treatment and integration systems. The second variation of the Mid-Basin Project as contained in the 2011 Region L Regional Water Plan consists of the new diversion with a maximum instantaneous diversion rate of 500 cfs subject to the current TCEQ default environmental criteria, also known as the Lyons Method, off-channel storage of 105,500 acft and delivery, water treatment and integration systems In the evaluations performed for the GSA BBASC (except where noted), the Mid-Basin Project consists of a new diversion from the

Guadalupe River at Gonzales with a maximum instantaneous diversion rate of 500 cfs, off-channel storage of 105,500 acft, delivery and conveyance systems to the Luling and San Marcos water treatment plants, and water treatment and integration.

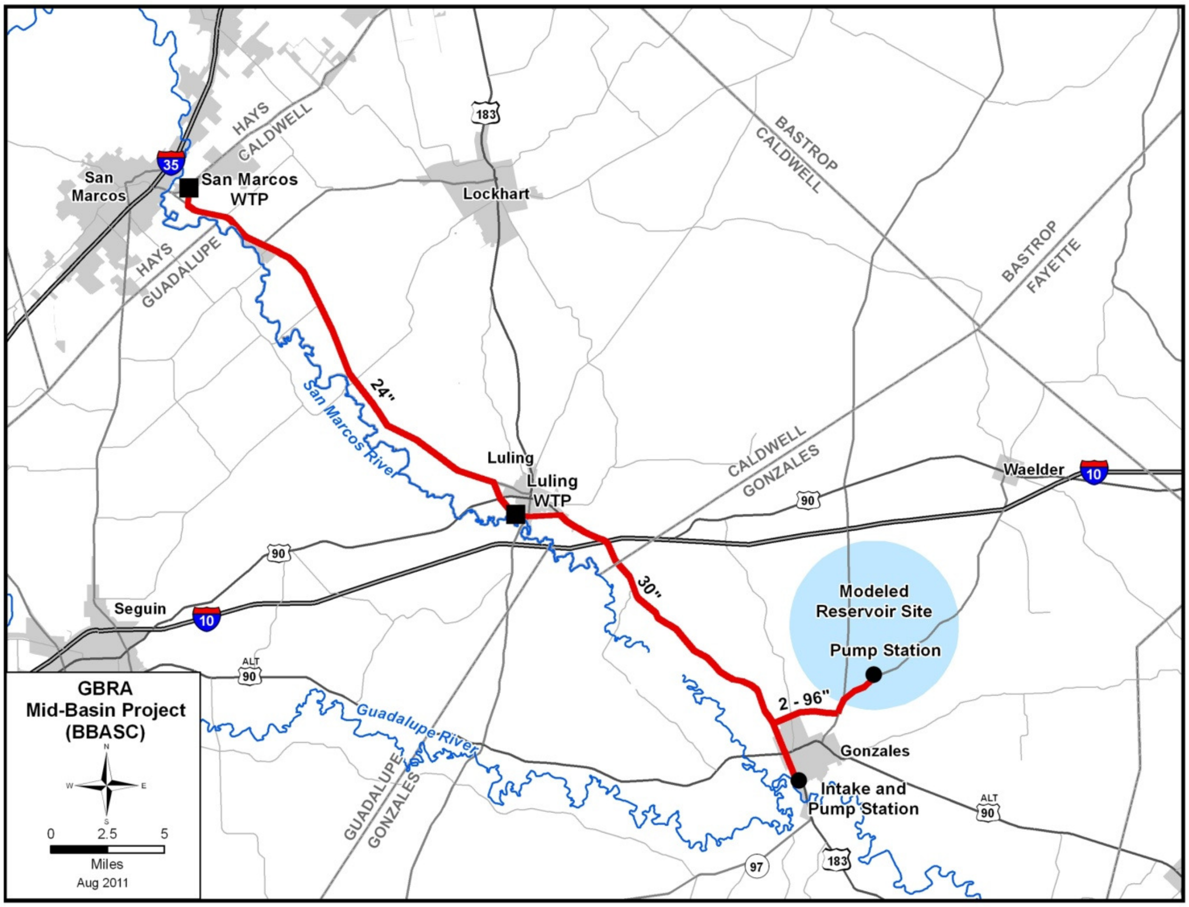

Figure 3.3-1. Location of the Mid-Basin Project[15]

San Antonio River Project

The San Antonio River Project is a hypothetical water supply project in the lower San Antonio River for the development of firm water for use in and around Bexar County. In the evaluations performed for the GSA BBASC, the San Antonio River Project consists of a new diversion from the San Antonio River at Goliad with a maximum instantaneous diversion rate of 800 cfs, off-channel storage of 150,000 acft, delivery and conveyance systems to the Twin Oaks water treatment plant, and water treatment and integration (see Figure 3.3-2).

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[15] Shaded area for "Modeled Reservoir Site" represents the general area within which the reservoir was modeled, and not the footprint of the reservoir itself.

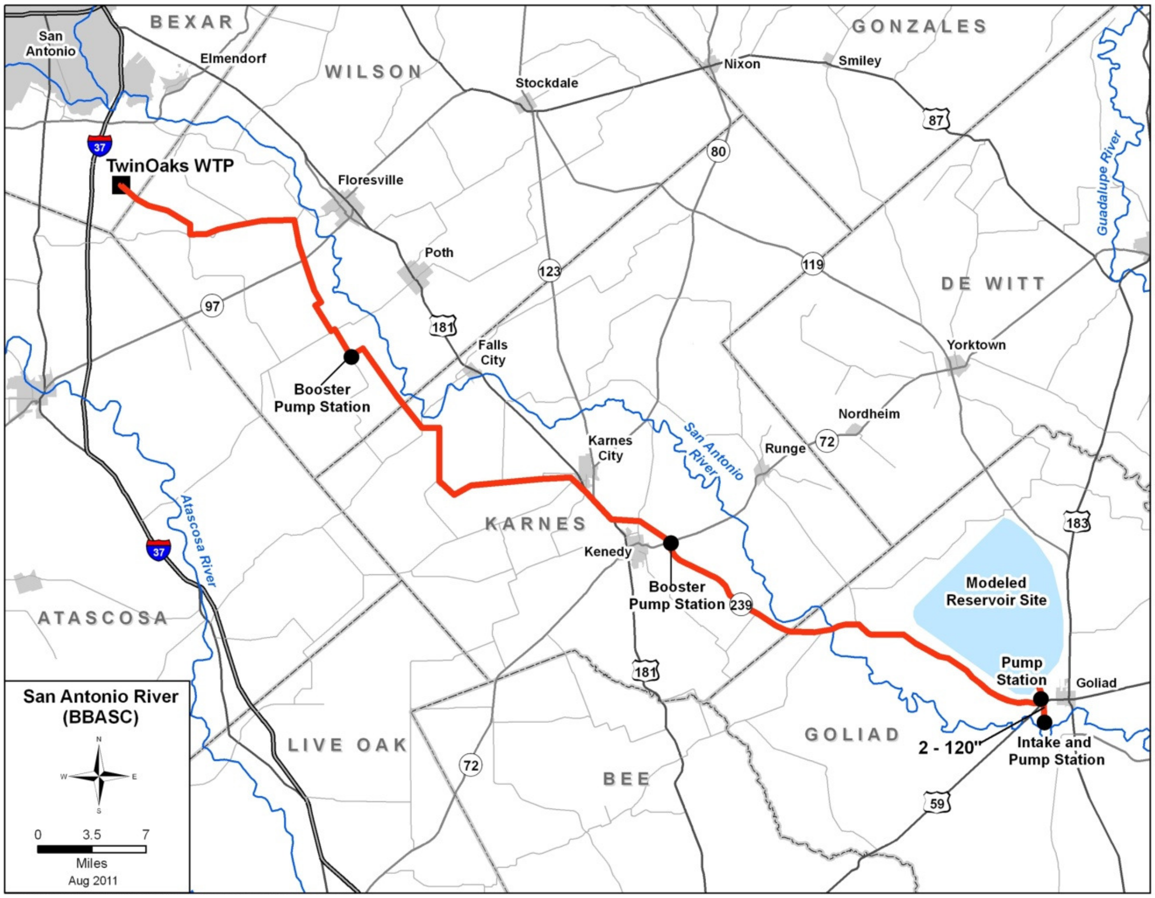

***Figure 3.3-2. Location of the San Antonio River Project*[16]**

3.3.1.1 Assumptions for Simulations

GUADALUPE-SAN ANTONIO WAM

Simulations for the GSA BBASC were performed using TCEQ's Guadalupe–San Antonio Water Availability Model (GSA WAM), as obtained from the TCEQ website on April 5, 2011, with modifications to address GSA BBASC assumptions and to ensure an accurate representation of streamflow and freshwater inflows to the Guadalupe Estuary. The WAM modifications made to the TCEQ's model are summarized in Appendix E1. The two most notable modifications include the use of returns flows consistent with 2006 reported effluent discharges and the use of updated simulated springflows using the Edwards Aquifer pumpage and critical period management rules consistent with Senate Bill 3 (80th Texas Legislature).

SAN ANTONIO/NUECES COASTAL WAM

For the San Antonio/Nueces Basin, the TCEQ's WAM model was obtained on 12/27/2010. No changes were made to this model and this model was used to generate the necessary WAM flows for the Mission River near Refugio instream site.

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[16] Shaded area for "Modeled Reservoir Site" represents the general area within which the reservoir was modeled, and not the footprint of the reservoir itself.

3.3.1.2 Baseline Simulation

The GSA WAM, as modified above, was used to establish the baseline for which the large-scale firm yield projects and run-of-river projects could be evaluated against. The baseline streamflows and resulting estuary inflows were used as the baseline flows. In addition, flow estimates for a historical flow scenario, and a present use conditions flow scenario were used to evaluate freshwater inflows to the Guadalupe Estuary.

Please note that within the report the baseline is referred to as "Baseline", but in some of the figures and appendices it may be referred to as "Region L Baseline". The terms are interchangeable and both refer to the baseline as described in this section.

INSTREAM ASSESSMENT

For the instream assessment, a standard procedure was implemented to test historical conditions and all subsequent model runs including baseline. The procedure involved the following steps:

- Actual (historical) or projected (baseline or evaluated projects with varying criteria) daily streamflow data was examined for the modeled period of record as daily flow time series and flow duration curves.
- Streamflow was then linked to Weighted Usable Area (WUA) curves on a daily time-step to create habitat time series and habitat duration curves. For the lower San Antonio River and lower Cibolo Creek, the WUA curves developed by the SB2 Texas Instream Flow Program (TIFP) study were used. For all other GSA BBASC sites where applicable, the WUA curves developed by the GSA BBEST were used. A detailed description of habitat guilds and associated suitability curves developed by both the GSA BBEST and SB2 TIFP are presented in Section 2.2 of Hardy (2011) (Appendix F).
- Habitat time series and duration curves were evaluated on an individual habitat guild basis (i.e. deep pools, shallow runs, riffles, etc.). A full examination of the daily habitat time-series was conducted to look for potential habitat bottlenecks (e.g. periods of complete loss of certain habitat types or significant reductions of key habitats during critical time periods, etc.). Results for each habitat guild were further evaluated on an annual time step as well as monthly time step (to examine seasonal patterns) for comparison amongst model runs.
- Habitat data was further analyzed as percent of maximum available habitat per flow per habitat guild per habitat exceedence level. This analysis allows for an examination of potential breakpoints, or in other words, large changes or shifts in habitat that might occur at certain flow levels.
- Total annual volume was then evaluated for each model run to evaluate the capacity for sediment transport and to compare between model runs.
- For the lower San Antonio River and lower Cibolo Creek total annual volume was also used to compare against SB2 TIFP riparian productivity recommendations. No such recommendations were available for comparison at other GSA BBASC sites.

The baseline analysis focused on a comparison to historical conditions. Relative to historical conditions, the baseline exhibited shifts in habitat availability depending on river system and habitat type. For instance, reductions in deep pool and deep run habitats were projected in most instances with the baseline scenario, while increases in shallow runs and riffle habitat were also projected for the baseline when compared to historical. This is simply explained by the baseline condition providing overall less water in the stream/river than historically observed. From an in-channel aquatic habitat perspective, the timing of streamflows and resulting habitats created play an important role in the ecological interpretation of streamflow reductions. From a riparian and sediment transport perspective, the timing, frequency, and magnitude of pulse and overbank flows play a critical role in ecosystem health. Unfortunately, the direct ecological linkages from these pulse events are only minimally understood throughout most of the basin, and therefore, total annual volume becomes the default criteria for comparison relative to these parameters.

The responsibility of the GSA BBASC was not to conduct a detailed evaluation of the baseline condition relative to ecological health as the SB3 mandate focuses on future water rights. However, a general assessment was needed to put the evaluated projects and GSA BBASC recommendations in context. It is no surprise that the baseline scenario causes considerable reductions in overall water in the stream. These flow reductions cause shifts in the modeled available habitat with typically greater amounts of shallow run and riffle habitat being projected and less deep pool and deep run habitat, in most cases. These in-channel habitat shifts have the potential to change aquatic communities, but are typically within the historically observed range in the basin, and thus, are not anticipated to be detrimental to the aquatic ecosystem based on in-channel conditions alone. In general, the reduction in total annual volume will likely cause changes in the riparian zone and current channel configurations, but it is difficult to quantify to what degree. Should significant changes in the riparian zone and channel configuration occur, subsequent changes in the in-channel aquatic habitat would be expected and could be detrimental depending on the level of change.

For the GSA BBASC instream assessment, all model run comparisons were made directly back to the baseline condition to assess the potential for environmental harm above and beyond what would be expected by the baseline.

ESTUARY ASSESSMENT

The GSA BBEST developed a set of recommended freshwater inflow criteria for the Guadalupe Estuary and the Mission-Aransas Estuary. In summary, the GSA BBEST estuary criteria were structured to cover two principal seasons, Spring consisting of February through May and Summer covering June through September. Then within each of these seasons, the criteria are a multi-tiered suite (e.g., A-prime, A, B, C, CC, D, and DD) of inflow volumes and an associated frequency of attainment goal for each. For the Guadalupe Estuary these criteria are called "G1" for the Spring and "G2" for the Summer[17]. Details on these and the recommendations for the Mission-Aransas Estuary can be found in Appendix E2.

In order to provide a basis of comparison for the GSA BBASC evaluations of potential water supply projects, several non-project scenarios were evaluated beforehand for their inflows to the Guadalupe Estuary. These non-project scenarios (the four simulations that do not include projects) were the first of numerous "time series" assessments with regard to how well any given

[17] Terminology regarding the estuary recommendations is further defined in Appendix E2 of this report and throughout the GSA BBEST Recommendations Report.

inflow scenario could meet the GSA BBEST estuary recommendations. The scenarios are summarized in Table 3.3-1.

Table 3.3-1. Summary of the Non-Project Scenarios Evaluated by the GSA BBASC for Attainment of the GSA BBEST Recommended Guadalupe Estuary Inflow Criteria

	Non-Project Scenarios				
Features	**Naturalized**	**Historical**	**Present use**	**Baseline**	**TCEQ Run3**
Surface water use - existing rights	n/a	historical, transient	max. 10yr, constant	Full use, constant	Full use, constant
new potential rights	n/a	n/a	n/a	n/a	n/a
Wastewater Effluent Discharges Returns	n/a	historical, transient	min. 5 yr, constant	recent (2006) levels, constant	near 0, few permits with requirement.
Edwards Aquifer Pumpage and Critical Period Rules	n/a	historical, transient	SB 3 , constant w. drought mgmt.	SB 3 , constant w. drought mgmt.	SB 3 , constant w. drought mgmt.
Environmental flow requirements	n/a	limited, transient	recent permits mostly post 1985	recent permits mostly post 1985	recent permits mostly post 1985
Data source	model	data	model	model	model
Period of record	1934-1989	1941 - 2009	1934-1989	1934-1989	1934-1989

As is evident in Table 3.3-1 the period of record that is common to these scenarios covers just the period 1941-89 or 49 years. Thus, there is a loss of 20 years of data from the historic period that was used in the derivation of the GSA BBEST Recommendations. This is an important difference which must be kept in mind when examining the attainment performance of any given scenario using the shorter 1941-89 period.

After each scenario's time series of estuary inflows is generated, either with the WAM or from historical records, the next step was to assess how well these meet the GSA BBEST recommendations. In summary, each Spring and each Summer inflow of any given scenario was categorized as to which tier of the respective GSA BBEST recommendations if falls within. Then the total number of those occurrences was compared to the GSA BBEST frequency attainment goals. Much more detail on this process is given in Appendix E2.

For the work of the GSA BBASC, a set of estuary assessment summary tables was developed to portray the results for all 49 years in the period of record. Table 3.3-2, in parts a-c, summarizes the attainment performance of each of the non-project scenarios with regard to the G1 criteria covering the springtime months (February – May). Part a) for each scenario is the count of the number of Spring seasons (=years) that fall in each inflow category. Part b) measures attainment performance for the portions of the criteria that are stand-alone "single" measures (e.g. occurrence of G1-A >12% of years). Part c) measures attainment for criteria that are to be assessed jointly (e.g. the total occurrence of G1-C and G1-CC). Attainment performance is highlighted with a color scheme indicated at the bottom.

The cells highlighted in red indicate GSA BBEST recommendations that the particular scenario fails to meet at levels that are cause for concern with regard to the ability to sustain a sound ecological environment. For instance, using the G1-D criteria as an example, Table 3.3-2 shows that the non-attainment of this criteria under the Baseline was due to the 14 years of its occurrence (indicated in Table 3.3-2 part a). This equates to this level of inflow occurring 28.6% of years (indicated in part b), whereas the GSA BBEST recommendation was for no more than 9% of years.

Table 3.3-3 similarly illustrates the performance of the various non-project scenarios with regard to meeting the GSA BBEST recommendations for the Summer June – September season. For example, under the Baseline G2-D and G2-DD inflows occur in a total of 11 years (indicated in Table 3.3-3 part a as 3 years and 8 years, respectively). This equates to these levels of inflow occurring 22.4% of years (indicated in part b), whereas the GSA BBEST recommendation was for no more than 9% of years in total.

The entries in both tables for the TCEQ Run 3 scenario were not extensively used by the GSA BBASC for any of their efforts to find a balance between environmental needs and water supply needs. However, the results of this theoretical permitting scenario used by TCEQ were necessary for the crafting of the GSA BBASC's final Guadalupe Estuary inflow recommendation (Section 4.2) so the results are included here.

Table 3.3-2. Summary of the Natural, Historic, Present Use, and Baseline Scenarios Attainment Performance for the G1 Suite (Spring Period) of Guadalupe Estuary Inflow Criteria (See notes at bottom)

Part a) Counts	Criteria G1 Attainment (no. years 1941-89)							
Scenario	**>A-pr**	**A-pr**	**A**	**B**	**C**	**CC**	**D**	**sum**
Naturalized	9	15	7	6	3	6	3	49
Historical	9	14	7	4	5	5	5	49
Present	8	14	4	5	5	5	8	49
Baseline	7	10	8	3	3	4	14	49
TCEQ Run 3	7	10	8	1	5	3	15	49

Part b) Attainment - single criteria measures	Single G1 criteria attainment (% of yrs.)						
Scenario	**>A-pr**	**A-pr**	**A**	**B**	**C**	**CC**	**D**
Goal	n/a	>12%	>12%	n/a	n/a	n/a	≤9%
Naturalized		30.6%	14.3%	12.2%	6.1%	12.2%	6.1%
Historical		28.6%	14.3%	8.2%	10.2%	10.2%	10.2%
Present		28.6%	8.2%	10.2%	10.2%	10.2%	16.3%
Baseline		20.4%	16.3%	6.1%	6.1%	8.2%	28.6%
TCEQ Run 3		20.4%	16.3%	2.0%	10.2%	6.1%	30.6%

Part c) Attainment - joint measures	Joint G1 criteria attainment (% of years and fractions)						
Scenario	**>A-pr**		**A & B**		**C & CC**	**frac. CC**	
Goal	n/a		>17%		≥19%	≤67%	
Naturalized			26.5%		18.4%	66.7%	
Historical			22.4%		20.4%	50.0%	
Present			18.4%		20.4%	50.0%	
Baseline			22.4%		14.3%	57.1%	
TCEQ Run 3			18.4%		16.3%	37.5%	

Notes: Part a) is the counts of seasons (=years) that fall in each inflow category. Part b) measures attainment performance for the portions of the criteria that are stand-alone measures (e.g. occurrence of G1-A >12% of years). Part c) measures attainment for criteria that are to be assessed jointly (e.g. the total occurrence of G1-C and G1-CC). Attainment performance is highlighted with a color scheme as in following[18].

Color Scheme				
meaning	criteria met	criteria nearly met. rounding & period of record change probable causes.	criteria not met, departure from BBEST recommendations not great	criteria not met, departure of concern from BBEST recommendations

[18] Color scheme as adopted by the BBEST Estuary Subcommittee in that groups report to the BBASC titled "Biological and Ecological Implications of Non-Attainment of the BBEST Guadalupe Estuary Criteria", July, 2011.

Table 3.3-3. Summary of the Naturalized, Historic, Present Use, and Baseline Scenarios Attainment Performance for the G2 Suite (Summer Period) of Guadalupe Estuary Inflow Criteria

Part a) Counts	**Criteria G2 Attainment (no. years 1941-89)**								
Scenario	**>A-pr**	**A-pr**	**A**	**B**	**C**	**CC**	**D**	**DD**	**sum**
Naturalized	9	11	15	7	3	2	2	0	
Historical	8	11	11	8	5	1	1	4	49
Present	5	11	8	10	8	1	1	5	49
Baseline	4	8	8	8	7	3	3	8	49
TCEQ Run 3	4	6	9	8	6	4	3	9	49

Part b) Attainment - single criteria measures	**Single G2 criteria attainment (% of yrs.)**							
Scenario	**>A-pr**	**A-pr**	**A**	**B**	**C**	**CC**	**D**	**DD**
Goal	n/a	>12%	>17%	n/a	n/a	n/a	n/a	≤6%
Naturalized		22.4%	30.6%	14.3%	6.1%	4.1%	4.1%	0.0%
Historical		22.4%	22.4%	16.3%	10.2%	2.0%	2.0%	8.2%
Present		22.4%	16.3%	20.4%	16.3%	2.0%	2.0%	10.2%
Baseline		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
TCEQ Run 3		12.2%	18.4%	16.3%	12.2%	8.2%	6.1%	18.4%

Part c) Attainment - joint measures	**Joint G2 criteria attainment (% of years and fractions)**							
Scenario	**>A-pr**		**A & B**		**C & CC**	**frac. CC**	**D & DD**	
Goal			≥30%		≥10%	≤17%	≤9%	
Naturalized			44.9%		10.2%	40.0%*	4.1%	
Historical			38.8%		12.2%	16.7%	10.2%	
Present			36.7%		18.4%	11.1%	12.2%	
Baseline			32.7%		20.4%	30.0%	22.4%	
TCEQ Run 3			34.7%		20.4%	40.0%	24.5%	

* The 40% level for this attainment is not problematic since the overall level of G2-C and G2-CC have not increased appreciably above 10% (as per Table 4.5.2 and discussion in Section 4.5.1.1 of the BBEST recommendations in).

Note: parts a), b), and c) and color scheme as in previous table.

The areas of non-attainment of the GSA BBEST recommendations of the Baseline as indicated in Tables 3.3-2 and 3.3-3 were of concern to many members of the GSA BBASC since the Baseline is the beginning point for the GSA BBASC evaluations of potential additional water supply project(s). The GSA BBASC tasked the Estuary Subcommittee of the GSA BBEST to evaluate what the biological and ecological implications of those evident non-attainments might be. While the complete report of the Subcommittee is found in Appendix G, some of the principal conclusions of that effort were:

a) Due to the increasing prevalence of low and average springtime inflows (G1-C & CC and G1-D levels) there is the potential for long-term alteration in the area or density of *Rangia* clams.

b) However, the continuing re-occurrence of higher levels of inflows in the G1-B and G1-A range at a sufficiently short return interval, means the clams would not likely be eliminated from any of the area used as a focal area by the GSA BBEST.

c) Because of the importance of *Rangia* as a filter feeder and as an apparent food source for other organisms, there would likely be some concomitant impacts if their abundance were reduced.

d) The Subcommittee found that the increased occurrence of G2-D and G2-DD inflows leads to an extension of duration of a severe drought such as that which would result from the same hydro-climatology of the historic 1950's period. Based upon published accounts of effects of the 1950's drought, there is the potential for significant mortality of oysters over a greater period within the estuary during the drought.

e) However, given that higher Summer levels of inflow, G2-A and G2-B, are predicted to continue, the cycle of oyster decline and rejuvenation of the historic period will continue.

f) The Subcommittee was concerned that the increased G2-CC years tend to sequence with other drought years of the G2- D and G2-DD tiers, likely hastening the onset of, or lengthening duration of, the already deleterious effects of those years.

3.3.1.3 Initial Simulations for Large-Scale Firm Yield Projects

The Mid-Basin Project and San Antonio River Project were evaluated under four scenarios of instream environmental flow criteria. A short description of each scenario is described below.

No Environmental Flow Criteria

The first was a scenario in which no environmental flows criteria was used. This scenario would show the theoretical maximum firm yield of the project, subject only to existing water rights.

Lyons Method

The second scenario was the use of the Lyons Method, as presented in Tables 3.3-4 and 3.3-5. The Lyons Method was the default desktop environmental flow criteria used by TCEQ prior to the initiation of the SB3 Environmental Flows process.

Table 3.3-4. Lyons Method Instream Flow Criteria for the Guadalupe River at Gonzales (cfs)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
398.2	399.0	668.8	794.8	839.7	766.2	544.2	443.5	499.3	366.6	345.3	333.2

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Table 3.3-5. Lyons Method Instream Flow Criteria for the San Antonio River at Goliad (cfs)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
398.2	399.0	668.8	794.8	839.7	766.2	544.2	443.5	499.3	366.6	345.3	333.2

Consensus Criteria for Environmental Flow Needs (CCEFN)

The third scenario included the use of the CCEFN method for determining environmental flow criteria. This was the default environmental flow criteria used in the regional planning process, per TWDB rules. The values for the CCEFN are presented in Tables 3.3-6 and 3.3-127.

Table 3.3-6. Consensus Criteria for Environmental Flow Needs Instream Flow Criteria for the Guadalupe River at Gonzales (cfs)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Median	294.2	306.6	306.8	305.8	371.0	346.3	241.9	199.4	239.9	258.0	283.1	288.9
Quartile	183.3	197.4	176.1	157.0	175.4	145.9	89.9	77.3	103.4	134.0	140.3	150.8
7Q2	77.0	77.0	77.0	77.0	77.0	77.0	77.0	77.0	77.0	77.0	77.0	77.0

Table 3.3-7. Consensus Criteria for Environmental Flow Needs Instream Flow Criteria for the San Antonio River at Goliad (cfs)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Median	820.6	887.5	867.3	923.5	1068.6	945.0	755.3	641.0	691.8	733.1	742.6	793.7
Quartile	580.3	610.0	585.9	581.1	625.8	576.5	545.0	545.0	545.0	545.0	545.0	531.8
7Q2	545.0	545.0	545.0	545.0	545.0	545.0	545.0	545.0	545.0	545.0	545.0	545.0

Full BBEST Recommendations

The final environmental flow criteria used in the initial evaluation of projects was the implementation of the GSA BBEST Recommendations. The full BBEST recommendations are presented in Tables 3.3-8 and 3.3-9 for the Mid-Basin Project and San Antonio River Project, respectively.

Table 3.3-8. Full BBEST Recommendations for the Guadalupe River at Gonzales (cfs)

	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
Overbank Flows	Qp: 36,700 cfs with Average Frequency 1 per 5 years Regressed Volume is 492,000 Duration Bound is 70			
	Qp: 24,400 cfs with Average Frequency 1 per 2 years Regressed Volume is 306,000 Duration Bound is 57			
	Qp: 14,300 cfs with Average Frequency 1 per year Regressed Volume is 165,000 Duration Bound is 43			
High Flow Pulses	Qp: 4,140 cfs with Average Frequency 1 per season Regressed Volume is 48,300 Duration Bound is 29	Qp: 6,590 cfs with Average Frequency 1 per season Regressed Volume is 58,400 Duration Bound is 24	Qp: 1,760 cfs with Average Frequency 1 per season Regressed Volume is 14,800 Duration Bound is 14	Qp: 4,330 cfs with Average Frequency 1 per season Regressed Volume is 41,200 Duration Bound is 23
	Qp: 1,150 cfs with Average Frequency 2 per season Regressed Volume is 9,640 Duration Bound is 13	Qp: 3,250 cfs with Average Frequency 2 per season Regressed Volume is 26,900 Duration Bound is 17	Qp: 950 cfs with Average Frequency 2 per season Regressed Volume is 7,060 Duration Bound is 10	Qp: 1,410 cfs with Average Frequency 2 per season Regressed Volume is 11,400 Duration Bound is 13
Base Flows (cfs)	860	870	800	810
	690	650	650	690
	540	440	440	510
Subsistence Flows (cfs)	210	210	210	180

Table 3.3-9. Full BBEST Recommendation for the San Antonio River at Goliad (cfs)

	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
Overbank Flows	Qp: 23,600 cfs with Average Frequency 1 per 5 years Regressed Volume is 273,000 Duration Bound is 69			
	Qp: 10,600 cfs with Average Frequency 1 per 2 years Regressed Volume is 107,000 Duration Bound is 45			
	Qp: 7,680 cfs with Average Frequency 1 per year Regressed Volume is 73,500 Duration Bound is 38			
High Flow Pulses	Qp: 1,520 cfs with Average Frequency 1 per season Regressed Volume is 12,800 Duration Bound is 19	Qp: 3,540 cfs with Average Frequency 1 per season Regressed Volume is 30,000 Duration Bound is 24	Qp: 1,640 cfs with Average Frequency 1 per season Regressed Volume is 11,200 Duration Bound is 16	Qp: 2,320 cfs with Average Frequency 1 per season Regressed Volume is 17,600 Duration Bound is 19
	Qp: 550 cfs with Average Frequency 2 per season Regressed Volume is 3,940 Duration Bound is 11	Qp: 1,570 cfs with Average Frequency 2 per season Regressed Volume is 11,300 Duration Bound is 16	Qp: 750 cfs with Average Frequency 2 per season Regressed Volume is 4,450 Duration Bound is 10	Qp: 780 cfs with Average Frequency 2 per season Regressed Volume is 5,070 Duration Bound is 11
Base Flows (cfs)	290	280	220	270
	200	180	150	200
	140	130	120	130
Subsistence Flows (cfs)	76	60	54	66

Simulations of the Mid-Basin Project and San Antonio River Project for the initial four scenarios were made using the GSA WAM. The time series of monthly regulated flow and availability from the GSA WAM were disaggregated to daily values using local gage information. The Flow Recommendation Application Tool (FRAT, v3.3) was then used to calculate the firm yield and resulting downstream flow for the two projects subject to the four initial environmental criteria. The firm yield results for the Mid-Basin Project and San Antonio River Project are presented in Figures 3.3-4 and 3.3-5, respectively. The flow frequency curves of the resulting streamflow immediately downstream of the Mid-Basin Project and San Antonio River Project are presented in Figures 3.3-6 and 3.3-7, respectively. Percentages presented reflect the firm yield reduction due to application of the environmental flow assumptions of each of the initial simulations.

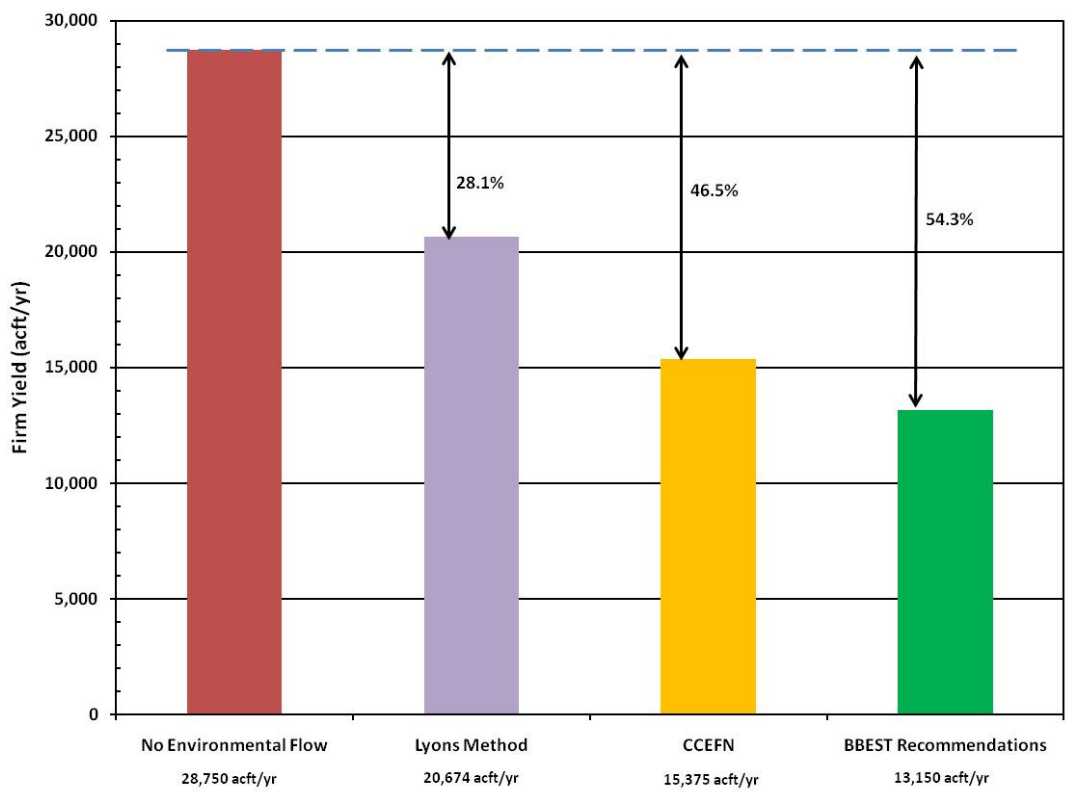

Figure 3.3-4. Initial Firm Yield Results – Mid-Basin Project

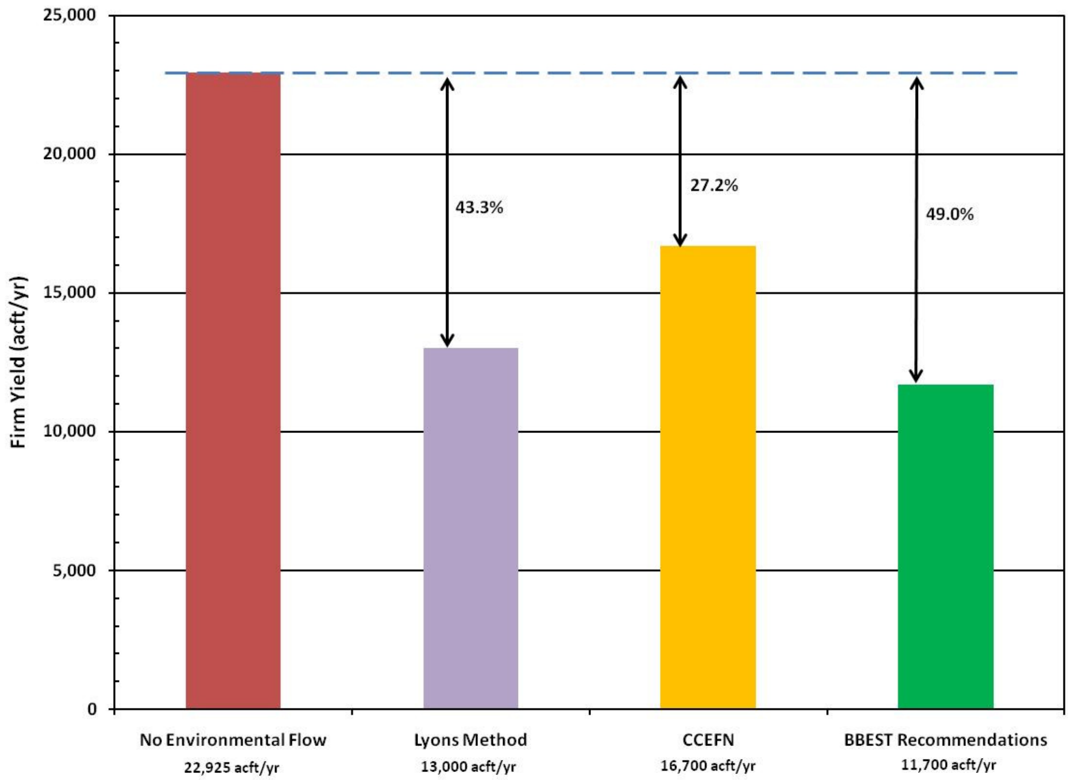

Figure 3.3-5. Initial Firm Yield Results San Antonio River Project

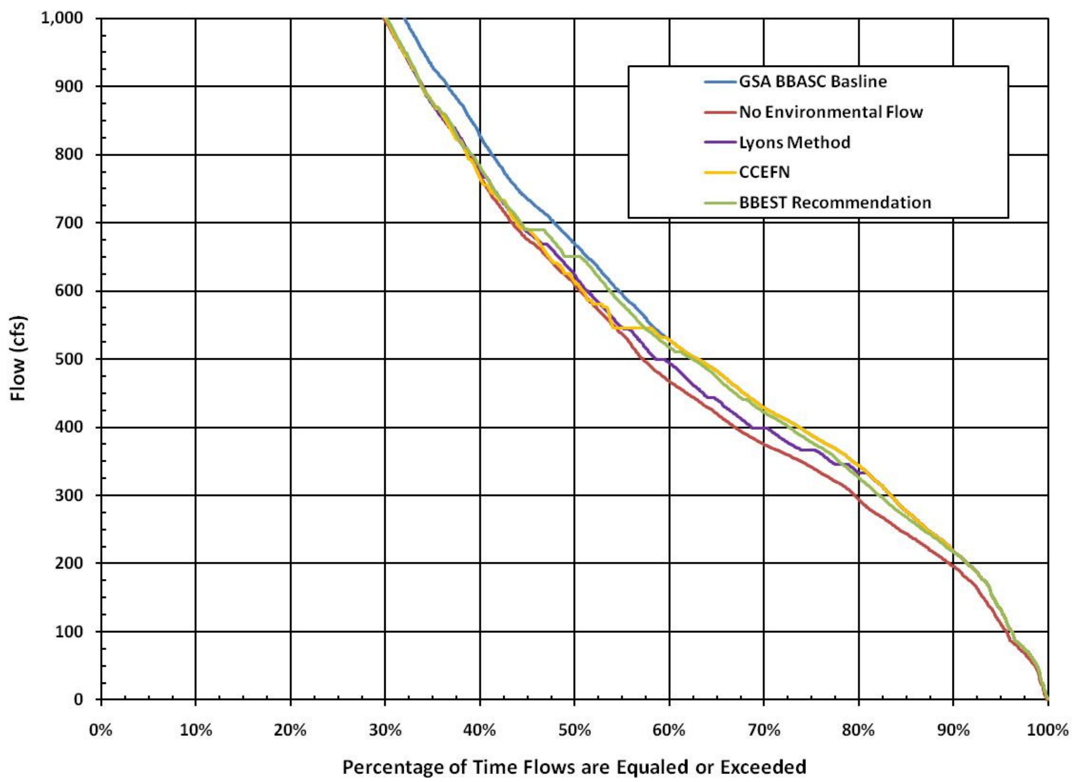

Figure 3.3-6. Resulting Downstream Flow – Mid-Basin Project

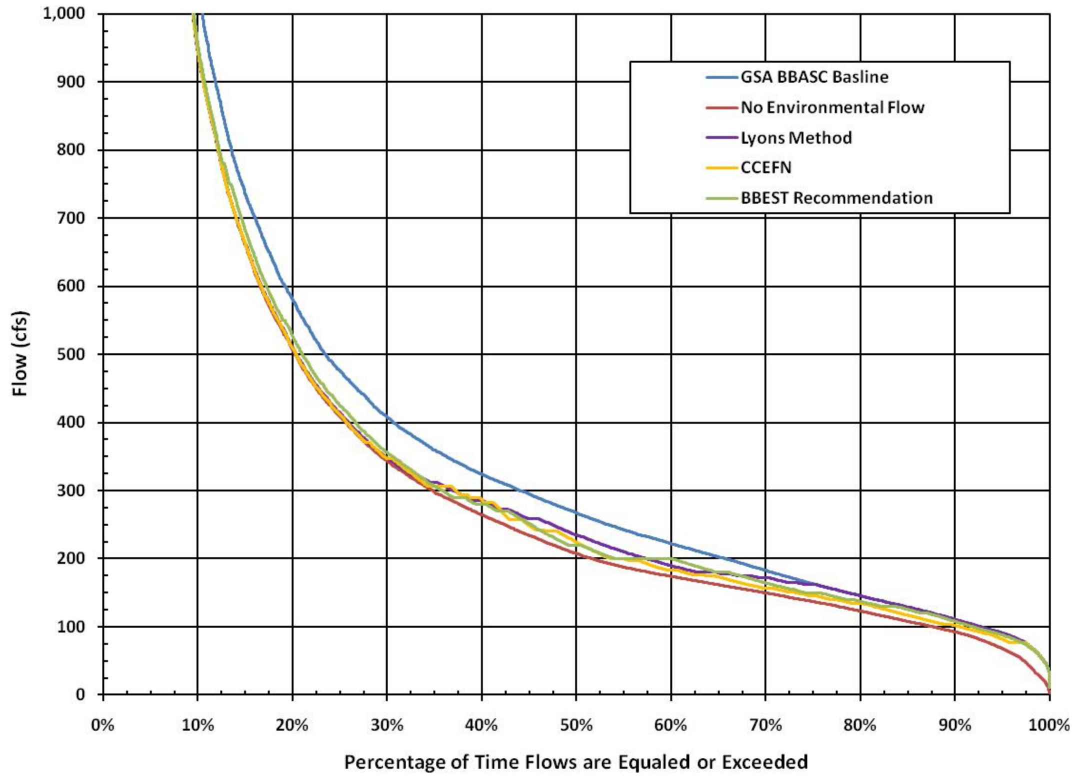

Figure 3.3-7. Resulting Downstream Flow – San Antonio River Project

INSTREAM ASSESSMENT

The full suite of instream analysis described above in Section 3.3.1.2 were applied to the FRAT output for the Mid-Basin Project and San Antonio River Project with the four initial instream environmental criteria scenarios. For Mid-Basin Project, the WUA curves developed by the GSA BBEST for Gonzales were used. For San Antonio River Project, the WUA curves developed by the SB2 TIFP study for Goliad were used. As presented at the May 4, 2011 GSA BBASC meeting, the projected aquatic habitat differences between all four of the environmental criteria for both projects and the baseline were so slight that no environmental consequences beyond that of the baseline scenario are evident. The No Environmental Flow Criteria did cause a few instances of extended low-flows beyond the other three scenarios, but these conditions were still within the range of seasonal subsistence flows and thus, are considered to provide the corresponding aquatic habitats and water quality conditions documented by the GSA BBEST. As with the aquatic habitat projections, the total annual volume calculations for each environmental criteria evaluated and the baseline are very similar. As such, no major changes to the riparian communities or channel configuration beyond that caused by the baseline is anticipated. It is important to remember that all comparisons are being examined directly back to the baseline scenario.

ESTUARY ASSESSMENT

The four differing scenarios of no instream environmental criteria and three actual instream environmental criteria were applied to both the Mid-Basin Project and the San Antonio River Project, each of these were then evaluated individually with regard to their capacity to meet the GSA BBEST inflow recommendations for the Guadalupe Estuary. The daily project passes of water for senior water rights and instream environmental flow criteria were summed into monthly values and placed in the GSA WAM in order to calculate the effects of each project/instream criteria combination on the freshwater inflow to the Guadalupe Estuary.

Using the same approach as described above for the "non-project scenarios" (e.g. Naturalized or Baseline), the inflows to the Guadalupe Estuary were compared to the GSA BBEST recommendations with each water supply project/ instream flow combination in place. The results of this evaluation for the Guadalupe Mid-Basin Project are summarized in Tables 3.3-10 and 3.3-11. Similar results for the San Antonio River Project are found in Tables 3.3-12 and 3.3-3.3-13. In these tables, each scenario is labeled with a number or letter for ease of reference and consistency with an appendix containing other scenarios.

As shown in Table 3.3-10 and 3.3-11, the inflows to the Guadalupe Estuary with the Mid-Basin Project subject to these four scenarios of instream flow environmental criteria (none, Full BBEST, CCEFN, and Lyons) led to little change in the attainment of the estuary criteria as compared to the Region L Baseline. The primary results of these evaluations for the Mid-Basin Project were:

▪ the very lowest levels of the Spring criteria G1-D occurred 28.6% of years in all cases (3.3-10, part b), whereas the GSA BBEST recommendation was for no more than 9% of years.;

▪ the three different instream criteria all led to the same result for G2-DD: 16.3% of years (3.3-11, part b) whereas the GSA BBEST recommendation was for no more than 6% of years;

▪ the case of No Instream Environmental Criteria raised the non-attainment for G2-DD to 18.4% of years (3.3-11, part b).

▪ the case of No Instream Environmental Criteria led to the fraction of G2-CC of the total for G2-C and G2-CC, increasing to 40%, whereas the GSA BBEST recommendation was for no more than 17% of years (3.3-11, part c).

Table 3.3-10. Summary of Initial Evaluations of the Mid-Basin Project Attainment Performance for the G1 Suite (Spring Period) of Guadalupe Estuary Inflow Criteria

Part a) Counts	Criteria G1 Attainment (no. years 1941-89)							
Scenario	**>A-pr**	**A-pr**	**A**	**B**	**C**	**CC**	**D**	**sum**
Historical	9	14	7	4	5	5	5	49
Baseline	7	10	8	3	3	4	14	49
w. Guadalupe Mid-Basin Project (500 cfs max. diversion)								
1: 105k, No instream flow (IF) criteria	7	9	9	1	5	4	14	49
2: 105k, Full BBEST IF recomms.	7	10	8	2	4	4	14	49
3: 105k, Consensus CEFN	7	9	9	1	5	4	14	49
4: 105k, Lyons Method	7	9	9	2	4	4	14	49

Part b) Attainment - single criteria measures	Single G1 criteria attainment (% of yrs.)						
Scenario	**>A-pr**	**A-pr**	**A**	**B**	**C**	**CC**	**D**
<u>Goal</u>	n/a	>12%	>12%	n/a	n/a	n/a	≤9%
Historical		28.6%	14.3%	8.2%	10.2%	10.2%	10.2%
Baseline		20.4%	16.3%	6.1%	6.1%	8.2%	28.6%
w. Guadalupe Mid-Basin Project (500 cfs max. diversion)							
1: 105k, No instream flow (IF) criteria		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
2: 105k, Full BBEST IF recomms.		20.4%	16.3%	4.1%	8.2%	8.2%	28.6%
3: 105k, Consensus CEFN		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
4: 105k, Lyons Method		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%

Part c) Attainment - joint measures	Joint G1 criteria attainment (% of years and fractions)			
Scenario	**>A-pr**	**A & B**	**C & CC**	**frac. CC**
<u>Goal</u>	n/a	>17%	≥19%	≤67%
Historical		22.4%	20.4%	50.0%
Baseline		22.4%	14.3%	57.1%
w. Guadalupe Mid-Basin Project (500 cfs max. diversion)				
1: 105k, No instream flow (IF) criteria		20.4%	18.4%	44.4%
2: 105k, Full BBEST IF recomms.		20.4%	16.3%	50.0%
3: 105k, Consensus CEFN		20.4%	18.4%	44.4%
4: 105k, Lyons Method		22.4%	16.3%	50.0%

Notes: Part a) is the counts of seasons (=years) that fall in each inflow category. Part b) measures attainment performance for the portions of the criteria that are stand-alone measures (e.g. occurrence of G1-A >12% of years). Part c) measures attainment for criteria that are to be assessed jointly (e.g. the total occurrence of G1-C and G1-CC). Attainment performance is highlighted with a color scheme indicated at the bottom[19]. 105k refers to reservoir size in thousands of acre-feet.

Color Scheme	(green)	(grey)	(orange)	(red)
meaning	criteria met	criteria nearly met. rounding & period of record change probable causes.	criteria not met, departure from BBEST recommendations not great	criteria not met, departure of concern from BBEST recommendations

[19] Color scheme as adopted by the BBEST Estuary Subcommittee in that groups report to the BBASC titled "Biological and Ecological Implications of Non-Attainment of the BBEST Guadalupe Estuary Criteria", July, 2011.

Table 3.3-11. Summary of Initial Evaluations of the Mid-Basin Project Attainment Performance for the G2 Suite (Summer Period) of Guadalupe Estuary Inflow Criteria

Part a) Counts	Criteria G2 Attainment (no. years 1941-89)								
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD	sum
Historical	8	11	11	8	5	1	1	4	49
Baseline	4	8	8	8	7	3	3	8	49
w. Guadalupe Mid-Basin Project (500 cfs max. diversion)									
1: 105k, No instream flow (IF) criteria	4	8	8	8	6	4	2	9	49
2: 105k, Full BBEST IF recomms.	4	8	8	8	7	3	3	8	49
3: 105k, Consensus CEFN	4	8	8	8	7	3	3	8	49
4: 105k, Lyons Method	4	8	8	8	7	3	3	8	49

Part b) Attainment - single criteria measures	Single G2 criteria attainment (% of yrs.)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD
Goal	n/a	>12%	>17%	n/a	n/a	n/a	n/a	≤6%
Historical		22.4%	22.4%	16.3%	10.2%	2.0%	2.0%	8.2%
Baseline; BBASC		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. Guadalupe Mid-Basin Project (500 cfs max. diversion)								
1: 105k, No instream flow (IF) criteria		16.3%	16.3%	16.3%	12.2%	8.2%	4.1%	18.4%
2: 105k, Full BBEST IF recomms.		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
3: 105k, Consensus CEFN		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
4: 105k, Lyons Method		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%

Part c) Attainment - joint measures	Joint G2 criteria attainment (% of years and fractions)				
Scenario	>A-pr	A & B	C & CC	frac. CC	D & DD
Goal		≥30%	≥10%	≤17%	≤9%
Historical		38.8%	12.2%	16.7%	10.2%
Baseline; BBASC		32.7%	20.4%	30.0%	22.4%
w. Guadalupe Mid-Basin Project (500 cfs max. diversion)					
1: 105k, No instream flow (IF) criteria		32.7%	20.4%	40.0%	22.4%
2: 105k, Full BBEST IF recomms.		32.7%	20.4%	30.0%	22.4%
3: 105k, Consensus CEFN		32.7%	20.4%	30.0%	22.4%
4: 105k, Lyons Method		32.7%	20.4%	30.0%	22.4%

A similar assessment was performed for the San Antonio River Project with the same three instream environmental flow criteria as well as the case of No Instream Environmental Criteria. The results of these assessments for the San Antonio River Project for the Guadalupe Estuary G1 and G2 criteria suites are shown in Table 3.3-12 and Table 3.3-13, respectively. The primary results of these evaluations for the San Antonio River Project were:

▪ the problematic occurrence of the G1-D level of inflow is not increased beyond the 28.6% of the Baseline (3.3-12, part b), whereas the GSA BBEST recommendation was for this to occur no more than 9% of years.

▪ the No Instream Environmental Criteria or Consensus Criteria for Environmental Flow Needs (CCEFN) scenarios both lead to an increase in the Summer G2-DD occurrence to 18.4% or years (3.3-13, part b), up from 16.3% in the Baseline. The GSA BBEST recommendation for this level of inflow was that it occur no more than 6% of years.

▪ the No Instream Environmental Criteria or Consensus Criteria for Environmental Flow Needs (CCEFN) scenarios led to increases in the fraction of G2-CC years to 36.4% and 40%, respectively, both well beyond the GSA BBEST recommendation of no more than 17%.

Table 3.3-12. Summary of Initial Evaluations of the San Antonio River Project Attainment Performance for the G1 Suite (Spring Period) of Guadalupe Estuary Inflow Criteria

Part a) Counts	**Criteria G1 Attainment (no. years 1941-89)**							
Scenario	**>A-pr**	**A-pr**	**A**	**B**	**C**	**CC**	**D**	**sum**
Historical	9	14	7	4	5	5	5	49
Baseline	7	10	8	3	3	4	14	49
w. San Antonio River Project (800 cfs max. diversion)								
A: 150k, No instream flow (IF) criteria	7	9	9	1	5	4	14	49
B: 150k, Full BBEST IF Recomms.	7	9	9	1	5	4	14	49
C: 150k, Consensus CEFN	7	9	9	1	5	4	14	49
D: 150k, Lyons Method	7	9	9	2	4	4	14	49

Part b) Attainment - single criteria measures	**Single G1 criteria attainment (% of yrs.)**						
Scenario	**>A-pr**	**A-pr**	**A**	**B**	**C**	**CC**	**D**
Goal	n/a	>12%	>12%	n/a	n/a	n/a	≤9%
Historical		28.6%	14.3%	8.2%	10.2%	10.2%	10.2%
Baseline		20.4%	16.3%	6.1%	6.1%	8.2%	28.6%
w. San Antonio River Project (800 cfs max. diversion)							
A: 150k, No instream flow (IF) criteria		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
B: 150k, Full BBEST IF Recomms.		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
C: 150k, Consensus CEFN		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
D: 150k, Lyons Method		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%

Part c) Attainment - joint measures	**Joint G1 criteria attainment (% of years and fractions)**			
Scenario	**>A-pr**	**A & B**	**C & CC**	**frac. CC**
Goal	n/a	>17%	≥19%	≤67%
Historical		22.4%	20.4%	50.0%
Baseline		22.4%	14.3%	57.1%
w. San Antonio River Project (800 cfs max. diversion)				
A: 150k, No instream flow (IF) criteria		20.4%	18.4%	44.4%
B: 150k, Full BBEST IF Recomms.		20.4%	18.4%	44.4%
C: 150k, Consensus CEFN		20.4%	18.4%	44.4%
D: 150k, Lyons Method		22.4%	16.3%	50.0%

Notes: Parts a), b), and c) as in previous tables. Attainment performance is highlighted with a color scheme as in previous tables. 150k refers to the volume of the reservoir in thousands of acre-feet.

Table 3.3-13. Summary of Initial Evaluations of the San Antonio River Project Attainment Performance for the G2 Suite (Summer Period) of Guadalupe Estuary Inflow Criteria

Part a) Counts	Criteria G2 Attainment (no. years 1941-89)								
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD	sum
Historical	8	11	11	8	5	1	1	4	49
Baseline	4	8	8	8	7	3	3	8	49
w. San Antonio River Project (800 cfs max. diversion)									
A: 150k, No instream flow (IF) criteria	4	7	9	7	7	4	2	9	49
B: 150k, Full BBEST IF Recomms.	4	8	8	8	7	3	3	8	49
C: 150k, Consensus CEFN	4	8	8	8	6	4	2	9	49
D: 150k, Lyons Method	4	8	8	8	7	3	3	8	49

Part b) Attainment - single criteria measures	Single G2 criteria attainment (% of yrs.)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD
Goal	n/a	>12%	>17%	n/a	n/a	n/a	n/a	≤6%
Historical		22.4%	22.4%	16.3%	10.2%	2.0%	2.0%	8.2%
Baseline; BBASC		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. San Antonio River Project (800 cfs max. diversion)								
A: 150k, No instream flow (IF) criteria		14.3%	18.4%	14.3%	14.3%	8.2%	4.1%	18.4%
B: 150k, Full BBEST IF Recomms.		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
C: 150k, Consensus CEFN		16.3%	16.3%	16.3%	12.2%	8.2%	4.1%	18.4%
D: 150k, Lyons Method		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%

Part c) Attainment - joint measures	Joint G2 criteria attainment (% of years and fractions)					
Scenario	>A-pr	A & B		C & CC	frac. CC	D & DD
Goal		≥30%		≥10%	≤17%	≤9%
Historical		38.8%		12.2%	16.7%	10.2%
Baseline; BBASC		32.7%		20.4%	30.0%	22.4%
w. San Antonio River Project (800 cfs max. diversion)						
A: 150k, No instream flow (IF) criteria		32.7%		22.4%	36.4%	22.4%
B: 150k, Full BBEST IF Recomms.		32.7%		20.4%	30.0%	22.4%
C: 150k, Consensus CEFN		32.7%		20.4%	40.0%	22.4%
D: 150k, Lyons Method		32.7%		20.4%	30.0%	22.4%

Notes: Parts a), b), and c) and color scheme as in previous tables. 150k refers to the volume of the reservoir in thousands of acre-feet.

One important result from the above estuary evaluations is notable. There is little difference among the scenarios, even that of "No Instream Environmental Flow criteria." This seems to indicate that there is little water available during low flows because of the demands of downstream senior water rights (as explored further in Appendix E2). Furthermore, during high flows, the limited diversion capacity of a project does not significantly decrease the streamflow. This will also lead to a lack of differentiation among the instream criteria with regard to the inflow to the Guadalupe Estuary.

PROJECT COST ANALYSES

Capital and Project Costs for the projects were determined for the facilities described in Section 3.3.1 using the same costing procedure as used in regional planning. The Annual Cost of water was determined by amortizing the total project cost for 20 years at six percent. The resulting unit costs were derived by dividing the annual cost of water by the firm yield of the projects. Cost estimates were prepared to show the unit cost of water both untreated at the reservoir and treated at the point of delivery. These cost estimates for the Mid-Basin Project and the San Antonio River Project are presented in Tables 3.3-14 and 3.3-15.

Table 3.3-14. Cost Estimate for the Mid-Basin Project

	No Environmental Flow	Lyons Method	CCEFN	BBEST Recommendation
Available Project Yield (acft/yr)	28,750	20,674	15,375	13,150
Raw Water at Reservoir				
Total Project Cost	$253,801,000	$253,801,000	$253,801,000	$253,801,000
Total Annual Cost	$22,908,000	$22,854,000	$22,636,000	$22,563,000
Annual Cost of Raw Water ($ per acft)	$797	$1,105	$1,472	$1,716
Annual Cost of Raw Water ($ per 1,000 gallons)	$2.45	$3.39	$4.52	$5.27
Treated Water Delivered				
Total Project Cost	$475,090,000	$413,942,000	$384,892,000	$369,922,000
Total Annual Cost	$49,713,000	$42,891,000	$38,912,000	$37,123,000
Annual Cost of Water ($ per acft)	$1,729	$2,075	$2,531	$2,823
Annual Cost of Water ($ per 1,000 gallons)	$5.31	$6.37	$7.77	$8.66

Table 3.3-15. Cost Estimate for the San Antonio River Project

	No Environmental Flow	Lyons Method	CCEFN	BBEST Recommendation
Available Project Yield (acft/yr)	22,925	13,000	16,700	11,700
Raw Water at Reservoir				
Total Project Cost	$273,450,000	$273,450,000	$273,450,000	$273,450,000
Total Annual Cost	$24,560,000	$24,378,000	$24,396,000	$24,232,000
Annual Cost of Raw Water ($ per acft)	$1,071	$1,875	$1,461	$2,071
Annual Cost of Raw Water ($ per 1,000 gallons)	$3.29	$5.75	$4.48	$6.36
Treated Water Delivered				
Total Project Cost	$523,535,000	$440,614,000	$471,271,000	$432,205,000
Total Annual Cost	$54,793,000	$44,634,000	$48,586,000	$43,006,000
Annual Cost of Water ($ per acft)	$2,390	$3,433	$2,909	$3,676
Annual Cost of Water ($ per 1,000 gallons)	$7.33	$10.54	$8.93	$11.28

3.3.1.4 Intermediate Simulations

In the deliberations of the GSA BBASC to strike a balance between environmental needs and water supply needs, several "intermediate" scenarios of differing instream flow criteria were applied to the firm yield projects. Appendix E contains presentations made to the GSA BBASC that summarize these simulations. Key simulations that aided the GSA BBASC in their decision-making process include:

- Simulations raising the subsistence flows up to the Q95 values for the Mid-Basin Project and San Antonio River Project. Both evaluations showed a decrease in firm yield (to 12,800 acft/yr and 11,475 acft/yr, respectively as shown in Figures 3.3-8 and 3.3-11). The resulting streamflow downstream of the project when compared to the Full BBEST Scenario is shown in Figures 3.3-9 and 3.3-12, respectively.
- Simulations to eliminate diversions below the Dry Base Flow for the Mid-Basin Project and San Antonio River Project. Both evaluations showed a decrease in firm yield (to 12,375 acft/yr and 11,160 acft/yr, respectively as shown in Figures 3.3-8 and 3.3-11, respectively). The resulting streamflow downstream of the project when compared to the Full BBEST Scenario is shown in Figures 3.3-9 and 3.3-12, respectively.
- Simulations implementing the East Texas Structure as adopted by TCEQ for the Trinity, San Jacinto, Neches, and Sabine basins (subsistence flows, one tier of baseflows [Dry], and one tier of pulses), with the values from the GSA BBEST Recommendations.
    - The simulation for the Mid-Basin Project showed an increase in the firm yield of the project (firm yield = 25,500 acft/yr, see Figure 3.3-8), with 0-75 cfs change in streamflow across the flow regime compared to the Full BBEST Scenario (see Figure 3.3-9). The simulation did show an increase of one to the number of G2-DD occurrences at the Guadalupe Estuary.
    - The simulation for the San Antonio River Project showed a noticeable increase in the firm yield of the project (firm yield = 17,300 acft/yr, see Figure 3.3-11), with 0-30 cfs change in streamflow across the flow regime compared to the Full BBEST Scenario (see Figure 3.3-12). The simulation did show an increase of one to the number of G2-CC occurrences at the Guadalupe Estuary.
- Simulation of the Mid-Basin Project with a larger off-channel reservoir capacity. This evaluation showed that with increased storage, the Mid-Basin Project could have a firm yield of over 20,000 acft/yr while still meeting the Full BBEST Recommendation for Environmental Flows. Cost analysis added that the increase to the unit cost would be an increase of about $100/acft/yr compared to the smaller off-channel reservoir.
- Simulations implementing the Pulse Exemption Rule at various percentages. Results from this simulation showed increases to the firm yields of the Mid-Basin Project and San Antonio River Project (See Figures 3.3-10 and 3.3-13, respectively).
- Simulation implementing the TIFP Interim Environmental Flows Recommendations. The evaluation indicated that the firm yield of the San Antonio River Project would increase under these recommendations (firm yield = 14,700 acft/yr, see Figure 3.3-11, labeled as "SB2").

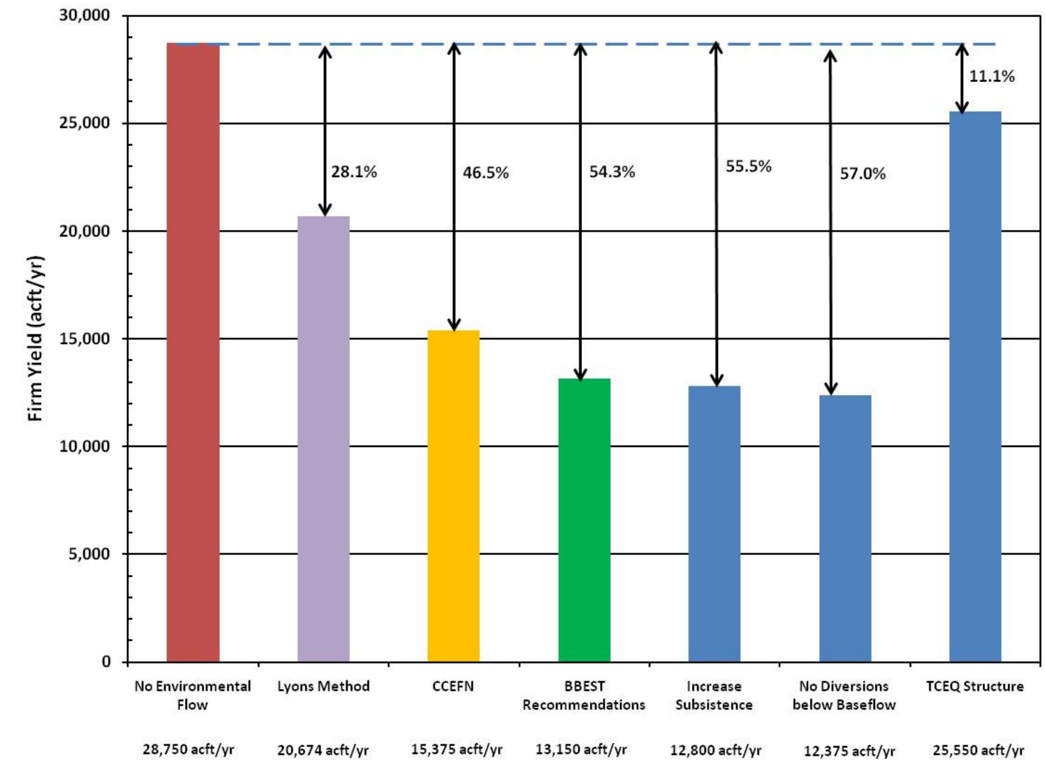

Figure 3.3-8. Firm Yield Results Including Iterative Simulations – Mid-Basin Project

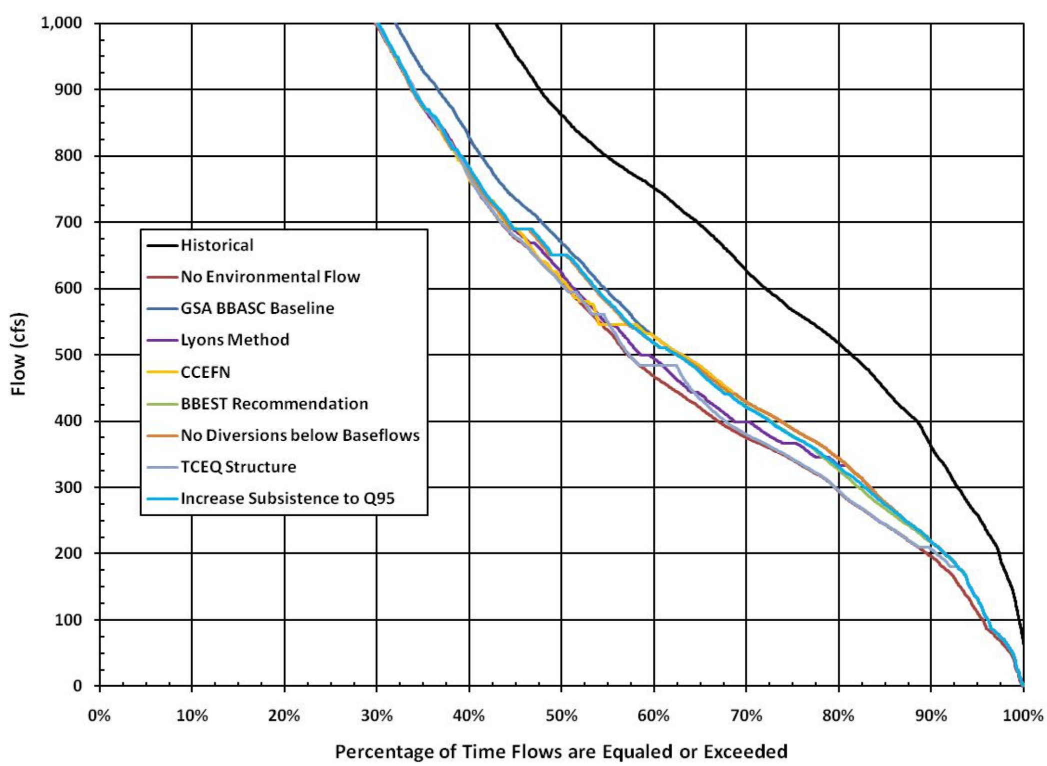

Figure 3.3-9. Resulting Downstream Flows for Iterative Simulations – Mid-Basin Project

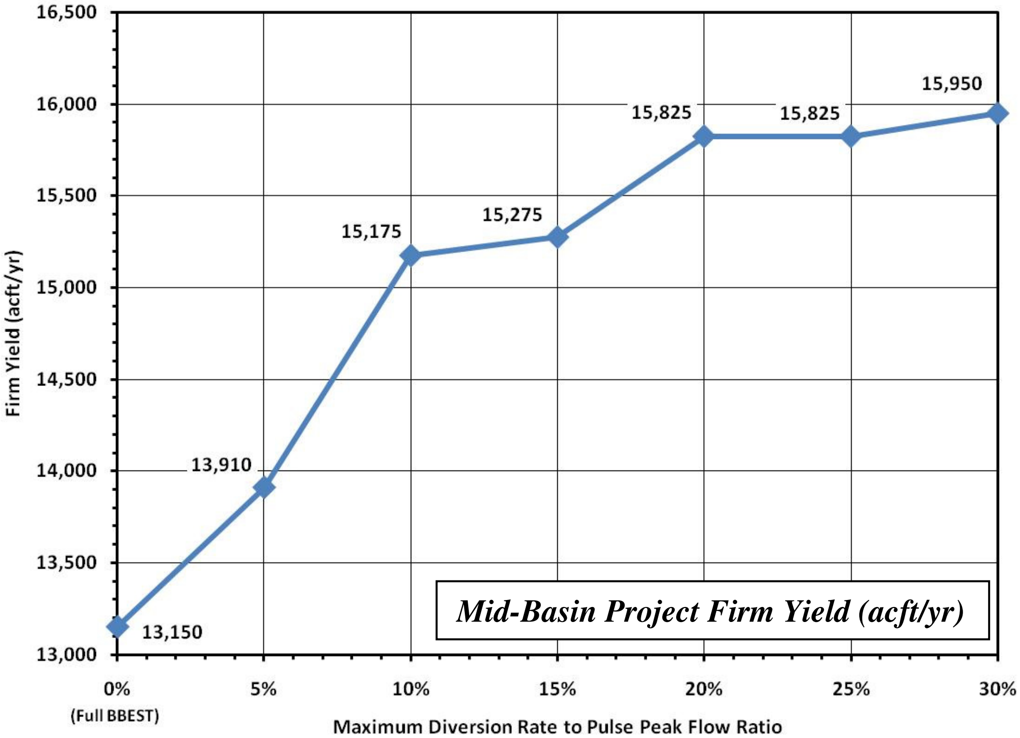

Figure 3.3-10. Firm Yield Results for the Pulse Exemption Rule – Mid-Basin Project

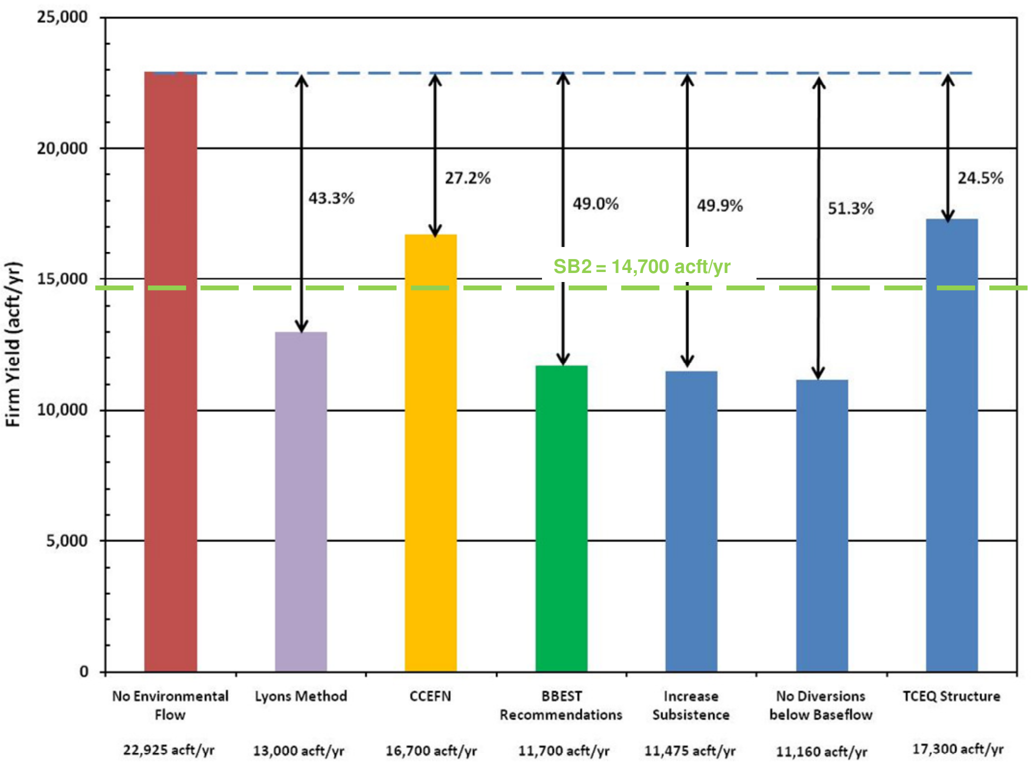

Figure 3.3-11. Firm Yield Results Including Iterative Simulations – San Antonio River Project

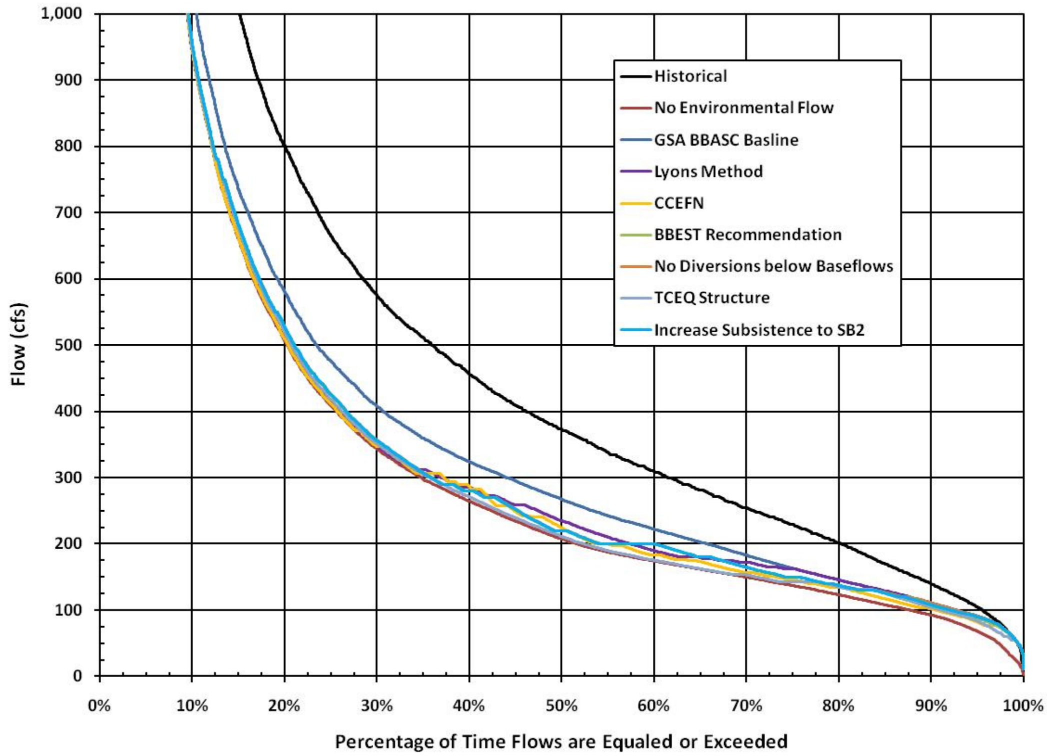

Figure 3.3-12. Resulting Downstream Flows for Iterative Simulations – San Antonio River Project

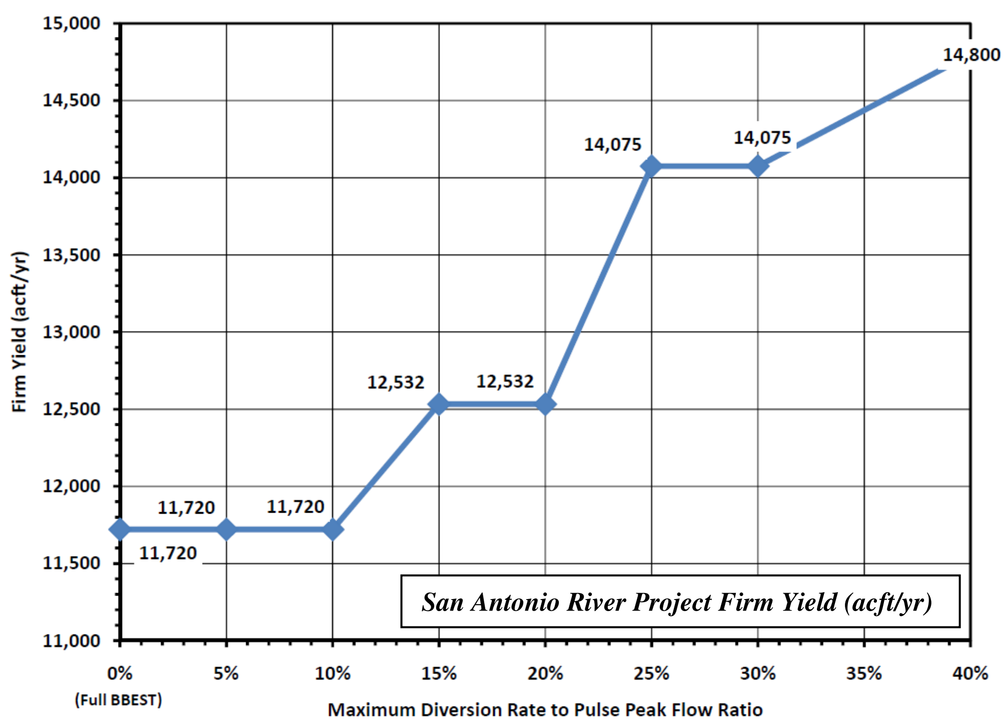

Figure 3.3-13. Firm Yield Results for the Pulse Exemption Rule – San Antonio River Project

Additionally, an exercise was conducted to see the potential firm yield impacts if the components of the Full BBEST Recommendations were systematically eliminated for the Mid-Basin Project and San Antonio River Project. Results of this exercise for the Mid-Basin Project and the San Antonio River Project are presented in Figures 3.3-14 and 3.3-15, respectively.

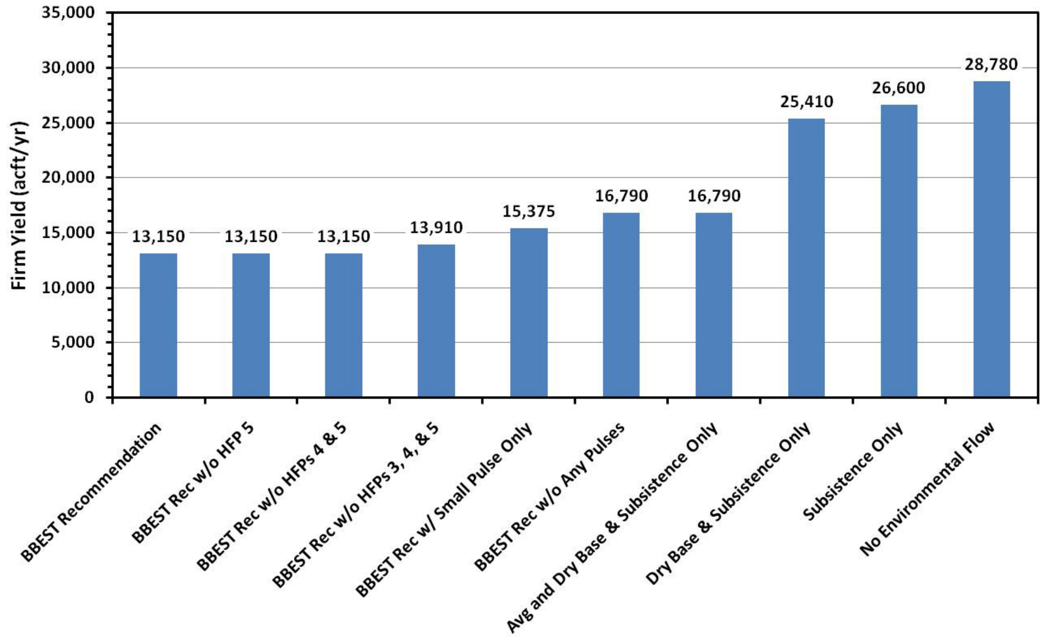

Figure 3.3-14. Firm Yield Results Eliminating Components of the Full BBEST Recommendation – Mid-Basin Project

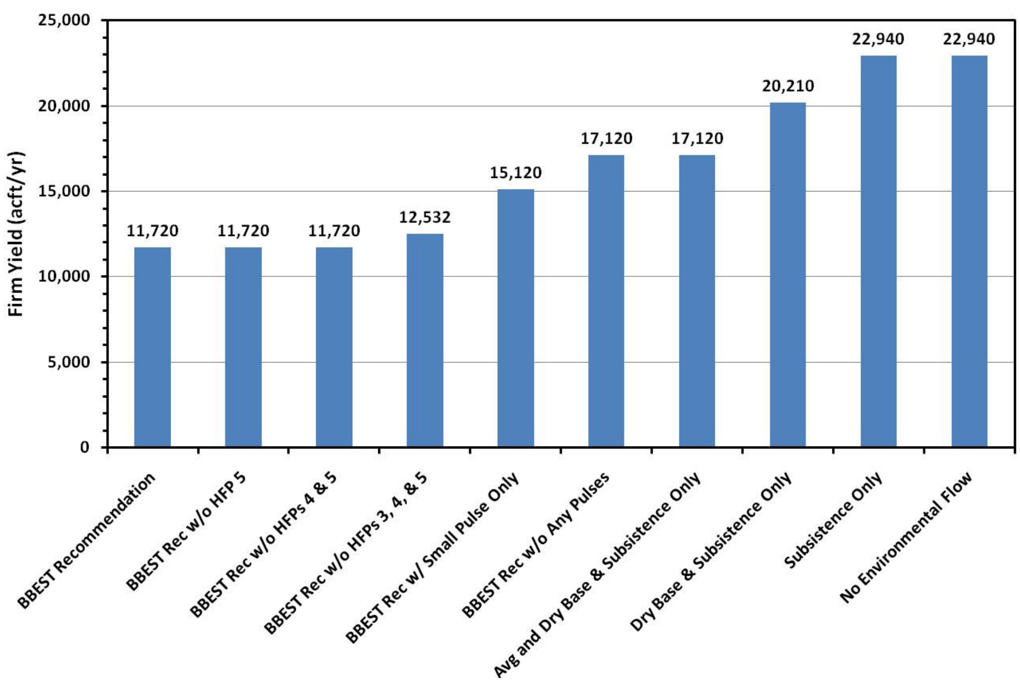

Figure 3.3-15. Firm Yield Results Eliminating Components of the Full BBEST Recommendation – San Antonio River Project

INSTREAM ASSESSMENT

As with the initial runs described above, the full suite of instream analysis were applied to the FRAT output for the Mid-Basin Project and San Antonio River Project for each iterative simulation. Projected aquatic habitat and total annual volume differences for each criteria scenario for both projects remained minimal relative to each other, the initial runs, and the baseline.

For both the Guadalupe Mid-basin Project and the San Antonio River Project, as various options were considered for the instream flow criteria at Gonzales and Goliad, respectively, each was also assessed for that particular scenario's capacity to meet the GSA BBEST estuary inflow recommendations. The same approach used previously for "non-project" and "initial" instream flow criteria was utilized, wherein the predicted Spring (Feb.-May) and Summer (June-Sept.) inflows for the entire 49 years of record (1941-89) were used. In each case the attainment performance or ability to meet the GSA BBEST recommendations was evaluated. For comparison purposes and consistency with previous sections, the results here also include the Historical and the Region L Baseline scenarios. Except for a change in the period of record from 1941-2009 to 1941-89, the Historical inflows correspond to those used by the GSA BBEST in deriving their recommendations.

ESTUARY ASSESSMENT

Table 3.3-16 and 3.3-17 tally the estuary attainment performance of the Guadalupe River Mid-basin Project with three "intermediate" variations of instream flow environmental criteria and the originally-sized off-channel reservoir with 105 thousand ac-ft capacity. Also among the intermediate scenarios was an examination of a larger reservoir with 192 thousand ac-ft capacity. Each scenario is labeled with a number for ease of reference and consistency with an appendix containing other scenarios. The principal findings of these assessments for the Mid-Basin Project were:

▪ all of these approaches led to no difference from the Region L Baseline with regard to the very lowest levels of the Spring G1 criteria, G1-CC and G1-D as is evident in parts a) and b) of Table 3.3-16. G1-D inflow occurred in 28.6% of years in all cases, whereas the GSA BBEST recommendation was for no more than 9% of years.

▪ all scenarios led to some changes in the attainment levels for the G1-C and G1-B levels but did not lead to any changes to the GSA BBEST recommendations as indicated by the green shading in parts b) and c) of the table.

▪ only the "East Tx. Structure " approach with one base flow level and one high-flow pulse had one additional year of Summer inflows in the G2-DD category (3.3-17, part b) raising this scenario's total to 9 years or 18.4% of years, whereas the GSA BBEST recommendation was for no more than 6% of years. The other three approaches were all at the 16.3 % level for this lowest tier of the G2 criteria suite.

▪ in all cases the combined occurrence of G2-D and G2-DD was at 22.4% of years (11 years as in 3.3-17, part a for the sum of these), while the GSA BBEST recommendation was for no more than 9% of years for this measure.

▪ only the “East Tx. Structure” raised the ratio of G2-CC to a total of 40% (3.3-17. part c) compared to the GSA BBEST recommendation of no more than 17%.

Table 3.3-16. Intermediate Evaluations, Summary of the Mid-Basin Project Attainment Performance for the G1 Suite (Spring Period) of Guadalupe Estuary Inflow Criteria

Part a) Counts	Criteria G1 Attainment (no. years 1941-89)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	sum
Historical	9	14	7	4	5	5	5	49
Region L Baseline	7	10	8	3	3	4	14	49
w. Guadalupe Mid-Basin Project (500 cfs max. diversion)								
5: 105k, BBEST IF, No Div if Q<Base Dry	7	10	8	2	4	4	14	49
6: 105k, BBEST IF & Pulse 10% Div Rule	7	9	9	2	4	4	14	49
9: 105k, East Tx. 1 Base / 1 Pulse Structure.	7	10	8	1	5	4	14	49
11: 192k, Full BBEST Recommendations.	7	10	8	2	4	4	14	49

Part b) Attainment - single criteria measures	Single G1 criteria attainment (% of yrs.)						
Scenario	>A-pr	A-pr	A	B	C	CC	D
goal	n/a	>12%	>12%	n/a	n/a	n/a	≤9%
Historical		28.6%	14.3%	8.2%	10.2%	10.2%	10.2%
Region L Baseline		20.4%	16.3%	6.1%	6.1%	8.2%	28.6%
w. Guadalupe Mid-Basin Project (500 cfs max. diversion)							
5: 105k, BBEST IF, No Div if Q<Base Dry		20.4%	16.3%	4.1%	8.2%	8.2%	28.6%
6: 105k, BBEST IF & Pulse 10% Div Rule		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%
9: 105k, East Tx. 1 Base / 1 Pulse structure.		20.4%	16.3%	2.0%	10.2%	8.2%	28.6%
11: 192k, Full BBEST Recommendations.		20.4%	16.3%	4.1%	8.2%	8.2%	28.6%

Part c) Attainment - joint measures	Joint G1 criteria attainment (% of years and fractions)			
Scenario	>A-pr	A & B	C & CC	frac. CC
goal	n/a	>17%	≥19%	≤67%
Historical		22.4%	20.4%	50.0%
Region L Baseline		22.4%	14.3%	57.1%
w. Guadalupe Mid-Basin Project (500 cfs max. diversion)				
5: 105k, BBEST IF, No Div if Q<Base Dry		20.4%	16.3%	50.0%
6: 105k, BBEST IF & Pulse 10% Div Rule		22.4%	16.3%	50.0%
9: 105k, East Tx. 1 Base / 1 Pulse structure.		18.4%	18.4%	44.4%
11: 192k, Full BBEST Recommsendations		20.4%	16.3%	50.0%

Notes: Parts a), b), and c) and color scheme as in earlier tables.. 105k or 192 k refers to reservoir size in thousands of acre-feet.

cell color scheme

color	(green)	(gray)	(orange)	(red)
meaning	criteria met	criteria nearly met. rounding & period of record change probable causes.	criteria not met, departure from BBEST recommendations not great	criteria not met, departure of concern from BBEST recommendations

Table 3.3-17. Intermediate Evaluations, Summary of the Mid-basin Project Attainment Performance for the G2 Suite (Summer Period) of Guadalupe Estuary Inflow Criteria

Part a) Counts	**Criteria G2 Attainment (no. years 1941-89)**								
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD	sum
Historical	8	11	11	8	5	1	1	4	49
Region L Baseline	4	8	8	8	7	3	3	8	49
w. Guadalupe Mid-Basin Project (500 cfs max. diversion)									
5: 105k, BBEST IF, No Div if Q<Base Dry	4	8	8	8	7	3	3	8	49
6: 105k, BBEST IF & Pulse 10% Div Rule	4	8	8	8	7	3	3	8	49
9: 105k, East Tx. 1 Base / 1 Pulse Structure.	4	8	8	8	6	4	2	9	49
11: 192k, Full BBEST Recommendations.	4	8	8	8	7	3	3	8	49

Part b) Attainment - single criteria measures	Single G2 criteria attainment (% of yrs.)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD
Goal	n/a	>12%	>17%	n/a	n/a	n/a	n/a	≤6%
Historical		22.4%	22.4%	16.3%	10.2%	2.0%	2.0%	8.2%
Region L Baseline; BBASC		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. Guadalupe Mid-Basin Project (500 cfs max. diversion)								
5: 105k, BBEST, No Div if Q<Base Dry		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
6: 105k, BBEST & Pulse 10% Div Rule		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
9: 105k, East Tx. 1 Base / 1 Pulse Structure.		16.3%	16.3%	16.3%	12.2%	8.2%	4.1%	18.4%
11: 192k, Full BBEST Recommendations.		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%

Part c) Attainment - joint measures	Joint G2 criteria attainment (% of years and fractions)					
Scenario	>A-pr	A & B		C & CC	frac. CC	D & DD
Goal		≥30%		≥10%	≤17%	≤9%
Historical		38.8%		12.2%	16.7%	10.2%
Region L Baseline; BBASC		32.7%		20.4%	30.0%	22.4%
w. Guadalupe Mid-Basin Project (500 cfs max. diversion)						
5: 105k, BBEST, No Div if Q<Base Dry		32.7%		20.4%	30.0%	22.4%
6: 105k, BBEST & Pulse 10% Div Rule		32.7%		20.4%	30.0%	22.4%
9: 105k, East Tx. 1 Base / 1 Pulse Structure.		32.7%		20.4%	40.0%	22.4%
11: 192k, Full BBEST Recommmendations.		32.7%		20.4%	30.0%	22.4%

Similarly, intermediate scenario assessments were performed for the San Antonio River Project with results in Tables 3.3-18 and Table 3.3-19 for G1 and G2 seasons, respectively. With the availability of interim Texas Instream Flow Program (Senate Bill 2) results for the San Antonio River, there was more of a focus on these for this project compared to the Mid-Basin Project in which the intermediate scenarios were largely modifications of the GSA BBEST recommendations. Again, each scenario is labeled with a letter for ease of reference and consistency with Appendix E2 containing other scenarios. The principal findings for these instream flow criteria applied to the San Antonio River Project were:

▪ all of the intermediate San Antonio River Project scenarios led to the G1-D level of inflow in 28.6% of years, whereas the GSA BBEST recommendation was for no more than 9% of years;

▪ all scenarios led to some increase in the occurrence of the G1-C levels, but the fraction of G1-CC to the total of G1-C and G1-CC was below the recommended 67% in all cases (see part c);

▪ all intermediate scenarios of instream flow criteria resulted in a G2-DD occurrence of 16.3% of years, whereas the GSA BBEST recommendation was for no more than 6% of years;

▪ for these two TIFP scenarios (“F: and “G”), there was an increase in the fraction of G2-CC to the total, raising it to 33.3% (part c). The Region L Baseline already exhibited the problematic level of 30%, whereas the GSA BBEST recommendation was for no more than 17% of years;

▪ for the “East Tx. Structure” the fraction of G2-CC rose to 36.4%;

▪ for both of the TIFP scenarios (“F: and “G”) there was a change in the attainment performance for the combined G2-A and G2-B measure: both fell to 28.6% of years, whereas the GSA BBEST recommendation was for this to occur at least 30% of years, This could be attributed potentially to the difference in the period of record between the GSA BBASC and the longer period of the GSA BBEST used to derive the criteria.

Table 3.3-18. Intermediate Evaluations, Summary of the San Antonio River Project Attainment Performance for the G1 Suite (Spring Period) of Guadalupe Estuary Inflow Criteria

Part a) Counts	Criteria G1 Attainment (no. years 1941-89)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	sum
Historical	9	14	7	4	5	5	5	49
Region L Baseline	7	10	8	3	3	4	14	49
w. San Antonio River Project (800 cfs max. diversion)								
E: 150k, BBEST IF, no div if Q<Base Dry	7	9	9	1	5	4	14	49
F: 150k, TIFP 80cfs subs., no 50% subs/base rule	7	9	9	2	4	4	14	49
G: 150k, TIFP 60cfs subs., 50% rule, Pulse 10% div. rule	7	9	9	2	4	4	14	49
H: 150k, East Tx. 1 base / 1 Pulse struc	7	9	9	1	5	4	14	49

Part b) Attainment - single criteria measures	Single G1 criteria attainment (% of yrs.)						
Scenario	>A-pr	A-pr	A	B	C	CC	D
goal	n/a	>12%	>12%	n/a	n/a	n/a	≤9%
Historical		28.6%	14.3%	8.2%	10.2%	10.2%	10.2%
Region L Baseline		20.4%	16.3%	6.1%	6.1%	8.2%	28.6%
w. San Antonio River Project (800 cfs max. diversion)							
E: 150k, BBEST IF, no div if Q<Base Dry		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
F: 150k, TIFP 80cfs subs., no 50% subs/base rule		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%
G: 150k, TIFP 60cfs subs., 50% rule, Pulse 10% div. rule		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%
H: 150k East Tx. 1 base / 1 Pulse struc		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%

Part c) Attainment - joint measures	Joint G1 criteria attainment (% of years and fractions)			
Scenario	>A-pr	A & B	C & CC	frac. CC
goal	n/a	>17%	≥19%	≤67%
Historical		22.4%	20.4%	50.0%
Region L Baseline		22.4%	14.3%	57.1%
w. San Antonio River Project (800 cfs max. diversion)				
E: 150k, BBEST IF, no div if Q<Base Dry		20.4%	18.4%	44.4%
F: 150k, TIFP 80cfs subs., no 50% subs/base rule		22.4%	16.3%	50.0%
G: 150k, TIFP 60cfs subs., 50% rule, Pulse 10% div. rule		22.4%	16.3%	50.0%
H: 150k East Tx. 1 base / 1 Pulse struc		20.4%	18.4%	44.4%

Notes: Parts a), b), and c) as in previous tables. Attainment performance is highlighted with a color scheme as in previous tables. 150k refers to the volume of the reservoir in thousands of acre-feet.

Table 3.3-19. Intermediate Evaluations, Summary of the San Antonio River Project Attainment Performance for the G2 Suite (Summer Period) of Guadalupe Estuary Inflow Criteria

Part a) Counts	**Criteria G2 Attainment (no. years 1941-89)**								
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD	sum
Historical	8	11	11	8	5	1	1	4	49
Region L Baseline	4	8	8	8	7	3	3	8	49
w. San Antonio River Project (800 cfs max. diversion)									
E: 150k, BBEST IF, no div if Q<Base Dry	4	8	8	8	7	3	3	8	49
F: 150k, TIFP 80cfs subs., no 50% subs/base rule	4	8	8	6	8	4	3	8	49
G: 150k, TIFP 60cfs subs., 50% rule, Pulse 10% div. rule	4	8	8	6	8	4	3	8	49
H: 150k East Tx. 1 base / 1 Pulse struc	4	8	8	7	7	4	3	8	49

Part b) Attainment - single criteria measures	Single G2 criteria attainment (% of yrs.)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD
goal	n/a	>12%	>17%	n/a	n/a	n/a	n/a	≤6%
Historical		22.4%	22.4%	16.3%	10.2%	2.0%	2.0%	8.2%
Region L Baseline; BBASC		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. San Antonio River Project (800 cfs max. diversion)								
E: 150k, BBEST IF, no div if Q<Base Dry		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
F: 150k, TIFP 80cfs subs., no 50% subs/base rule		16.3%	16.3%	12.2%	16.3%	8.2%	6.1%	16.3%
G: 150k, TIFP 60cfs subs., 50% rule, Pulse 10% div. rule		16.3%	16.3%	12.2%	16.3%	8.2%	6.1%	16.3%
H: 150k East Tx. 1 base / 1 Pulse struc		16.3%	16.3%	14.3%	14.3%	8.2%	6.1%	16.3%

Part c) Attainment - joint measures	Joint G2 criteria attainment (% of years and fractions)						
Scenario	>A-pr	A & B		C & CC	frac. CC	D & DD	
goal		≥30%		≥10%	≤17%	≤9%	
Historical		38.8%		12.2%	16.7%	10.2%	
Region L Baseline; BBASC		32.7%		20.4%	30.0%	22.4%	
w. San Antonio River Project (800 cfs max. diversion)							
E: 150k, BBEST IF, no div if Q<Base Dry		32.7%		20.4%	30.0%	22.4%	
F: 150k, TIFP 80cfs subs., no 50% subs/base rule		28.6%		24.5%	33.3%	22.4%	
G: 150k, TIFP 60cfs subs., 50% rule, Pulse 10% div. rule		28.6%		24.5%	33.3%	22.4%	
H: 150k East Tx. 1 base / 1 Pulse struc		30.6%		22.4%	36.4%	22.4%	

Notes: Parts a), b), and c) and color scheme as in previous tables. 150k refers to reservoir size in thousands of acft.

ADDITIONAL ANALYSIS

In support of the analyses performed by members of the GSA BBEST Estuary Subcommittee, Sam Vaugh of the GSA BBEST used existing equations and data to perform simple quantitative analyses estimating potential effects of changes in freshwater inflow on oyster harvest in the Guadalupe Estuary. These quantitative analyses were presented to the GSA BBASC during its meeting of July 28, 2011 and are briefly summarized in the following paragraphs.

An equation facilitating calculation of annual harvest of Eastern oysters from averages of bi-monthly freshwater inflows in the current and preceding two years were developed and applied by the TPWD and TWDB in preparing freshwater inflow recommendations for the Guadalupe Estuary[20]. As part of a study performed in preparation of the 2011 Region L Regional Water Plan[21], this equation was refined using improved estimates of freshwater inflow accounting for diversions and return flows prior to 1977. The refined equation has an associated coefficient of determination of 0.64 indicating that 64 percent of the variation in annual Eastern oyster harvest can be explained by this equation based only on freshwater inflow.

The refined equation has been applied to selected monthly time series of freshwater inflows for the 1941-1989 historical period and long-term averages of annual oyster harvests have been calculated. Conclusions drawn from these relatively simple quantitative analyses include the following:

a. For Present, Baseline, and Mid-Basin Project (with full GSA BBEST recommendations applied) scenarios, long-term average oyster harvests are estimated to be 91 percent, 84 percent, and 80 percent, respectively, of the historical average.
b. Results tend to support the GSA BBEST Estuary Subcommittee conclusion that potential changes in oyster abundance may be affected by full use of existing water rights to greater degree than by a new permit operated subject to instream environmental flow standards.
c. Equations use inflows in parts of three consecutive years so the GSA BBEST Estuary Subcommittee concern with potential effects of extended drought durations is quantitatively addressed to some degree.
d. Equations showed that each of the scenarios evaluated met or exceeded the optimization target of 80 percent of mean historical harvest used by the TPWD and TWDB in the development of their current freshwater inflow recommendations for the Guadalupe Estuary.

3.3.1.5 Simulations Using the Final GSA BBASC Recommendations

The final instream GSA BBASC recommendation for the Guadalupe River at Gonzales (location of the Mid-Basin Project can be found in Section 4.1.6. For the Guadalupe River at Gonzales the GSA BBASC Recommendation increased the firm yield to 22,800 acft/yr of the project

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[20] Texas Parks & Wildlife Department and Texas Water Development Board, "Freshwater Inflow Recommendation for the Guadalupe Estuary of Texas," Coastal Studies Technical Report No. 98-1, December 1998.

[21] HDR Engineering, Inc., "Environmental Studies, 2011 Regional Water Plan, Study 4, Part A," South Central Texas Regional Water Planning Group, Texas Water Development Board, San Antonio River Authority, April 2009.

compared to the application of the Full BBEST Recommendation (13,150 acft/yr), which includes the Pulse Exemption Rule, the single-tier of base flows in the Winter and Fall seasons, and the 50 Percent Rule as described in Section 4.1.1.2(b).

The final instream GSA BBASC recommendation for the San Antonio River at Goliad (location of the San Antonio River Project) can be found in Section 4.1.15. The GSA BBASC chose to adopt the TIFP Interim Recommendations, with a few modifications. No simulation was made for the San Antonio River Project, as the GSA BBASC recommendations for the San Antonio River at Goliad were formed in a fashion that the current FRAT cannot simulate. However, simulations of the San Antonio River Project with earlier TIFP recommendations can be referenced to approximate the firm yield of the project of about 14,000 acft/yr, as compared to the application of the Full BBEST Recommendation (firm yield = 11,700 acft/yr)

INSTREAM ASSESSMENT

Time did not permit the application of the full suite of instream analysis described above for the final GSA BBASC recommendations on the Mid-Basin Project or San Antonio River Project. However, the final recommendations were bracketed by previous iterations such that results stemming from a full instream analysis would fall somewhere in between the results already discussed. As such, there are no anticipated significant differences to aquatic habitats or total annual volume relative to the baseline scenario. As discussed at the August 3, 2011 GSA BBASC meeting, this does not mean that no environmental consequences would be experienced with the development of either the Mid-Basin Project or San Antonio River Project. All projects will have some level of environmental consequences. Additionally, as previously noted, environmental consequences relative to existing conditions will be experienced under the baseline scenario. It must also be reiterated that at some point, multiple projects and/or larger projects subject to the GSA BBASC final recommendations would likely show measurable differences compared to the baseline. This again highlights the importance of the GSA BBASC's charge of balancing and foresight to consider the potential for cumulative impacts and what is really considered feasible relative to future projections for this basin.

ESTUARY ASSESSMENT

With the recommendations of the GSA BBASC narrowing in on a final set of instream flow criteria applicable at the Guadalupe River at Gonzales site, it was possible to perform an estuary inflow assessment of these as applicable to the Mid-Basin Project. The single scenario ("13" labeled for consistency with an appendix) presented here is for the case in which there are three levels of base flow in Spring and Summer and just the Base Wet level in the Fall and Winter, also called the 1-3-3-1 approach. Similar to many, but not all, previous scenarios, there is the 50% rule applied to pro-rate diversions between the lowest level of Base and Subsistence flows. The final recommendations of the GSA BBASC for this site also include a Pulse Exemption Rule of 20% governing the applicability of pulse requirements, whereas the previous scenarios in Section 3.3.1.4 for the Mid-Basin Project had a 10% ratio (see Section 4.3.2).

As shown in Table 3.3-20 and 3.3-21 there were minimal differences in the attainment performance of the resulting estuary inflows for this set of instream flow criteria applied to the

Mid-Basin Project. The principal findings of this assessment for the final Gonzales instream flow recommendations applied to the Mid-Basin Project were:

▪ there was no change to the very lowest levels, G1-CC and G1-D, as was evident in parts a) and b) of Table 3.3-20. Specifically, the G1-D level of inflow occurred in 14 years (28.6% of years), whereas the GSA BBEST recommendation was for no more than 9% of years;

▪ there was a single year change of one additional year of G1-B falling to the G2-C level compared to the Region L Baseline (3.3-20, part a). However, while this led to some small changes in the joint attainment measures (e.g. for G1-A and G1-B combined, as in part c), there were no changes to the GSA BBEST recommendations in these higher tiers;

▪ the occurrence of the lowest Summer tier, G2-DD, was at 16.3% of years (3.3-21, part b), whereas the GSA BBEST recommendation was for no more than 6% of years.

▪ the combined occurrence of G2-D and G2-DD was at 22.4% of years (11 years as in part a for the sum of these), while the GSA BBEST recommendation was for no more than 9% of years for this measure (3.3-21, part c).

▪ the same overall count of G2-C and G2-CC inflows (10 years) occurred as in the Region L Baseline, both with a fraction of 30% of G2-CC (3.3-21, part c) compared to the GSA BBEST recommendation of no more than 17%.

Table 3.3-20. Final Recommendations, Summary of the Mid-Basin Project Attainment Performance for the G1 Suite (Spring Period) of Guadalupe Estuary Inflow Criteria

Part a) Counts	Criteria G1 Attainment (no. years 1941-89)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	sum
Historical	9	14	7	4	5	5	5	49
Region L Baseline	7	10	8	3	3	4	14	49
w. Guadalupe Mid-Basin Project (500 cfs max. diversion)								
13: 105k, 1-3-3-1 Base Wet; Subs 50% rule; Pulse 20% div rule	7	10	8	2	4	4	14	49

Part b) Attainment - single criteria measures	Single G1 criteria attainment (% of yrs.)						
Scenario	>A-pr	A-pr	A	B	C	CC	D
goal	n/a	>12%	>12%	n/a	n/a	n/a	≤9%
Historical		28.6%	14.3%	8.2%	10.2%	10.2%	10.2%
Region L Baseline		20.4%	16.3%	6.1%	6.1%	8.2%	28.6%
w. Guadalupe Mid-Basin Project (500 cfs max. diversion)							
13: 105k, 1-3-3-1 Base Wet; Subs 50% rule; Pulse 20% div rule		20.4%	16.3%	4.1%	8.2%	8.2%	28.6%

Part c) Attainment - joint measures	Joint G1 criteria attainment (% of years and fractions)			
Scenario	>A-pr	A & B	C & CC	frac. CC
goal	n/a	>17%	≥19%	≤67%
Historical		22.4%	20.4%	50.0%
Region L Baseline		22.4%	14.3%	57.1%
w. Guadalupe Mid-Basin Project (500 cfs max. diversion)				
13: 105k, 1-3-3-1 Base Wet; Subs 50% rule; Pulse 20% div rule		20.4%	16.3%	50.0%

Notes: Parts a) b) and c) and color scheme as in previous tables. 105k refers to reservoir size in thousands of acre-feet.

Table 3.3-21. Final Recommendations, Summary of the Mid-Basin Project Attainment Performance for the G2 Suite (Summer Period) of Guadalupe Estuary Inflow Criteria

Part a) Counts	**Criteria G2 Attainment (no. years 1941-89)**								
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD	sum
Historical	8	11	11	8	5	1	1	4	49
Region L Baseline	4	8	8	8	7	3	3	8	49
w. Guadalupe Mid-Basin Project (500 cfs max. diversion)									
13: 105k, 1-3-3-1 Base Wet; Subs 50% rule; Pulse 20% div rule	4	8	8	8	7	3	3	8	49

Part b) Attainment - single criteria measures	Single G2 criteria attainment (% of yrs.)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD
goal	n/a	>12%	>17%	n/a	n/a	n/a	n/a	≤6%
Historical		22.4%	22.4%	16.3%	10.2%	2.0%	2.0%	8.2%
Region L Baseline; BBASC		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. Guadalupe Mid-Basin Project (500 cfs max. diversion)								
13: 105k, 1-3-3-1 Base Wet; Subs 50% rule; Pulse 20% div rule		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%

Part c) Attainment - joint measures	Joint G2 criteria attainment (% of years and fractions)				
Scenario	>A-pr	A & B	C & CC	frac. CC	D & DD
goal		≥30%	≥10%	≤17%	≤9%
Historical		38.8%	12.2%	16.7%	10.2%
Region L Baseline; BBASC		32.7%	20.4%	30.0%	22.4%
w. Guadalupe Mid-Basin Project (500 cfs max. diversion)					
13: 105k, 1-3-3-1 Base Wet; Subs 50% rule; Pulse 20% div rule		32.7%	20.4%	30.0%	22.4%

The GSA BBASC also developed a final set of recommendations at the Goliad site on the San Antonio River. Unfortunately, time and budget constraints, as well as limitations in the available technical tools, prevented the GSA BBASC's technical consultants and GSA BBEST members from performing a calculation of the inflows to the Guadalupe Estuary for the final San Antonio River Project instream flow criteria. However, the previously evaluated scenarios, as presented in Section 3.3.1.4, do provide some significant insights. The closest "intermediate" instream flow criteria set for the San Antonio River Project was that labeled "G" which had the final Subsistence and Base Flow values as adopted by the GSA BBASC. That scenario also had the 50% rule applied to pro-rate diversions between the lowest level of Base and Subsistence flows. The principal changes for the final GSA BBASC recommendations at this site involved a change in the Pulse Exemption Rule concept with a ratio of 20% governing the applicability of pulse requirements compared to 10% previously. The final GSA BBASC recommendations on pulses also included an intermediate pulse level compared to the scenarios evaluated previously for the San Antonio River Project.

Given these differences, it is not possible to completely predict the effects on estuary inflows. However, as has been the case through all the San Antonio River Project scenarios there is little water available to a new project at low levels of river flow due to the demands of existing downstream water rights. Thus, it is very unlikely that the final instream flow criteria recommendations at Goliad, applied to the San Antonio River Project, would lead to any change in the attainment performance of the lower tiers of either the G1 Spring or G2 Summer GSA BBEST recommendations (e.g. G1-D, G2-D and G2-DD). The revision of the Pulse Exemption Rule to 20% and the addition of the intermediate pulse requirements would counteract one another with regard to the ability of the project to divert water at higher river flows, thus the net effects on upper estuary inflow tiers is unknown due to modeling limitations.

3.3.2 Run-of-River Simulations

Simulations of new run-of-river diversions were made at six locations in the stakeholder area (see Figure 3.3-16). The locations were:

- San Marcos River at Luling
- Guadalupe River at Goliad
- Guadalupe River at Victoria
- San Antonio River at Elmendorf
- Cibolo Creek near Falls City
- Mission River at Refugio

Each new authorized diversion was for 10,000 acft/yr with a uniform diversion of streamflow subject to downstream senior water rights and three environmental flow criteria: No Environmental Flow Criteria, Lyons Method, and Full BBEST Recommendation. For the Full BBEST Recommendation, the environmental criteria were limited to the subsistence and baseflow components only. These simulation results are summarized in Appendix E1.

It is noted that the inclusion of the Pulse Exemption Rule (Section 4.3.1) in the GSA BBASC Recommendations has addressed the issue of pulse recommendations for new run-of-river appropriations. As such, the simulations presented in this section were superseded by the GSA BBASC Recommendations.

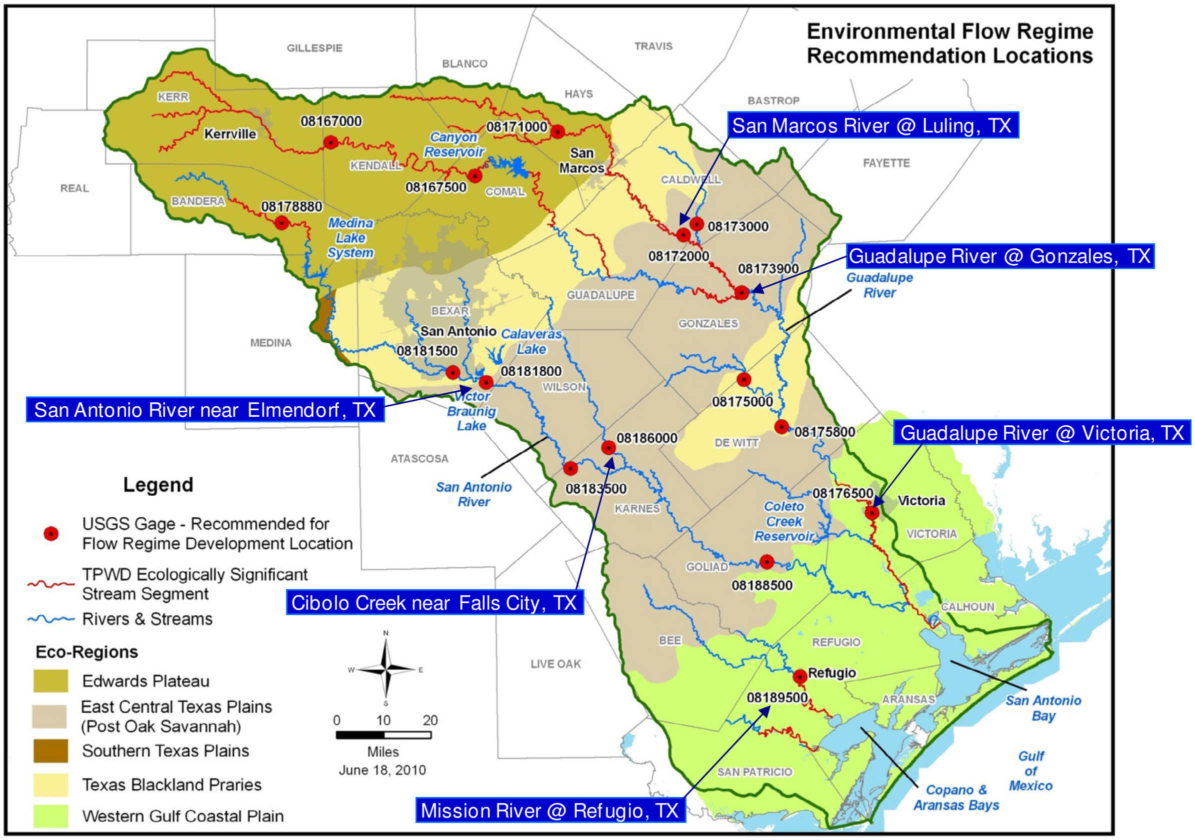

Figure 3.3-16. Locations of the Run-of-River Simulations

3.3.3 Trinity Aquifer and Upper Guadalupe River Streamflow[22]

The most recent TWDB Groundwater Availability Model (GAM) for the Trinity Aquifer System subdivides it into four layers, including (1) Edwards Group of the Edwards-Trinity (Plateau) Aquifer, (2) Upper Trinity, (3) Middle Trinity, and (4) Lower Trinity. The areal extent of the model domain is essentially from the Colorado River to the northeast and the surface divide between the San Antonio and Nueces River basins to the southwest.

In the development and adoption of the Desired Future Conditions (DFCs), Groundwater Management Area 9 (GMA 9) officials held numerous public meetings and requested that the TWDB conduct many GAM runs. During the course of defining the DFCs, considerable value was placed on: (1) the relationship and interdependency of groundwater, springs, creeks, and rivers; (2) local demographic and socio-economic considerations, and (4) local hydrogeological characteristics. In support of GMA 9, the TWDB's GAM Task 10-005 Report presents an extensive sensitivity analysis by varying annual pumping from 0 to 120,000 acft in 20,000 acft/yr increments. This resulted in seven long-term simulations for comparison. From these results, statistics were generated, by layer, for pumping versus drawdown, springflow and baseflow, and outflow across the Balcones Fault Zone. The selected DFC by GMA 9 was Scenario 6 in this

[22] Note: This task was included in the technical consultant's scope of work, but not presented in time to aid in the formulation of the GSA BBASC Recommendations.

report, which allows the total annual pumpage to be about 100,000 acft, an increase of about 40,000 acft/yr from the 2008 estimate of 60,000 acft/yr. This scenario results in a regional drawdown in the Upper, Middle and Lower Trinity of about 30 ft through 2060. For the Edwards Group of the Edwards-Trinity (Plateau) in Kendall and Bandera Counties, the DFC is no net increase in average drawdown.

The impact of increasing the Trinity pumping from 2008 to DFC conditions in Comal, Kendall, and Kerr Counties on aquifer discharge to springs, creeks and rivers range from 6,610 acft/yr to 8,183 acft/yr, with an average of 7,062 acft/yr, or about 10 percent on average of baseflow.

3.3.4 Effects of Climate Change on Streamflow and Freshwater Inflow[23]

There has been an abundance of work completed on the effects of global climate change on large-scale regional temperature and precipitation changes. However, very little work has been completed regarding the effects that such changes have on water resources, particularly streamflow. Three resources on the matter, specifically relevant to Texas, include:

> Wurbs, RA; Muttiah, RS; and Feldon, F. 2005. *Incorporation of Climate Change in Water Availability Modeling*. Journal of Hydrologic Engineering 10(5): 375-385.
>
> Banner, JL; Jackson, CS; et al. 2010. *Climate Change Impacts on Texas Water*. Texas Water Journal 1(1): 1-19.
>
> Ward, GH. 2011. *Chapter 3: Water Resources*. Effects of Global Warming on Texas, 2nd Edition.

While comprehensive modeling has not been completed, available information does indicate that global climate change will result in more frequent and intense extreme events, both in drought and flooding, and that the watersheds amplify the temperature and precipitation changes. In his chapter on effects of global warming on water resources, Dr. Ward uses rudimentary water budget calculation to determine that a five percent change in rainfall in the central part of Texas (an area that includes the Guadalupe–San Antonio River Basin) could result in a 25 percent change in flows to the estuaries by 2050 under average conditions. Dr. Ward concludes that "In general, the effect of climate on water demands and watershed processing of rainfall is to amplify the changed-climate signal, because the causal connections are nonlinear and reinforcing."

3.3.5 Effects of Invasive Plant Species on Streamflow[24]

Section 3.6 of the GSA BBEST report provides an overview of the riparian communities, processes, and interactions in the GSA basin. As described in the GSA BBEST report, riparian communities of the GSA basin provide many ecosystem functions including quality habitat for native fish, wildlife, and bird species, while also being integral to bank and floodplain stability. Both the GSA BBEST report and SB2 Interim Progress report discuss the importance of timing, magnitude and frequency of flood disturbance events on determining community structure within

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[23] Note: This task was included in the technical consultant's scope of work, but not presented in time to aid in the formulation of the GSA BBASC Recommendations.

[24] Note: This task was included in the technical consultant's scope of work, but not presented in time to aid in the formulation of the GSA BBASC Recommendations.

riparian corridors, including invasive non-native species. Both reports discuss water needs for the riparian community but only contain minimal discussion on water use of the riparian community. Invasive non-native species are a serious threat to riparian plant communities in that they often invade streamside areas and out-compete native plants. Not only do they tend to provide less quality habitat for wildlife, species such as tamarisk and giant reed use large amounts of water.

There is limited information on the annual rates of evapotranspiration (ET) in native and non-native riparian communities in the GSA basin. As such, it is difficult to fully assess the effect that non-native plants are having on the regional water budget. The GSA BBASC recognizes this as a key component to be further explored in the Work Plan as a better understanding of this topic may assist in improving water management options and/or restoration efforts.

3.4 Texas Instream Flow Studies (SB2) Interim Report

Senate Bill 2 (SB2), enacted in 2001 by the 77th Texas Legislature, established the Texas Instream Flow Program (TIFP). The purpose of the TIFP is to perform scientific studies to determine flow conditions necessary to support a sound ecological environment in the rivers and streams of Texas. In the Fall of 2008, the TIFP in coordination with the San Antonio River Authority (SARA), as a local sponsor), embarked on a full-blown SB2 study on the Lower San Antonio River (LSAR) and lower Cibolo Creek. Stakeholder involvement has been a key component of the TIFP lower San Antonio River sub-basin study. Through a series of TIFP sponsored meetings, TIFP stakeholders were briefed on the TIFP, informed about the available information and current conditions in the sub-basin, and provided a framework from which to define the study goal, objectives, and indicators. From that foundation, a Study Design document was prepared in 2009 for the LSAR and Lower Cibolo Creek Instream Flow Study (TIFP 2010).[25] The Study Design was peer reviewed by the U.S. Geological Survey (USGS) and subsequently modified based on comments received.

Over the course of the LSAR SB2 study, a wealth of hydrological, biological, geomorphological, and water quality information has been collected and analyzed. That information has been condensed and compiled, and the TIFP in conjunction with SARA is in the final stages of completing an Interim Progress Report. The Interim Progress Report provides 1) an update of study progress to the Stakeholders and 2) Interim Instream Flow recommendations for the lower San Antonio River and lower Cibolo Creek. Specific instream flow Interim recommendations for four categories (subsistence flows, base flows, high flow pulses, and overbank flows) were established at three locations (Calaveras[26], Falls City, and Goliad) for the Lower San Antonio River and one site (near Falls City) on Lower Cibolo Creek. Interim recommendations were integrated into one flow regime for each study site and the report provides an overview of ecological functions supported by each flow category. The recommendations are termed "Interim" as ongoing SB2-sponsored efforts and future SB2 studies/activities implemented in relation to long-term monitoring and adaptive management will provide additional information that may result in modifications or revisions to the Interim recommendations. The Interim

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[25] Texas Instream Flow Program. 2010. Instream Flow Study of the Lower San Antonio River and Lower Cibolo Creek. Study Design. Texas Instream Flow Program and San Antonio River Authority. April 2010.

[26] The LSAR TIFP site (labeled Calaveras) is approximately 12 river miles downstream of the San Antonio River at Elmendorf streamflow gaging station, with no major tributaries in the intervening drainage area. For the purposes of this GSA BBASC Recommendations Report, the two sites are interchangeable.

recommendations will be subjected to SB2 stakeholder review and adjustments may occur based on provided feedback. Final recommendations will be developed after meeting with sub-basin workgroups and obtaining their input related to integrating data and generating instream flow recommendations, as described in the Technical Overview (TIFP 2008).[27]

The Interim Progress report represents the culmination of study efforts to date which have resulted in the characterization of flow-habitat and flow-ecological relationships associated with the riverine environment within the Lower San Antonio River sub-basin (Lower San Antonio River and Lower Cibolo Creek from just downstream of the city of San Antonio to the confluence with the Guadalupe River). The TIFP in coordination with SARA have informed the GSA BBEST and GSA BBASC of SB2 study progress throughout the SB3 process and have provided the Interim SB2 study recommendations for consideration by the GSA BBASC in advance of final SB2 stakeholder review with the understanding that changes may occur.

[27] Texas Instream Flow Program. 2008. Texas Instream Flow Studies: Technical Overview. Texas Commission on Environmental Quality, Texas Parks and Wildlife Department, and Texas Water Development Board. TWDB Report No. 369, Austin, Texas.
http://www.twdb.state.tx.us/publications/reports/GroundWaterReports/GWReports/R369_InstreamFlows.pdf

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4.0 GSA BBASC Recommendations for Environmental Flow Standards

The recommendations of the GSA BBASC regarding environmental flow standards for the Guadalupe–San Antonio River Basin, the San Antonio–Nueces Coastal Basin, and the Mission, Aransas, Copano, and San Antonio Bays are summarized in the following pages. The environmental flow standard recommendations of the GSA BBASC include not only schedules of flow quantities, but also descriptions of how these flow quantities are to be applied in the contexts of environmental flow standards. It is the general expectation of the GSA BBASC that the TCEQ will consider direct translation of recommended instream environmental flow standards into rules and, ultimately, consider seasonal subsistence, base, and pulse flow values within such recommended standards as potential permit conditions applicable to new surface water appropriations. Such permit conditions may specify when impoundment or diversion of streamflow is authorized under a new water rights permit. Similarly, it is the expectation of the GSA BBASC that the TCEQ will consider direct translation recommended environmental flow standards for the estuaries, expressed in terms of seasonal ranges of freshwater inflows and associated attainment goals, into rules and, ultimately, apply such rules in the evaluation of applications for new surface water appropriations. The GSA BBASC believes that it is important to explicitly address application or implementation of the recommended environmental flow standards.

The following subsections of this report focus on presentation and brief discussion of the recommended environmental flow standards for instream locations (Section 4.1) and for bays and estuaries (Section 4.2). Additional recommendations regarding environmental flow standards ultimately becoming water right permit conditions are presented and briefly discussed in Section 4.3.

Except where noted, the recommendations regarding environmental flow standards included in this section were adopted by consensus.

4.1 GSA BBASC Recommendations for Instream Flow Standards

Recommendations regarding instream environmental flow standard components and definitions of hydrologic conditions are included in Section 4.1.1. The recommended environmental flow standards for 15 stream locations throughout the Guadalupe–San Antonio River Basin are summarized in Sections 4.1.2 through 4.1.16 in upstream to downstream order (see Figure 4.1-1). The recommended environmental flow standards for one instream location in the San Antonio–Nueces Coastal Basin are summarized in Section 4.1.17.

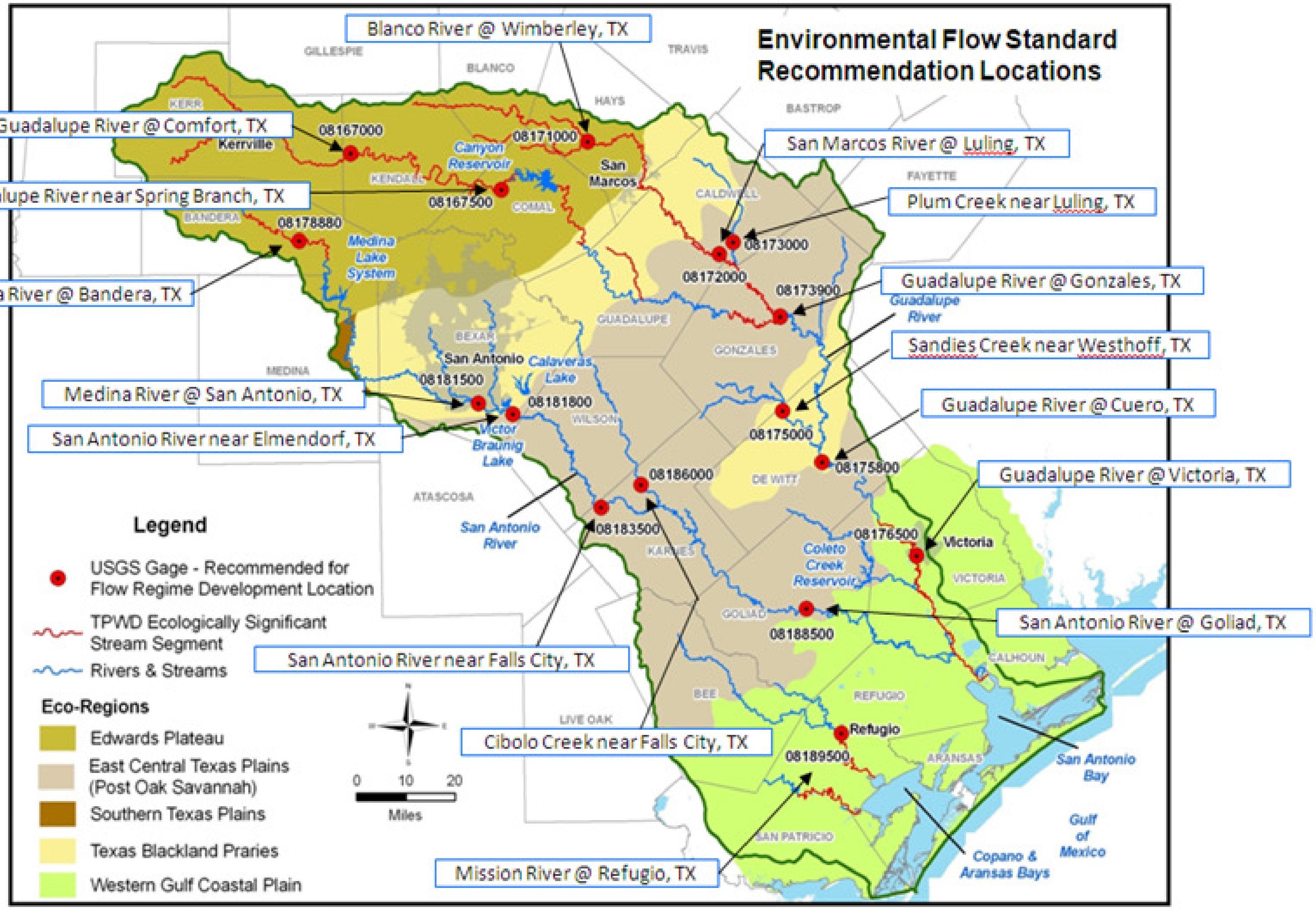

Figure 4.1-1. Instream Measurement Points for Environmental Flow Standards

4.1.1 Schedule of Flow Quantities

The tables in the following sub-sections provide the numerical elements of the GSA BBASC instream environmental flow standard recommendations. Another essential component of the GSA BBASC environmental flow standard recommendations is specification of how such numerical elements might be applied to new surface water appropriations. Hence, our recommendations regarding application or implementation of environmental flow standards are summarized in the following paragraphs, progressing from low- to high-flow situations with recognition of situations when hydrologic conditions are to be considered. It is noted that the GSA BBASC recommendations regarding application of environmental flow standards are generally consistent with GSA BBEST recommendations as summarized in Section 6.4 of the GSA BBEST Environmental Flows Recommendations Report.

4.1.1.1 Hydrologic Conditions (Wet/Average/Dry)

The GSA BBASC recommends that seasonal hydrologic conditions at any specific location be determined on the basis of the 12-month cumulative antecedent flow volumes near that location with the understanding that these volumes will be selected such that dry, average, and wet conditions will apply 25%, 50%, and 25% of the time, respectively. Use of 12-month cumulative flow volumes will provide adequate recognition of the persistence of drought and avoid more complex antecedent seasonal computations associated with shorter durations. It is recommended that the applicable hydrologic condition for the entire season be defined on the basis of an assessment of hydrologic condition at the beginning of the first day of the season, thereby recognizing practical operations. In addition, the GSA BBASC recommends that a preliminary assessment of hydrologic condition(s) throughout the river basins be posted for the upcoming season five (5) days in advance of the first day of the season to allow for operational planning and adjustments. Furthermore, the GSA BBASC recommends that hydrologic conditions be applicable only at times when inflows are less than the lowest applicable pulse peak flow.

4.1.1.2 Subsistence Flows

Ecological functions of subsistence flows include provision for aquatic habitat, longitudinal connectivity, dissolved oxygen, and temperature sufficient to ensure survival of aquatic species for transient low flow periods. Recommendations of the GSA BBASC indicate that translation of seasonal subsistence flows into environmental flow standards and permit conditions should not result in more frequent occurrence of flows less than the recommended seasonal subsistence values as a result of the issuance of new surface water appropriations or amendments. Specific recommendations of the GSA BBASC regarding application of the subsistence flow component of its recommended environmental flow standards are summarized as follows:

a. If inflow is less than the seasonal subsistence value, then all inflow must be passed and none impounded or diverted. Hydrologic conditions are not a factor.

4.1.1.3 Base Flows and 50% Rule

Base flows provide variable flow conditions, suitable and diverse aquatic habitat, longitudinal connectivity, soil moisture, and water quality sufficient to sustain aquatic species and proximate riparian vegetation for extended periods. As simply stated in SAC guidance, "base flows provide instream habitat conditions needed to maintain the diversity of biological communities in streams and rivers (SAC, August 31, 2009)." Specific recommendations of the GSA BBASC regarding application of the base flow component of its recommended environmental flow standards are summarized as follows:

a. Hydrologic conditions as defined in Section 4.1.1.1 are applicable when inflow is less than the lowest applicable pulse peak value or all pulse recommendations have been satisfied.
b. Under average and wet hydrologic conditions, if inflow is less than the seasonal base value, then all inflow must be passed and none impounded.
c. Under dry hydrologic conditions, if inflow is less than the seasonal base value and greater than the seasonal subsistence value, then the seasonal subsistence flow plus 50 percent of the difference between inflow and the seasonal subsistence value must be passed, and the balance may be impounded or diverted to the extent available, subject to senior water rights. This "50% Rule" was recommended by the GSA BBEST and is recommended by the GSA BBASC for all instream measurement sites.
d. If inflow is less than the lowest applicable pulse peak value and greater than the seasonal base value for the current hydrologic condition, then that seasonal base value must be passed, and the balance may be impounded or diverted to the extent available, subject to senior water rights.

4.1.1.4 High Flow Pulses (including Overbank Flows)

High flow pulses provide elevated in-channel flows of short duration, recruitment events for organisms, lateral connectivity, channel and substrate maintenance, limitation of riparian vegetation encroachment, and in-channel water quality restoration after prolonged low flow periods as necessary for long-term support of a sound ecological environment. Overbank flows, a sub-set of high flow pulses, provide significantly elevated flows exceeding channel capacity, life phase cues for organisms, riparian vegetation diversity maintenance, conditions conducive to seedling development, floodplain connectivity, lateral channel movement, floodplain maintenance, recharge of floodplain water table, flushing of organic material into the channel, nutrient deposition in the floodplain, and restoration of water quality in isolated floodplain water bodies as necessary for long-term support of a sound ecological environment. Specific recommendations of the GSA BBASC regarding application of the high flow pulse and overbank flow components of its recommended environmental flow standards are summarized as follows:

a. The GSA BBASC recommends that applicable high flow pulses for a new surface water appropriation be determined in accordance with the Pulse Exemption Rule as described in Section 4.3.1.
b. If inflow is greater than a specified peak trigger (Qp) and less than the next greatest specified peak trigger, and all applicable pulse recommendations have not been satisfied, then all inflow up to the lower of the two peak triggers must be passed until either the recommended volume or duration has passed, and the balance of inflow may be impounded or diverted to the extent available, subject to senior water rights.
c. If all applicable pulse recommendations have been satisfied and inflow is greater than the seasonal base value for the current hydrologic condition, then that seasonal base value

must be passed, and the balance may be impounded or diverted to the extent available, subject to senior water rights.

d. Pulse events are identified upon occurrence of specified trigger flow (or in the case of the Lower San Antonio River – San Antonio River at Elmendorf, Falls City, and Goliad and Cibolo Creek near Falls City – occurrence being for the specified duration), counted in the season or year in which they begin, and assumed to continue into the following season or year as necessary to meet specified volumes or durations. Once a pulse event has been identified, volumes passed during the event, but prior to exceeding the specified trigger flow (equivalent to Qp in the environmental flow recommendations), may be credited towards the specified volume requirement.
e. One large pulse counts as one pulse in each of the smaller categories subject to reset at season or return period end.
f. Each return period (i.e., season, series of months, one-year, two-years, or five-years) is independent of the preceding and subsequent return period with respect to high flow pulse attainment frequency.

4.1.1.5 Geographic Interpolation

The GSA BBASC has provided environmental flow standard recommendations at streamflow gaging stations located throughout the Guadalupe–San Antonio River Basin and the San Antonio–Nueces Coastal Basin. These reference locations are, among other things, representative of major streams above and below existing reservoirs as well as some tributary streams in the middle portions of each river basin. The GSA BBASC recommends that the TCEQ develop appropriate methods for geographic interpolation of flow conditions applicable to future inter-adjacent permits and amendments from reference locations for which environmental flow standards are established. Such methods should include, at a minimum, drainage area adjustments, but may also include consideration of springflow contributions, channel losses, aquifer recharge zones, soil cover complex, and other factors as necessary and appropriate. The GSA BBASC recommends that instream environmental flow standards be applicable below the streamflow gaging stations on the Guadalupe River at Victoria and the San Antonio River at Goliad all the way to the bay.

4.1.1.6 General Consideration

The GSA BBASC recommends that flows passed for senior water rights count toward satisfaction of any specified subsistence, base, and pulse flow rates and volumes.

4.1.2 Guadalupe River at Comfort

The streamflow gaging station and recommended instream measurement point on the Guadalupe River at Comfort (USGS #08167000) is located in western Kendall County, has a drainage area of 839 square miles, and has records extending back in time through 1940. The environmental flow standard recommendation of the GSA BBASC for this location is summarized in Table 4.1-1. For reference, the environmental flow regime recommendation of the GSA BBEST for this location is summarized in Table 4.1-2. Differences between the GSA BBASC and GSA BBEST recommendations include the following:

a. Increasing the GSA BBEST Winter, Spring, and Fall subsistence flows to seasonal Q95[28] values provided by TPWD; and
b. Applying the GSA BBASC Pulse Exemption Rule (Section 4.3.1); and
c. Applying the Ten Percent Dedication to Environmental Flows (10% Rule) (Section 4.3.2).

As the GSA BBEST found no available measurements of dissolved oxygen or temperature at subsistence flow levels, the primary rationale for the GSA BBASC increasing the seasonal subsistence flows is a "high" level of concern expressed by TPWD. The bases for this level of concern are summarized in Appendix C which was prepared by TPWD in response to a GSA BBASC request for their technical review.

GSA BBASC discussions pertinent to *present and future needs for water for other uses related to water supply planning* specifically relevant to this location included the following subjects:

a. Future surface water rights would be very difficult to obtain as water available for diversion or impoundment would be significantly limited by senior water rights associated with Canyon Reservoir.
b. The 2011 South Central Texas Regional Water Plan includes Storage Above Canyon Reservoir (ASR) as a recommended water management strategy with an estimated firm yield of 3,340 acft/yr subject to Consensus Criteria for Environmental Flow Needs (CCEFN).
c. Present and future groundwater use impacts on upper basin streamflows (see Sections 3.3.3 and 6.0).
d. Recognition that recreational use is very important in this stream segment.

Due to time and funding constraints, very limited or no detailed technical evaluations were conducted at this streamgage to quantitatively address these subjects. The Pulse Exemption Rule was applied in consideration of present and future water needs related to water supply planning.

[28] Seasonal Q95 is defined to be the daily average flow rate exceeded 95 percent of the time within a selected season. GSA BBEST seasonal subsistence flow values were calculated as the median of the lowest 10 percent of base flows within a selected season.

Table 4.1-1. GSA BBASC Environmental Flow Standard Recommendation - Guadalupe River at Comfort[29]

	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
Overbank Flows	Qp: 15,900 cfs with Average Frequency 1 per 5 years Regressed Volume is 100,000 Duration Bound is 97			
Overbank Flows	Qp: 7,420 cfs with Average Frequency 1 per 2 years Regressed Volume is 72,400 Duration Bound is 69			
High Flow Pulses	Qp: 4,020 cfs with Average Frequency 1 per year Regressed Volume is 37,400 Duration Bound is 53			
High Flow Pulses	Qp: 350 cfs with Average Frequency 1 per season Regressed Volume is 3,390 Duration Bound is 20	Qp: 1,190 cfs with Average Frequency 1 per season Regressed Volume is 8,950 Duration Bound is 26	Qp: 570 cfs with Average Frequency 1 per season Regressed Volume is 4,110 Duration Bound is 19	Qp: 500 cfs with Average Frequency 1 per season Regressed Volume is 4,060 Duration Bound is 24
High Flow Pulses	Qp: 140 cfs with Average Frequency 2 per season Regressed Volume is 1,030 Duration Bound is 11	Qp: 400 cfs with Average Frequency 2 per season Regressed Volume is 2,980 Duration Bound is 17	Qp: 160 cfs with Average Frequency 2 per season Regressed Volume is 1,130 Duration Bound is 12	Qp: 160 cfs with Average Frequency 2 per season Regressed Volume is 1,110 Duration Bound is 13
Base Flows (cfs)	110	100	75	110
Base Flows (cfs)	77	69	50	77
Base Flows (cfs)	54	35	25	48
Subsistence Flows (cfs)	31.0	18.0	2.0	25.0

Table 4.1-2. GSA BBEST Environmental Flow Regime Recommendation - Guadalupe River at Comfort[30]

	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
Overbank Flows	Qp: 15,900 cfs with Average Frequency 1 per 5 years Regressed Volume is 100,000 Duration Bound is 97			
Overbank Flows	Qp: 7,420 cfs with Average Frequency 1 per 2 years Regressed Volume is 72,400 Duration Bound is 69			
High Flow Pulses	Qp: 4,020 cfs with Average Frequency 1 per year Regressed Volume is 37,400 Duration Bound is 53			
High Flow Pulses	Qp: 350 cfs with Average Frequency 1 per season Regressed Volume is 3,390 Duration Bound is 20	Qp: 1,190 cfs with Average Frequency 1 per season Regressed Volume is 8,950 Duration Bound is 26	Qp: 570 cfs with Average Frequency 1 per season Regressed Volume is 4,110 Duration Bound is 19	Qp: 500 cfs with Average Frequency 1 per season Regressed Volume is 4,060 Duration Bound is 24
High Flow Pulses	Qp: 140 cfs with Average Frequency 2 per season Regressed Volume is 1,030 Duration Bound is 11	Qp: 400 cfs with Average Frequency 2 per season Regressed Volume is 2,980 Duration Bound is 17	Qp: 160 cfs with Average Frequency 2 per season Regressed Volume is 1,130 Duration Bound is 12	Qp: 160 cfs with Average Frequency 2 per season Regressed Volume is 1,110 Duration Bound is 13
Base Flows (cfs)	110	100	75	110
Base Flows (cfs)	77	69	50	77
Base Flows (cfs)	54	35	25	48
Subsistence Flows (cfs)	10	5.2	2.0	2.7

[29] Volumes are in acre-feet and durations are in days.
[30] Volumes are in acre-feet and durations are in days.

4.1.3 Guadalupe River near Spring Branch

The streamflow gaging station and recommended instream measurement point on the Guadalupe River near Spring Branch (USGS #08167500) is located in western Comal County, has a drainage area of 1,315 square miles, and has records extending back in time through 1923. The environmental flow standard recommendation of the GSA BBASC for this location is summarized in Table 4.1-3. For reference, the environmental flow regime recommendation of the GSA BBEST for this location is summarized in Table 4.1-4. Differences between the GSA BBASC and GSA BBEST recommendations include the following:

a. Increasing the GSA BBEST seasonal subsistence flows to the annual Q95[31,32] value provided by TPWD; and
b. Applying the GSA BBASC Pulse Exemption Rule (Section 4.3.1); and
c. Applying the Ten Percent Dedication to Environmental Flows (10% Rule) (Section 4.3.2).

As the GSA BBEST reported that all available measurements of dissolved oxygen and temperature at subsistence flow levels met TCEQ stream standards, the primary rationale for the GSA BBASC increasing the seasonal subsistence flows is a “high” level of concern expressed by TPWD. The bases for this level of concern are summarized in Appendix C which was prepared by TPWD in response to a GSA BBASC request for their technical review.

GSA BBASC discussions pertinent to *present and future needs for water for other uses related to water supply planning* specifically relevant to this location included the following subjects:

a. Future surface water rights would be very difficult to obtain as water available for diversion or impoundment would be significantly limited by senior water rights associated with Canyon Reservoir.
b. The 2011 South Central Texas Regional Water Plan includes Storage Above Canyon Reservoir (ASR) as a recommended water management strategy with an estimated firm yield of 3,340 acft/yr subject to CCEFN.
c. Present and future groundwater use impacts on upper basin streamflows (see Sections 3.3.3 and 6.0).
d. Recognition that recreational use is very important in this stream segment.

Due to time and funding constraints, very limited or no detailed technical evaluations were conducted at this streamgage to quantitatively address these subjects. The Pulse Exemption Rule was applied in consideration of present and future water needs related to water supply planning.

[31] Annual Q95 is defined to be the daily average flow rate exceeded 95 percent of the time. GSA BBEST seasonal subsistence flow values were calculated as the median of the lowest 10 percent of base flows within a selected season.
[32] GSA BBASC discussions indicate that recommendation of the annual Q95 value for all seasons, in lieu of the seasonal Q95 values, is due to the fact that Winter, Spring, and Fall Q95 values are more than three times the seasonal subsistence values recommended by the GSA BBEST.

Table 4.1-3. GSA BBASC Environmental Flow Standard Recommendation - Guadalupe River near Spring Branch[33]

	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
High Flow Pulses	Qp: 23,700 cfs with Average Frequency 1 per 5 years Regressed Volume is 242,000 Duration Bound is 82			
	Qp: 11,300 cfs with Average Frequency 1 per 2 years Regressed Volume is 109,000 Duration Bound is 60			
	Qp: 5,720 cfs with Average Frequency 1 per year Regressed Volume is 51,900 Duration Bound is 45			
	Qp: 570 cfs with Average Frequency 1 per season Regressed Volume is 5,150 Duration Bound is 19	Qp: 2,310 cfs with Average Frequency 1 per season Regressed Volume is 17,500 Duration Bound is 26	Qp: 870 cfs with Average Frequency 1 per season Regressed Volume is 5,970 Duration Bound is 19	Qp: 1,000 cfs with Average Frequency 1 per season Regressed Volume is 8,060 Duration Bound is 23
	Qp: 210 cfs with Average Frequency 2 per season Regressed Volume is 1,520 Duration Bound is 11	Qp: 870 cfs with Average Frequency 2 per season Regressed Volume is 6,500 Duration Bound is 19	Qp: 240 cfs with Average Frequency 2 per season Regressed Volume is 1,520 Duration Bound is 11	Qp: 230 cfs with Average Frequency 2 per season Regressed Volume is 1,660 Duration Bound is 12
Base Flows (cfs)	160	160	110	150
	100	91	64	100
	70	44	36	57
Subsistence Flows (cfs)	18.0	18.0	18.0	18.0

Table 4.1-4. GSA BBEST Environmental Flow Regime Recommendation - Guadalupe River near Spring Branch[34]

	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
High Flow Pulses	Qp: 23,700 cfs with Average Frequency 1 per 5 years Regressed Volume is 242,000 Duration Bound is 82			
	Qp: 11,300 cfs with Average Frequency 1 per 2 years Regressed Volume is 109,000 Duration Bound is 60			
	Qp: 5,720 cfs with Average Frequency 1 per year Regressed Volume is 51,900 Duration Bound is 45			
	Qp: 570 cfs with Average Frequency 1 per season Regressed Volume is 5,150 Duration Bound is 19	Qp: 2,310 cfs with Average Frequency 1 per season Regressed Volume is 17,500 Duration Bound is 26	Qp: 870 cfs with Average Frequency 1 per season Regressed Volume is 5,970 Duration Bound is 19	Qp: 1,000 cfs with Average Frequency 1 per season Regressed Volume is 8,060 Duration Bound is 23
	Qp: 210 cfs with Average Frequency 2 per season Regressed Volume is 1,520 Duration Bound is 11	Qp: 870 cfs with Average Frequency 2 per season Regressed Volume is 6,500 Duration Bound is 19	Qp: 240 cfs with Average Frequency 2 per season Regressed Volume is 1,520 Duration Bound is 11	Qp: 230 cfs with Average Frequency 2 per season Regressed Volume is 1,660 Duration Bound is 12
Base Flows (cfs)	160	160	110	150
	100	91	64	100
	70	44	36	57
Subsistence Flows (cfs)	13	6.6	4.6	6.6

[33] Volumes are in acre-feet and durations are in days.
[34] Volumes are in acre-feet and durations are in days.

4.1.4 Blanco River at Wimberley

The streamflow gaging station and recommended instream measurement point on the Blanco River at Wimberley (USGS #08171000) is located in central Hays County, has a drainage area of 355 square miles, and has records extending back in time through 1929. The environmental flow standard recommendation of the GSA BBASC for this location is summarized in Table 4.1-5. For reference, the environmental flow regime recommendation of the GSA BBEST for this location is summarized in Table 4.1-6. Differences between the GSA BBASC and GSA BBEST recommendations include the following:

a. Increasing the GSA BBEST Winter, Spring, and Fall seasonal subsistence flows to the seasonal Q95[35] values provided by TPWD; and
b. Applying the GSA BBASC Pulse Exemption Rule (Section 4.3.1); and
c. Applying the Ten Percent Dedication to Environmental Flows (10% Rule) (Section 4.3.2).

It was brought to the attention of the GSA BBASC that several violations of the TCEQ stream standard for dissolved oxygen have been measured at this site. The primary rationales for the GSA BBASC increasing the seasonal subsistence flows are these violations and a "high" level of concern expressed by TPWD. The bases for this level of concern are summarized in Appendix C which was prepared by TPWD in response to a GSA BBASC request for their technical review.

GSA BBASC discussions pertinent to *present and future needs for water for other uses related to water supply planning* specifically relevant to this location included the following subjects:

a. The 2011 South Central Texas Regional Water Plan includes Edwards Aquifer Recharge – Type 2 Projects as a recommended water management strategy with an estimated firm yield of 21,577 acft/yr subject to CCEFN (note: the Blanco Recharge Dam contributes only a small portion of the total firm yield of the water management strategy).
b. Present and future groundwater use impacts on upper basin streamflows (see Sections 3.3.3 and 6.0).
c. Recognition that recreational use is very important in this stream segment.

Due to time and funding constraints, very limited or no detailed technical evaluations were conducted at this streamgage to quantitatively address these subjects. The Pulse Exemption Rule was applied in consideration of present and future water needs related to water supply planning.

[35] Seasonal Q95 is defined to be the daily average flow rate exceeded 95 percent of the time within a selected season. GSA BBEST seasonal subsistence flow values were calculated as the median of the lowest 10 percent of base flows within a selected season.

Table 4.1-5. GSA BBASC Environmental Flow Standard Recommendation - Blanco River at Wimberley[36]

	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
High Flow Pulses	Qp: 8,310 cfs with Average Frequency 1 per 5 years Regressed Volume is 82,000 Duration Bound is 74			
High Flow Pulses	Qp: 4,640 cfs with Average Frequency 1 per 2 years Regressed Volume is 43,100 Duration Bound is 58			
High Flow Pulses	Qp: 2,820 cfs with Average Frequency 1 per year Regressed Volume is 24,900 Duration Bound is 47			
High Flow Pulses	Qp: 380 cfs with Average Frequency 1 per season Regressed Volume is 3,840 Duration Bound is 28	Qp: 960 cfs with Average Frequency 1 per season Regressed Volume is 6,540 Duration Bound is 26	Qp: 190 cfs with Average Frequency 1 per season Regressed Volume is 1,130 Duration Bound is 13	Qp: 440 cfs with Average Frequency 1 per season Regressed Volume is 3,220 Duration Bound is 21
High Flow Pulses	Qp: 54 cfs with Average Frequency 2 per season Regressed Volume is 360 Duration Bound is 10	Qp: 360 cfs with Average Frequency 2 per season Regressed Volume is 2,370 Duration Bound is 18	Qp: 74 cfs with Average Frequency 2 per season Regressed Volume is 410 Duration Bound is 9	Qp: 82 cfs with Average Frequency 2 per season Regressed Volume is 500 Duration Bound is 10
Base Flows (cfs)	52	64	56	54
Base Flows (cfs)	34	40	36	36
Base Flows (cfs)	20	18	18	18
Subsistence Flows (cfs)	10.0	13.0	7.6	9.5

Table 4.1-6. GSA BBEST Environmental Flow Regime Recommendation - Blanco River at Wimberley[37]

	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
High Flow Pulses	Qp: 8,310 cfs with Average Frequency 1 per 5 years Regressed Volume is 82,000 Duration Bound is 74			
High Flow Pulses	Qp: 4,640 cfs with Average Frequency 1 per 2 years Regressed Volume is 43,100 Duration Bound is 58			
High Flow Pulses	Qp: 2,820 cfs with Average Frequency 1 per year Regressed Volume is 24,900 Duration Bound is 47			
High Flow Pulses	Qp: 380 cfs with Average Frequency 1 per season Regressed Volume is 3,840 Duration Bound is 28	Qp: 960 cfs with Average Frequency 1 per season Regressed Volume is 6,540 Duration Bound is 26	Qp: 190 cfs with Average Frequency 1 per season Regressed Volume is 1,130 Duration Bound is 13	Qp: 440 cfs with Average Frequency 1 per season Regressed Volume is 3,220 Duration Bound is 21
High Flow Pulses	Qp: 54 cfs with Average Frequency 2 per season Regressed Volume is 360 Duration Bound is 10	Qp: 360 cfs with Average Frequency 2 per season Regressed Volume is 2,370 Duration Bound is 18	Qp: 74 cfs with Average Frequency 2 per season Regressed Volume is 410 Duration Bound is 9	Qp: 82 cfs with Average Frequency 2 per season Regressed Volume is 500 Duration Bound is 10
Base Flows (cfs)	52	64	56	54
Base Flows (cfs)	34	40	36	36
Base Flows (cfs)	20	18	18	18
Subsistence Flows (cfs)	7.9	6.7	7.6	7.1

36 Volumes are in acre-feet and durations are in days.
37 Volumes are in acre-feet and durations are in days.

4.1.5 San Marcos River at Luling

The streamflow gaging station and recommended instream measurement point on the San Marcos River at Luling (USGS #08172000) is located in southern Caldwell County, has a drainage area of 838 square miles, and has records extending back in time through 1940. The environmental flow standard recommendation of the GSA BBASC for this location is summarized in Table 4.1-7. For reference, the environmental flow regime recommendation of the GSA BBEST for this location is summarized in Table 4.1-8. Differences between the GSA BBASC and GSA BBEST recommendations include the following:

a. Increasing the GSA BBEST Winter, Spring, and Fall subsistence flows to seasonal Q95[38] values provided by TPWD; and
b. Applying the GSA BBASC Pulse Exemption Rule (Section 4.3.1); and
c. Applying the Ten Percent Dedication to Environmental Flows (10% Rule) (Section 4.3.2).

As the GSA BBEST reported that all available measurements of dissolved oxygen and temperature at subsistence flow levels met TCEQ stream standards, the primary rationale for the GSA BBASC increasing the seasonal subsistence flows is a "moderate" level of concern expressed by TPWD. The bases for this level of concern are summarized in Appendix C which was prepared by TPWD in response to a GSA BBASC request for their technical review.

GSA BBASC discussions pertinent to *present and future needs for water for other uses related to water supply planning* specifically relevant to this location included the following subject:

a. Recognition that recreational use is very important in this stream segment.

An evaluation of a hypothetical new 10,000 acft/yr run-of-river appropriation was performed at the San Marcos River at Luling site. The results of this analysis are summarized in Section 3.3.2 of this report. The Pulse Exemption Rule was applied in consideration of present and future water needs related to water supply planning.

[38] Seasonal Q95 is defined to be the daily average flow rate exceeded 95 percent of the time within a selected season. GSA BBEST seasonal subsistence flow values were calculated as the median of the lowest 10 percent of base flows within a selected season.

Table 4.1-7. GSA BBASC Environmental Flow Standard Recommendation - San Marcos River at Luling[39]

	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
Overbank Flows	Qp: 17,900 cfs with Average Frequency 1 per 5 years Regressed Volume is 208,000 Duration Bound is 78			
Overbank Flows	Qp: 10,600 cfs with Average Frequency 1 per 2 years Regressed Volume is 110,000 Duration Bound is 57			
Overbank Flows	Qp: 6,120 cfs with Average Frequency 1 per year Regressed Volume is 56,400 Duration Bound is 41			
High Flow Pulses	Qp: 1,330 cfs with Average Frequency 1 per season Regressed Volume is 11,400 Duration Bound is 23	Qp: 2,740 cfs with Average Frequency 1 per season Regressed Volume is 18,400 Duration Bound is 21	Qp: 500 cfs with Average Frequency 1 per season Regressed Volume is 2,670 Duration Bound is 9	Qp: 1,710 cfs with Average Frequency 1 per season Regressed Volume is 11,200 Duration Bound is 18
High Flow Pulses	Qp: 340 cfs with Average Frequency 2 per season Regressed Volume is 1,800 Duration Bound is 8	Qp: 1,140 cfs with Average Frequency 2 per season Regressed Volume is 6,800 Duration Bound is 14	Qp: 240 cfs with Average Frequency 2 per season Regressed Volume is 1,090 Duration Bound is 6	Qp: 540 cfs with Average Frequency 2 per season Regressed Volume is 2,740 Duration Bound is 9
Base Flows (cfs)	210	220	220	200
Base Flows (cfs)	160	160	170	170
Base Flows (cfs)	120	110	110	120
Subsistence Flows (cfs)	89.0	88.6	73	81

Table 4.1-8. GSA BBEST Environmental Flow Regime Recommendation - San Marcos River at Luling[40]

	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
Overbank Flows	Qp: 17,900 cfs with Average Frequency 1 per 5 years Regressed Volume is 208,000 Duration Bound is 78			
Overbank Flows	Qp: 10,600 cfs with Average Frequency 1 per 2 years Regressed Volume is 110,000 Duration Bound is 57			
Overbank Flows	Qp: 6,120 cfs with Average Frequency 1 per year Regressed Volume is 56,400 Duration Bound is 41			
High Flow Pulses	Qp: 1,330 cfs with Average Frequency 1 per season Regressed Volume is 11,400 Duration Bound is 23	Qp: 2,740 cfs with Average Frequency 1 per season Regressed Volume is 18,400 Duration Bound is 21	Qp: 500 cfs with Average Frequency 1 per season Regressed Volume is 2,670 Duration Bound is 9	Qp: 1,710 cfs with Average Frequency 1 per season Regressed Volume is 11,200 Duration Bound is 18
High Flow Pulses	Qp: 340 cfs with Average Frequency 2 per season Regressed Volume is 1,800 Duration Bound is 8	Qp: 1,140 cfs with Average Frequency 2 per season Regressed Volume is 6,800 Duration Bound is 14	Qp: 240 cfs with Average Frequency 2 per season Regressed Volume is 1,090 Duration Bound is 6	Qp: 540 cfs with Average Frequency 2 per season Regressed Volume is 2,740 Duration Bound is 9
Base Flows (cfs)	210	220	220	200
Base Flows (cfs)	160	160	170	170
Base Flows (cfs)	120	110	110	120
Subsistence Flows (cfs)	78	75	73	77

[39] Volumes are in acre-feet and durations are in days.
[40] Volumes are in acre-feet and durations are in days.

4.1.6 Plum Creek near Luling

The streamflow gaging station and recommended instream measurement point on Plum Creek near Luling (USGS #08173000) is located in southern Caldwell County, has a drainage area of 309 square miles, and has records extending back in time through 1931. The environmental flow standard recommendation of the GSA BBASC for this location is summarized in Table 4.1-9. For reference, the environmental flow regime recommendation of the GSA BBEST for this location is summarized in Table 4.1-10. Differences between the GSA BBASC and GSA BBEST recommendations include the following:

a. Increasing the GSA BBEST Winter and Spring seasonal subsistence flows to the seasonal Q95[41] values provided by TPWD; and
b. Applying the GSA BBASC Pulse Exemption Rule (Section 4.3.1); and
c. Applying the Ten Percent Dedication to Environmental Flows (10% Rule) (Section 4.3.2).

It was brought to the attention of the GSA BBASC that several violations of the TCEQ stream standard for dissolved oxygen have been measured at this site. The primary rationales for the GSA BBASC increasing the seasonal subsistence flows are these violations and a "high" level of concern expressed by TPWD. The bases for this level of concern are summarized in Appendix C which was prepared by TPWD in response to a GSA BBASC request for their technical review.

GSA BBASC discussions pertinent to *present and future needs for water for other uses related to water supply planning* specifically relevant to this location included the following subject:

a. Recognition that water quality is an issue at this site. This site had previously been listed on the TCEQ 303(d) list (2004) for bacteria concerns.

Due to time and funding constraints, very limited or no detailed technical evaluations were conducted at this streamgage to quantitatively address this subject. The Pulse Exemption Rule was applied in consideration of present and future water needs related to water supply planning.

[41] Seasonal Q95 is defined to be the daily average flow rate exceeded 95 percent of the time within a selected season. GSA BBEST seasonal subsistence flow values were calculated as the median of the lowest 10 percent of base flows within a selected season.

Table 4.1-9. GSA BBASC Environmental Flow Standard Recommendation - Plum Creek near Luling[42]

	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
Overbank Flows	Qp: 10,800 cfs with Average Frequency 1 per 5 years Regressed Volume is 43,100 Duration Bound is 32			
Overbank Flows	Qp: 7,280 cfs with Average Frequency 1 per 2 years Regressed Volume is 29,700 Duration Bound is 29			
High Flow Pulses	Qp: 4,550 cfs with Average Frequency 1 per year Regressed Volume is 19,000 Duration Bound is 26			
High Flow Pulses	Qp: 1,470 cfs with Average Frequency 1 per season Regressed Volume is 6,870 Duration Bound is 23	Qp: 2,100 cfs with Average Frequency 1 per season Regressed Volume is 8,860 Duration Bound is 21	Qp: 230 cfs with Average Frequency 1 per season Regressed Volume is 1,080 Duration Bound is 15	Qp: 750 cfs with Average Frequency 1 per season Regressed Volume is 3,280 Duration Bound is 17
High Flow Pulses	Qp: 350 cfs with Average Frequency 2 per season Regressed Volume is 1,800 Duration Bound is 17	Qp: 720 cfs with Average Frequency 2 per season Regressed Volume is 3,300 Duration Bound is 17	Qp: 48 cfs with Average Frequency 2 per season Regressed Volume is 230 Duration Bound is 10	Qp: 150 cfs with Average Frequency 2 per season Regressed Volume is 720 Duration Bound is 13
Base Flows (cfs)	12	10	5.0	8.3
Base Flows (cfs)	8.4	5.6	2.5	5.2
Base Flows (cfs)	4.6	2.6	1.6	2.5
Subsistence Flows (cfs)	2.7	1.5	1.0	1.0

Table 4.1-10. GSA BBEST Environmental Flow Regime Recommendation - Plum Creek near Luling[43]

	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
Overbank Flows	Qp: 10,800 cfs with Average Frequency 1 per 5 years Regressed Volume is 43,100 Duration Bound is 32			
Overbank Flows	Qp: 7,280 cfs with Average Frequency 1 per 2 years Regressed Volume is 29,700 Duration Bound is 29			
High Flow Pulses	Qp: 4,550 cfs with Average Frequency 1 per year Regressed Volume is 19,000 Duration Bound is 26			
High Flow Pulses	Qp: 1,470 cfs with Average Frequency 1 per season Regressed Volume is 6,870 Duration Bound is 23	Qp: 2,100 cfs with Average Frequency 1 per season Regressed Volume is 8,860 Duration Bound is 21	Qp: 230 cfs with Average Frequency 1 per season Regressed Volume is 1,080 Duration Bound is 15	Qp: 750 cfs with Average Frequency 1 per season Regressed Volume is 3,280 Duration Bound is 17
High Flow Pulses	Qp: 350 cfs with Average Frequency 2 per season Regressed Volume is 1,800 Duration Bound is 17	Qp: 720 cfs with Average Frequency 2 per season Regressed Volume is 3,300 Duration Bound is 17	Qp: 48 cfs with Average Frequency 2 per season Regressed Volume is 230 Duration Bound is 10	Qp: 150 cfs with Average Frequency 2 per season Regressed Volume is 720 Duration Bound is 13
Base Flows (cfs)	12	10	5.0	8.3
Base Flows (cfs)	8.4	5.6	2.5	5.2
Base Flows (cfs)	4.6	2.6	1.6	2.5
Subsistence Flows (cfs)	1.0	1.0	1.0	1.0

[42] Volumes are in acre-feet and durations are in days.
[43] Volumes are in acre-feet and durations are in days.

4.1.7 Guadalupe River at Gonzales

The streamflow gaging station and recommended instream measurement point on the Guadalupe River at Gonzales (USGS #08173900) is located in central Gonzales County, has a drainage area of 3,490 square miles, and has records extending back in time through only 1997. Estimates of daily streamflows from 1940 through 1996 were developed and used by the GSA BBEST. The environmental flow standard recommendation of the GSA BBASC for this location is summarized in Table 4.1-11. GSA BBASC recommendations associated with the Guadalupe River at Gonzales instream measurement point were adopted by a vote of 19 to 3. For reference, the environmental flow regime recommendation of the GSA BBEST for this location is summarized in Table 4.1-12. Differences between the GSA BBASC and GSA BBEST recommendations include the following:

a. Decreasing the Spring and Summer dry base flow values by 40 cfs in accordance with supplemental evaluations of aquatic habitat relationships at this location by Dr. Thom Hardy of the GSA BBEST (Appendix F);
b. Decreasing the Spring and Summer average base flow values by 59 cfs as estimated by proportional adjustment in accordance with supplemental evaluations of aquatic habitat relationships at this location by Dr. Thom Hardy of the GSA BBEST (Appendix F);
c. Decreasing the Spring and Summer wet base flow values by 79 and 73 cfs, respectively, as estimated by proportional adjustment in accordance with supplemental evaluations of aquatic habitat relationships at this location by Dr. Thom Hardy of the GSA BBEST (Appendix F);
d. Replacing the three-tiered base flow structure with a single-tiered structure in the Winter and Fall seasons and using values for the Winter and Fall base flows estimated by proportional decrease of the GSA BBEST wet base flow values in accordance with supplemental evaluations of aquatic habitat relationships at this location by Dr. Thom Hardy of the GSA BBEST (Appendix F); and
e. Applying the GSA BBASC Pulse Exemption Rule (Section 4.3.1); and
f. Applying the Ten Percent Dedication to Environmental Flows (10% Rule) (Section 4.3.2)

The primary rationales for the GSA BBASC decreasing the base flow values in all seasons include acceptable adjustments based on best available science in the form of supplemental evaluations of aquatic habitat in order to maintain planned project viability in the lower reaches of the Guadalupe River without substantially affecting the likelihood of maintaining a sound ecological environment based on physical habitat.

GSA BBASC discussions pertinent to *present and future needs for water for other uses related to water supply planning* specifically relevant to this location included the following subject:

a. The 2011 South Central Texas Regional Water Plan includes the GBRA Mid-Basin Project (Surface Water) as a recommended water management strategy with an estimated firm yield of 25,000 acft/yr subject to CCEFN and/or the TCEQ default Lyons method.

Detailed technical evaluations of the GBRA Mid-Basin Project were conducted at this instream flow measurement point to quantitatively address effects of potential environmental flow standard recommendations on firm yield, instream flows, suitable instream habitat availability, geomorphology, freshwater inflows to the Guadalupe Estuary, and compliance with GSA BBEST freshwater inflow attainment criteria for *Rangia* and oysters. Information regarding these analyses is presented in Section 3.3 of this report. In addition, an evaluation of a hypothetical

Table 4.1-11. GSA BBASC Environmental Flow Standard Recommendation - Guadalupe River at Gonzales[44]

Overbank Flows	Qp: 36,700 cfs with Average Frequency 1 per 5 years Regressed Volume is 492,000 Duration Bound is 70			
	Qp: 24,400 cfs with Average Frequency 1 per 2 years Regressed Volume is 306,000 Duration Bound is 57			
	Qp: 14,300 cfs with Average Frequency 1 per year Regressed Volume is 165,000 Duration Bound is 43			
High Flow Pulses	Qp: 4,140 cfs with Average Frequency 1 per season Regressed Volume is 48,300 Duration Bound is 29	Qp: 6,590 cfs with Average Frequency 1 per season Regressed Volume is 58,400 Duration Bound is 24	Qp: 1,760 cfs with Average Frequency 1 per season Regressed Volume is 14,800 Duration Bound is 14	Qp: 4,330 cfs with Average Frequency 1 per season Regressed Volume is 41,200 Duration Bound is 23
	Qp: 1,150 cfs with Average Frequency 2 per season Regressed Volume is 9,640 Duration Bound is 13	Qp: 3,250 cfs with Average Frequency 2 per season Regressed Volume is 26,900 Duration Bound is 17	Qp: 950 cfs with Average Frequency 2 per season Regressed Volume is 7,060 Duration Bound is 10	Qp: 1,410 cfs with Average Frequency 2 per season Regressed Volume is 11,400 Duration Bound is 13
Base Flows (cfs)	796	791	727	746
		591	591	
		400	400	
Subsistence Flows (cfs)	210	210	210	180
	Jan Feb Mar	Apr May Jun	Jul Aug Sep	Oct Nov Dec
	Winter	Spring	Summer	Fall

Table 4.1-12. GSA BBEST Environmental Flow Regime Recommendation - Guadalupe River at Gonzales[45]

Overbank Flows	Qp: 36,700 cfs with Average Frequency 1 per 5 years Regressed Volume is 492,000 Duration Bound is 70			
	Qp: 24,400 cfs with Average Frequency 1 per 2 years Regressed Volume is 306,000 Duration Bound is 57			
	Qp: 14,300 cfs with Average Frequency 1 per year Regressed Volume is 165,000 Duration Bound is 43			
High Flow Pulses	Qp: 4,140 cfs with Average Frequency 1 per season Regressed Volume is 48,300 Duration Bound is 29	Qp: 6,590 cfs with Average Frequency 1 per season Regressed Volume is 58,400 Duration Bound is 24	Qp: 1,760 cfs with Average Frequency 1 per season Regressed Volume is 14,800 Duration Bound is 14	Qp: 4,330 cfs with Average Frequency 1 per season Regressed Volume is 41,200 Duration Bound is 23
	Qp: 1,150 cfs with Average Frequency 2 per season Regressed Volume is 9,640 Duration Bound is 13	Qp: 3,250 cfs with Average Frequency 2 per season Regressed Volume is 26,900 Duration Bound is 17	Qp: 950 cfs with Average Frequency 2 per season Regressed Volume is 7,060 Duration Bound is 10	Qp: 1,410 cfs with Average Frequency 2 per season Regressed Volume is 11,400 Duration Bound is 13
Base Flows (cfs)	860	870	800	810
	690	650	650	690
	540	440	440	510
Subsistence Flows (cfs)	210	210	210	180
	Jan Feb Mar	Apr May Jun	Jul Aug Sep	Oct Nov Dec
	Winter	Spring	Summer	Fall

[44] Volumes are in acre-feet and durations are in days.
[45] Volumes are in acre-feet and durations are in days.

new 10,000 acft/yr run-of-river appropriation was performed at the Guadalupe River at Gonzales site. The results of this analysis are summarized in Section 3.3.2 of this report.

As referenced above, the GSA BBASC recommends replacement of the GSA BBEST three-tiered base flow structure in the Winter and Fall with a single-tiered structure which is intended to increase water potentially available for diversion and firm yield. This change, along with the Pulse Exemption Rule, are the adjustments to the GSA BBEST recommendations included in the GSA BBASC environmental flow standard recommendations for the Guadalupe River at Gonzales on the basis of needs for water for other uses related to water supply planning.

In order to balance the needs of the environment and water supply needs, the Ten Percent Dedication to Environmental Flows permit condition was adopted by the GSA BBASC by a vote of 19-3 in lieu of a three-tier base flow structure during Fall and Winter for Guadalupe River at Gonzales, Guadalupe River at Cuero, and Guadalupe River at Victoria. A single-tier base flow was recommended for the Fall and Winter.

4.1.8 Sandies Creek near Westhoff

The streamflow gaging station and recommended instream measurement point on Sandies Creek near Westhoff (USGS #0817500) is located in northwestern DeWitt County, has a drainage area of 549 square miles, and has records extending back in time through 1965. The environmental flow standard recommendation of the GSA BBASC for this location is summarized in Table 4.1-13. For reference, the environmental flow regime recommendation of the GSA BBEST for this location is summarized in Table 4.1-14. Differences between the GSA BBASC and GSA BBEST recommendations include the following:

a. Increasing the GSA BBEST Winter, Spring, and Fall seasonal subsistence flows to the seasonal Q95[46] values provided by TPWD; and
b. Applying the GSA BBASC Pulse Exemption Rule (Section 4.3.1); and
c. Applying the Ten Percent Dedication to Environmental Flows (10% Rule) (Section 4.3.2).

It was brought to the attention of the GSA BBASC that several violations of the TCEQ stream standard for dissolved oxygen have been measured at this site. The primary rationales for the GSA BBASC increasing the seasonal subsistence flows are these violations and a “high” level of concern expressed by TPWD. The bases for this level of concern are summarized in Appendix C which was prepared by TPWD in response to a GSA BBASC request for their technical review.

The GSA BBASC did not engage in discussions pertinent to *present and future needs for water for other uses related to water supply planning* specifically relevant to this location.

Due to time and funding constraints, very limited or no detailed technical evaluations were conducted at this streamgage. The Pulse Exemption Rule was applied in consideration of present and future water needs related to water supply planning.

[46] Seasonal Q95 is defined to be the daily average flow rate exceeded 95 percent of the time within a selected season. GSA BBEST seasonal subsistence flow values were calculated as the median of the lowest 10 percent of base flows within a selected season.

Table 4.1-13. GSA BBASC Environmental Flow Regime Recommendation – Sandies Creek near Westhoff[47]

	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
Overbank Flows	Qp: 14,300 cfs with Average Frequency 1 per 5 years Regressed Volume is 86,700 Duration Bound is 39			
Overbank Flows	Qp: 6,240 cfs with Average Frequency 1 per 2 years Regressed Volume is 38,000 Duration Bound is 32			
Overbank Flows	Qp: 4,020 cfs with Average Frequency 1 per year Regressed Volume is 24,500 Duration Bound is 29			
High Flow Pulses	Qp: 770 cfs with Average Frequency 1 per season Regressed Volume is 4,840 Duration Bound is 21	Qp: 1,670 cfs with Average Frequency 1 per season Regressed Volume is 10,100 Duration Bound is 24	Qp: 250 cfs with Average Frequency 1 per season Regressed Volume is 1,430 Duration Bound is 16	Qp: 570 cfs with Average Frequency 1 per season Regressed Volume is 3,650 Duration Bound is 18
High Flow Pulses	Qp: 300 cfs with Average Frequency 2 per season Regressed Volume is 1,880 Duration Bound is 16	Qp: 440 cfs with Average Frequency 2 per season Regressed Volume is 2,710 Duration Bound is 18	Qp: 59 cfs with Average Frequency 2 per season Regressed Volume is 330 Duration Bound is 11	Qp: 150 cfs with Average Frequency 2 per season Regressed Volume is 960 Duration Bound is 14
Base Flows (cfs)	12	9.0	3.8	9.4
Base Flows (cfs)	9.9	6.0	2.7	5.9
Base Flows (cfs)	6.3	3.1	1.8	3.2
Subsistence Flows (cfs)	3.5	1.4	1.0	1.7

Table 4.1-14. GSA BBEST Environmental Flow Regime Recommendation – Sandies Creek near Westhoff[48]

	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
Overbank Flows	Qp: 14,300 cfs with Average Frequency 1 per 5 years Regressed Volume is 86,700 Duration Bound is 39			
Overbank Flows	Qp: 6,240 cfs with Average Frequency 1 per 2 years Regressed Volume is 38,000 Duration Bound is 32			
Overbank Flows	Qp: 4,020 cfs with Average Frequency 1 per year Regressed Volume is 24,500 Duration Bound is 29			
High Flow Pulses	Qp: 770 cfs with Average Frequency 1 per season Regressed Volume is 4,840 Duration Bound is 21	Qp: 1,670 cfs with Average Frequency 1 per season Regressed Volume is 10,100 Duration Bound is 24	Qp: 250 cfs with Average Frequency 1 per season Regressed Volume is 1,430 Duration Bound is 16	Qp: 570 cfs with Average Frequency 1 per season Regressed Volume is 3,650 Duration Bound is 18
High Flow Pulses	Qp: 300 cfs with Average Frequency 2 per season Regressed Volume is 1,880 Duration Bound is 16	Qp: 440 cfs with Average Frequency 2 per season Regressed Volume is 2,710 Duration Bound is 18	Qp: 59 cfs with Average Frequency 2 per season Regressed Volume is 330 Duration Bound is 11	Qp: 150 cfs with Average Frequency 2 per season Regressed Volume is 960 Duration Bound is 14
Base Flows (cfs)	12	9.0	3.8	9.4
Base Flows (cfs)	9.9	6.0	2.7	5.9
Base Flows (cfs)	6.3	3.1	1.8	3.2
Subsistence Flows (cfs)	1.0	1.0	1.0	1.0

47 Volumes are in acre-feet and durations are in days.
48 Volumes are in acre-feet and durations are in days.

4.1.9 Guadalupe River at Cuero

The streamflow gaging station and recommended instream measurement point on the Guadalupe River at Cuero (USGS #08175800) is located in central DeWitt County, has a drainage area of 4,934 square miles, and has records extending back in time through 1936. The environmental flow standard recommendation of the GSA BBASC for this location is summarized in Table 4.1-15. GSA BBASC recommendations associated with the Guadalupe River at Cuero instream measurement point were adopted by a vote of 19 to 3. For reference, the environmental flow regime recommendation of the GSA BBEST for this location is summarized in Table 4.1-16. Differences between the GSA BBASC and GSA BBEST recommendations include the following:

a. Replacing the three-tiered base flow structure with a single-tiered structure in the Winter and Fall seasons and using values for the GSA BBEST Winter and Fall wet base flows;
b. Applying the GSA BBASC Pulse Exemption Rule (Section 4.3.1); and
c. Applying the Ten Percent Dedication to Environmental Flows (10% Rule) (Section 4.3.2).

The GSA BBASC had only limited discussions pertinent to *present and future needs for water for other uses related to water supply planning* specifically relevant to this location. For consistency with recommendations for the Guadalupe River at Gonzales and Victoria, the GSA BBASC recommends replacement of the GSA BBEST three-tiered base flow structure in the Winter and Fall with a single-tiered structure which is intended to increase water potentially available for diversion and firm yield. This change, along with the Pulse Exemption Rule, are the adjustments to the GSA BBEST recommendations included in the GSA BBASC environmental flow standard recommendations for the Guadalupe River at Cuero on the basis of needs for water for other uses related to water supply planning.

In order to balance the needs of the environment and water supply needs, the Ten Percent Dedication to Environmental Flows permit condition was adopted by the GSA BBASC by a vote of 19-3 in lieu of a three-tier base flow structure during Fall and Winter for Guadalupe River at Gonzales, Guadalupe River at Cuero, and Guadalupe River at Victoria. A single-tier base flow was recommended for the Fall and Winter.

Table 4.1-15. GSA BBASC Environmental Flow Regime Recommendation - Guadalupe River at Cuero[49]

Overbank Flows	Qp: 45,400 cfs with Average Frequency 1 per 5 years Regressed Volume is 869,000 Duration Bound is 91			
	Qp: 24,700 cfs with Average Frequency 1 per 2 years Regressed Volume is 406,000 Duration Bound is 64			
	Qp: 16,600 cfs with Average Frequency 1 per year Regressed Volume is 247,000 Duration Bound is 50			
High Flow Pulses	Qp: 4,610 cfs with Average Frequency 1 per season Regressed Volume is 55,300 Duration Bound is 26	Qp: 8,870 cfs with Average Frequency 1 per season Regressed Volume is 110,000 Duration Bound is 32	Qp: 2,110 cfs with Average Frequency 1 per season Regressed Volume is 19,300 Duration Bound is 17	Qp: 5,200 cfs with Average Frequency 1 per season Regressed Volume is 54,700 Duration Bound is 23
	Qp: 1,610 cfs with Average Frequency 2 per season Regressed Volume is 14,100 Duration Bound is 13	Qp: 3,370 cfs with Average Frequency 2 per season Regressed Volume is 31,800 Duration Bound is 18	Qp: 1,050 cfs with Average Frequency 2 per season Regressed Volume is 8,300 Duration Bound is 12	Qp: 1,730 cfs with Average Frequency 2 per season Regressed Volume is 14,100 Duration Bound is 13
Base Flows (cfs)	980	940 / 680 / 410	800 / 600 / 390	870
Subsistence Flows (cfs)	130	120	130	86
	Jan Feb Mar	Apr May Jun	Jul Aug Sep	Oct Nov Dec
	Winter	Spring	Summer	Fall

Table 4.1-16. GSA BBEST Environmental Flow Regime Recommendation - Guadalupe River at Cuero[50]

Overbank Flows	Qp: 45,400 cfs with Average Frequency 1 per 5 years Regressed Volume is 869,000 Duration Bound is 91			
	Qp: 24,700 cfs with Average Frequency 1 per 2 years Regressed Volume is 406,000 Duration Bound is 64			
	Qp: 16,600 cfs with Average Frequency 1 per year Regressed Volume is 247,000 Duration Bound is 50			
High Flow Pulses	Qp: 4,610 cfs with Average Frequency 1 per season Regressed Volume is 55,300 Duration Bound is 26	Qp: 8,870 cfs with Average Frequency 1 per season Regressed Volume is 110,000 Duration Bound is 32	Qp: 2,110 cfs with Average Frequency 1 per season Regressed Volume is 19,300 Duration Bound is 17	Qp: 5,200 cfs with Average Frequency 1 per season Regressed Volume is 54,700 Duration Bound is 23
	Qp: 1,610 cfs with Average Frequency 2 per season Regressed Volume is 14,100 Duration Bound is 13	Qp: 3,370 cfs with Average Frequency 2 per season Regressed Volume is 31,800 Duration Bound is 18	Qp: 1,050 cfs with Average Frequency 2 per season Regressed Volume is 8,300 Duration Bound is 12	Qp: 1,730 cfs with Average Frequency 2 per season Regressed Volume is 14,100 Duration Bound is 13
Base Flows (cfs)	980 / 760 / 550	940 / 680 / 410	800 / 600 / 390	870 / 670 / 480
Subsistence Flows (cfs)	130	120	130	86
	Jan Feb Mar	Apr May Jun	Jul Aug Sep	Oct Nov Dec
	Winter	Spring	Summer	Fall

49 Volumes are in acre-feet and durations are in days.
50 Volumes are in acre-feet and durations are in days.

4.1.10 Guadalupe River at Victoria

The streamflow gaging station and recommended instream measurement point on the Guadalupe River at Victoria (USGS #08176500) is located in central Victoria County, has a drainage area of 5,198 square miles, and has records extending back in time through 1935. The environmental flow standard recommendation of the GSA BBASC for this location is summarized in Table 4.1-17. GSA BBASC recommendations associated with the Guadalupe River at Victoria instream measurement point were adopted by a vote of 19 to 3. For reference, the environmental flow regime recommendation of the GSA BBEST for this location is summarized in Table 4.1-18. Differences between the GSA BBASC and GSA BBEST recommendations include the following:

a. Decreasing the Spring and Summer dry base flow values by 50 cfs in accordance with supplemental evaluations of aquatic habitat relationships at this location by Dr. Thom Hardy of the GSA BBEST (Appendix F);
b. Decreasing the Spring and Summer average base flow values by 62.5 cfs in accordance with supplemental evaluations of aquatic habitat relationships at this location by Dr. Thom Hardy of the GSA BBEST (Appendix F);
c. Decreasing the Spring and Summer wet base flow values by 75 in accordance with supplemental evaluations of aquatic habitat relationships at this location by Dr. Thom Hardy of the GSA BBEST (Appendix F);
d. Replacing the three-tiered base flow structure with a single-tiered structure in the Winter and Fall seasons and using values for the Winter and Fall base flows estimated by 75 cfs decrease of the GSA BBEST wet base flow values in accordance with supplemental evaluations of aquatic habitat relationships at this location by Dr. Thom Hardy of the GSA BBEST (Appendix F); and
e. Applying the GSA BBASC Pulse Exemption Rule (Section 4.3.1); and
f. Applying the Ten Percent Dedication to Environmental Flows (10% Rule) (Section 4.3.2).

The primary rationales for the GSA BBASC decreasing the base flow values in all seasons include acceptable adjustments based on best available science in the form of supplemental evaluations of aquatic habitat in order to maintain planned project viability in the lower reaches of the Guadalupe River without substantially affecting the likelihood of maintaining a sound ecological environment based on physical habitat.

GSA BBASC discussions pertinent to *present and future needs for water for other uses related to water supply planning* specifically relevant to this location included the following subjects:

a. The 2011 South Central Texas Regional Water Plan includes the GBRA New Appropriation (Lower Basin) as a recommended water management strategy with an estimated firm yield of 11,300 acft/yr subject to CCEFN.
b. Potential effects of recommended environmental flow standards on a hypothetical new permit similar to that obtained by the City of Victoria in the 1990s and/or amendments of water rights as currently being pursued by the City of Victoria.

An evaluation of a hypothetical new 10,000 acft/yr run-of-river appropriation was performed at the Guadalupe River at Victoria site. The results of this analysis are summarized in Section 3.3.2 of this report.

Table 4.1-17. GSA BBASC Environmental Flow Regime Recommendation - Guadalupe River at Victoria[51]

	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
Overbank Flows	Qp: 48,000 cfs with Average Frequency 1 per 5 years Regressed Volume is 971,000 Duration Bound is 96	Qp: 48,000 cfs with Average Frequency 1 per 5 years Regressed Volume is 971,000 Duration Bound is 96	Qp: 48,000 cfs with Average Frequency 1 per 5 years Regressed Volume is 971,000 Duration Bound is 96	Qp: 48,000 cfs with Average Frequency 1 per 5 years Regressed Volume is 971,000 Duration Bound is 96
Overbank Flows	Qp: 25,500 cfs with Average Frequency 1 per 2 years Regressed Volume is 438,000 Duration Bound is 66	Qp: 25,500 cfs with Average Frequency 1 per 2 years Regressed Volume is 438,000 Duration Bound is 66	Qp: 25,500 cfs with Average Frequency 1 per 2 years Regressed Volume is 438,000 Duration Bound is 66	Qp: 25,500 cfs with Average Frequency 1 per 2 years Regressed Volume is 438,000 Duration Bound is 66
Overbank Flows	Qp: 16,700 cfs with Average Frequency 1 per year Regressed Volume is 257,000 Duration Bound is 51	Qp: 16,700 cfs with Average Frequency 1 per year Regressed Volume is 257,000 Duration Bound is 51	Qp: 16,700 cfs with Average Frequency 1 per year Regressed Volume is 257,000 Duration Bound is 51	Qp: 16,700 cfs with Average Frequency 1 per year Regressed Volume is 257,000 Duration Bound is 51
High Flow Pulses	Qp: 4,620 cfs with Average Frequency 1 per season Regressed Volume is 56,100 Duration Bound is 26	Qp: 9,020* cfs with Average Frequency 1 per season Regressed Volume is 119,000 Duration Bound is 34	Qp: 2,060 cfs with Average Frequency 1 per season Regressed Volume is 19,200 Duration Bound is 16	Qp: 5,370 cfs with Average Frequency 1 per season Regressed Volume is 57,800 Duration Bound is 23
High Flow Pulses	Qp: 1,690 cfs with Average Frequency 2 per season Regressed Volume is 14,400 Duration Bound is 13	Qp: 3,300 cfs with Average Frequency 2 per season Regressed Volume is 33,000 Duration Bound is 18	Qp: 1,040 cfs with Average Frequency 2 per season Regressed Volume is 8,570 Duration Bound is 11	Qp: 1,880 cfs with Average Frequency 2 per season Regressed Volume is 15,600 Duration Bound is 13
Base Flows (cfs)	975	945 647.5 400	795 567.5 370	865
Subsistence Flows (cfs)	160	130	150	110

Table 4.1-18. GSA BBEST Environmental Flow Regime Recommendation - Guadalupe River at Victoria[52]

	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
Overbank Flows	Qp: 48,000 cfs with Average Frequency 1 per 5 years Regressed Volume is 971,000 Duration Bound is 96	Qp: 48,000 cfs with Average Frequency 1 per 5 years Regressed Volume is 971,000 Duration Bound is 96	Qp: 48,000 cfs with Average Frequency 1 per 5 years Regressed Volume is 971,000 Duration Bound is 96	Qp: 48,000 cfs with Average Frequency 1 per 5 years Regressed Volume is 971,000 Duration Bound is 96
Overbank Flows	Qp: 25,500 cfs with Average Frequency 1 per 2 years Regressed Volume is 438,000 Duration Bound is 66	Qp: 25,500 cfs with Average Frequency 1 per 2 years Regressed Volume is 438,000 Duration Bound is 66	Qp: 25,500 cfs with Average Frequency 1 per 2 years Regressed Volume is 438,000 Duration Bound is 66	Qp: 25,500 cfs with Average Frequency 1 per 2 years Regressed Volume is 438,000 Duration Bound is 66
Overbank Flows	Qp: 16,700 cfs with Average Frequency 1 per year Regressed Volume is 257,000 Duration Bound is 51	Qp: 16,700 cfs with Average Frequency 1 per year Regressed Volume is 257,000 Duration Bound is 51	Qp: 16,700 cfs with Average Frequency 1 per year Regressed Volume is 257,000 Duration Bound is 51	Qp: 16,700 cfs with Average Frequency 1 per year Regressed Volume is 257,000 Duration Bound is 51
High Flow Pulses	Qp: 4,620 cfs with Average Frequency 1 per season Regressed Volume is 56,100 Duration Bound is 26	Qp: 9,020* cfs with Average Frequency 1 per season Regressed Volume is 119,000 Duration Bound is 34	Qp: 2,060 cfs with Average Frequency 1 per season Regressed Volume is 19,200 Duration Bound is 16	Qp: 5,370 cfs with Average Frequency 1 per season Regressed Volume is 57,800 Duration Bound is 23
High Flow Pulses	Qp: 1,690 cfs with Average Frequency 2 per season Regressed Volume is 14,400 Duration Bound is 13	Qp: 3,300 cfs with Average Frequency 2 per season Regressed Volume is 33,000 Duration Bound is 18	Qp: 1,040 cfs with Average Frequency 2 per season Regressed Volume is 8,570 Duration Bound is 11	Qp: 1,880 cfs with Average Frequency 2 per season Regressed Volume is 15,600 Duration Bound is 13
Base Flows (cfs)	1,050 800 580	1,020 710 450	870 630 420	940 720 510
Subsistence Flows (cfs)	160	130	150	110

[51] Volumes are in acre-feet and durations are in days.
[52] Volumes are in acre-feet and durations are in days.

The GSA BBASC recommends replacement of the GSA BBEST three-tiered base flow structure in the Winter and Fall with a single-tiered structure which is intended to increase water potentially available for diversion and firm yield while minimizing associated ecological risks. This change, along with the Pulse Exemption Rule, are the adjustments to the GSA BBEST recommendations included in the GSA BBASC environmental flow standard recommendations for the Guadalupe River at Victoria on the basis of needs for water for other uses related to water supply planning.

In order to balance the needs of the environment and water supply needs, the Ten Percent Dedication to Environmental Flows permit condition was adopted by the GSA BBASC by a vote of 19-3 in lieu of a three-tier base flow structure during Fall and Winter for Guadalupe River at Gonzales, Guadalupe River at Cuero, and Guadalupe River at Victoria. A single-tier base flow was recommended for the Fall and Winter.

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4.1.11 Medina River at Bandera

The streamflow gaging station and recommended instream measurement point on Medina River at Bandera (USGS #08178880) is located in central Bandera County, has a drainage area of 427 square miles, and has records extending back in time through 1941. The environmental flow standard recommendation of the GSA BBASC for this location is summarized in Table 4.1-19. For reference, the environmental flow regime recommendation of the GSA BBEST for this location is summarized in Table 4.1-20. Differences between the GSA BBASC and GSA BBEST recommendations include the following:

a. Increasing the GSA BBEST seasonal subsistence flows to the seasonal Q95[53] values provided by TPWD; and
b. Applying the GSA BBASC Pulse Exemption Rule (Section 4.3.1); and
c. Applying the Ten Percent Dedication to Environmental Flows (10% Rule) (Section 4.3.2).

As the GSA BBEST reported that all available measurements of dissolved oxygen and temperature at subsistence flow levels met TCEQ stream standards, the primary rationale for the GSA BBASC increasing the seasonal subsistence flows is a "high" level of concern expressed by TPWD. The bases for this level of concern are summarized in Appendix C which was prepared by TPWD in response to a GSA BBASC request for their technical review.

GSA BBASC discussions pertinent to *present and future needs for water for other uses related to water supply planning* specifically relevant to this location included the following subjects:

a. Future surface water rights would be very difficult to obtain as water available for diversion or impoundment would be significantly limited by senior water rights associated with the Medina Lake System.
b. Present and future groundwater use impacts on upper basin streamflows.
c. Recognition that recreational use is very important in this stream segment.

Due to time and funding constraints, very limited or no detailed technical evaluations were conducted at this streamgage to quantitatively address these subjects. The Pulse Exemption Rule was applied in consideration of present and future water needs related to water supply planning.

[53] Seasonal Q95 is defined to be the daily average flow rate exceeded 95 percent of the time within a selected season. GSA BBEST seasonal subsistence flow values were calculated as the median of the lowest 10 percent of base flows within a selected season.

Table 4.1-19. GSA BBASC Environmental Flow Regime Recommendation – Medina River at Bandera[54]

	Winter	Spring	Summer	Fall
Overbank Flows	Qp: 6,920 cfs with Average Frequency 1 per 5 years Regressed Volume is 50,000 Duration Bound is 83			
Overbank Flows	Qp: 3,470 cfs with Average Frequency 1 per 2 years Regressed Volume is 34,500 Duration Bound is 63			
High Flow Pulses	Qp: 1,890 cfs with Average Frequency 1 per year Regressed Volume is 18,000 Duration Bound is 50			
High Flow Pulses	Qp: 110 cfs with Average Frequency 1 per season Regressed Volume is 960 Duration Bound is 17	Qp: 480 cfs with Average Frequency 1 per season Regressed Volume is 4,190 Duration Bound is 28	Qp: 340 cfs with Average Frequency 1 per season Regressed Volume is 2,310 Duration Bound is 21	Qp: 220 cfs with Average Frequency 1 per season Regressed Volume is 1,930 Duration Bound is 24
High Flow Pulses	Qp: 53 cfs with Average Frequency 2 per season Regressed Volume is 400 Duration Bound is 12	Qp: 110 cfs with Average Frequency 2 per season Regressed Volume is 900 Duration Bound is 17	Qp: 94 cfs with Average Frequency 2 per season Regressed Volume is 670 Duration Bound is 14	Qp: 68 cfs with Average Frequency 2 per season Regressed Volume is 500 Duration Bound is 14
Base Flows (cfs)	54	48	41	49
Base Flows (cfs)	32	22	16	33
Base Flows (cfs)	17	9.8	6.2	16
Subsistence Flows (cfs)	5.5	6.6	1.4	1.7
	Jan Feb Mar	Apr May Jun	Jul Aug Sep	Oct Nov Dec
	Winter	Spring	Summer	Fall

Table 4.1-20. GSA BBEST Environmental Flow Regime Recommendation – Medina River at Bandera[55]

	Winter	Spring	Summer	Fall
Overbank Flows	Qp: 6,920 cfs with Average Frequency 1 per 5 years Regressed Volume is 50,000 Duration Bound is 83			
Overbank Flows	Qp: 3,470 cfs with Average Frequency 1 per 2 years Regressed Volume is 34,500 Duration Bound is 63			
High Flow Pulses	Qp: 1,890 cfs with Average Frequency 1 per year Regressed Volume is 18,000 Duration Bound is 50			
High Flow Pulses	Qp: 110 cfs with Average Frequency 1 per season Regressed Volume is 960 Duration Bound is 17	Qp: 480 cfs with Average Frequency 1 per season Regressed Volume is 4,190 Duration Bound is 28	Qp: 340 cfs with Average Frequency 1 per season Regressed Volume is 2,310 Duration Bound is 21	Qp: 220 cfs with Average Frequency 1 per season Regressed Volume is 1,930 Duration Bound is 24
High Flow Pulses	Qp: 53 cfs with Average Frequency 2 per season Regressed Volume is 400 Duration Bound is 12	Qp: 110 cfs with Average Frequency 2 per season Regressed Volume is 900 Duration Bound is 17	Qp: 94 cfs with Average Frequency 2 per season Regressed Volume is 670 Duration Bound is 14	Qp: 68 cfs with Average Frequency 2 per season Regressed Volume is 500 Duration Bound is 14
Base Flows (cfs)	54	48	41	49
Base Flows (cfs)	32	22	16	33
Base Flows (cfs)	17	9.8	6.2	16
Subsistence Flows (cfs)	1.1	1.0	1.2	1.0
	Jan Feb Mar	Apr May Jun	Jul Aug Sep	Oct Nov Dec
	Winter	Spring	Summer	Fall

[54] Volumes are in acre-feet and durations are in days.
[55] Volumes are in acre-feet and durations are in days.

4.1.12 Medina River at San Antonio

The streamflow gaging station and recommended instream measurement point on Medina River at San Antonio (USGS #08181500) is located in south central Bexar County, has a drainage area of 1,317 square miles, and has records extending back in time through 1940. The environmental flow standard recommendation of the GSA BBASC for this location is summarized in Table 4.1-21. For reference, the environmental flow regime recommendation of the GSA BBEST for this location is summarized in Table 4.1-22. Differences between the GSA BBASC and GSA BBEST recommendations include the following:

a. Increasing the GSA BBEST seasonal subsistence flows to the seasonal Q95[56] values provided by TPWD; and
b. Applying the GSA BBASC Pulse Exemption Rule (Section 4.3.1); and
c. Applying the Ten Percent Dedication to Environmental Flows (10% Rule) (Section 4.3.2).

As the GSA BBEST found no available measurements of dissolved oxygen or temperature at subsistence flow levels, the primary rationale for the GSA BBASC increasing the seasonal subsistence flows is a "high" level of concern expressed by TPWD. The bases for this level of concern are summarized in Appendix C which was prepared by TPWD in response to a GSA BBASC request for their technical review.

The GSA BBASC did not engage in discussions pertinent to *present and future needs for water for other uses related to water supply planning* specifically relevant to this location.

Due to time and funding constraints, very limited or no detailed technical evaluations were conducted at this streamgage. The Pulse Exemption Rule was applied in consideration of present and future water needs related to water supply planning.

[56] Seasonal Q95 is defined to be the daily average flow rate exceeded 95 percent of the time within a selected season. GSA BBEST seasonal subsistence flow values were calculated as the median of the lowest 10 percent of base flows within a selected season.

Table 4.1-21. GSA BBASC Environmental Flow Regime Recommendation – Medina River at San Antonio[57]

	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
Overbank Flows	Qp: 9,940 cfs with Average Frequency 1 per 5 years Regressed Volume is 123,000 Duration Bound is 107			
Overbank Flows	Qp: 6,020 cfs with Average Frequency 1 per 2 years Regressed Volume is 69,300 Duration Bound is 83			
High Flow Pulses	Qp: 2,920 cfs with Average Frequency 1 per year Regressed Volume is 30,400 Duration Bound is 58			
High Flow Pulses	Qp: 350 cfs with Average Frequency 1 per season Regressed Volume is 3,570 Duration Bound is 27	Qp: 1,000 cfs with Average Frequency 1 per season Regressed Volume is 7,950 Duration Bound is 27	Qp: 440 cfs with Average Frequency 1 per season Regressed Volume is 3,050 Duration Bound is 21	Qp: 450 cfs with Average Frequency 1 per season Regressed Volume is 3,890 Duration Bound is 28
High Flow Pulses	Qp: 120 cfs with Average Frequency 2 per season Regressed Volume is 970 Duration Bound is 15	Qp: 380 cfs with Average Frequency 2 per season Regressed Volume is 2,680 Duration Bound is 17	Qp: 140 cfs with Average Frequency 2 per season Regressed Volume is 860 Duration Bound is 12	Qp: 130 cfs with Average Frequency 2 per season Regressed Volume is 930 Duration Bound is 14
Base Flows (cfs)	71	77	72	74
	53	62	57	60
	20	37	33	27
Subsistence Flows (cfs)	14.0	12.0	8.3	13.0

Table 4.1-22. GSA BBEST Environmental Flow Regime Recommendation – Medina River at San Antonio[58]

	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
Overbank Flows	Qp: 9,940 cfs with Average Frequency 1 per 5 years Regressed Volume is 123,000 Duration Bound is 107			
Overbank Flows	Qp: 6,020 cfs with Average Frequency 1 per 2 years Regressed Volume is 69,300 Duration Bound is 83			
High Flow Pulses	Qp: 2,920 cfs with Average Frequency 1 per year Regressed Volume is 30,400 Duration Bound is 58			
High Flow Pulses	Qp: 350 cfs with Average Frequency 1 per season Regressed Volume is 3,570 Duration Bound is 27	Qp: 1,000 cfs with Average Frequency 1 per season Regressed Volume is 7,950 Duration Bound is 27	Qp: 440 cfs with Average Frequency 1 per season Regressed Volume is 3,050 Duration Bound is 21	Qp: 450 cfs with Average Frequency 1 per season Regressed Volume is 3,890 Duration Bound is 28
High Flow Pulses	Qp: 120 cfs with Average Frequency 2 per season Regressed Volume is 970 Duration Bound is 15	Qp: 380 cfs with Average Frequency 2 per season Regressed Volume is 2,680 Duration Bound is 17	Qp: 140 cfs with Average Frequency 2 per season Regressed Volume is 860 Duration Bound is 12	Qp: 130 cfs with Average Frequency 2 per season Regressed Volume is 930 Duration Bound is 14
Base Flows (cfs)	71	77	72	74
	53	62	57	60
	20	37	33	27
Subsistence Flows (cfs)	7.9	7.6	7.0	7.4

[57] Volumes are in acre-feet and durations are in days.
[58] Volumes are in acre-feet and durations are in days.

4.1.13 San Antonio River near Elmendorf

The streamflow gaging station and recommended instream measurement point on the San Antonio River at Elmendorf (USGS #08181800) is located in southern Bexar County, has a drainage area of 1,743 square miles, and has records extending back in time through 1963. The environmental flow standard recommendation of the GSA BBASC for this location is summarized in Table 4.1-23. For reference, the environmental flow regime recommendation of the GSA BBEST and the LSAR TIFP Interim Report for this location are summarized in Tables 4.1-24 and 4.1-25, respectively.

As noted in Section 3.4, an interim report from the Texas Instream Flow Program on the Lower San Antonio River was submitted to the GSA BBASC during its deliberations. The GSA BBASC viewed the TIFP data as the best available science as it showed demonstrated links between instream flow levels and habitat responses both in the river and in the adjacent riparian area. The GSA BBASC considered this information alongside the GSA BBEST report and other data presented to formulate its recommendations.

The GSA BBASC flow recommendation is as follows:

a. Adopt a 60 cfs subsistence flow for all seasons which is a volume consistent with the GSA BBEST recommendation and consistent with the LSAR TIFP Interim Flow Recommendations of maintaining a consistent flow for all seasons to avoid conflicting with the natural flow pattern;
b. Maintain the LSAR TFIP base flows volumes which are higher than the GSA BBEST recommendations; maintain hydrologic conditions as recommended by both the GSA BBEST and the LSAR TFIP;
c. Maintain the 50 Percent Rule for diversions below dry base flow and above subsistence as recommended by the GSA BBEST to remain consistent with the other 15 gages;
d. Maintain the LSAR TIFP recommended pulses with the inclusion of an additional set of high flow pulses from the GSA BBEST Recommendation to bridge the gap between the three tiers of baseflows and the TIFP high flow pulses *(The GSA BBASC recognized that the LSAR TIFP final recommendations may include, based upon ongoing studies and analyses, a lower volume pulse to support seasonal habitat and sediment transport needs within the river system)*;
e. Applying the GSA BBASC Pulse Exemption Rule (Section 4.3.1) to remain consistent with the other 15 gages; and
f. Applying the Ten Percent Dedication to Environmental Flows (10% Rule) (Section 4.3.2).

The GSA BBASC did not engage in discussions pertinent to *present and future needs for water for other uses related to water supply planning* specifically relevant to this location.

An evaluation of a hypothetical new 10,000 acft/yr run-of-river appropriation was performed at the San Antonio River near Elmendorf site. The results of this analysis are summarized in Section 3.3.2 of this report. The Pulse Exemption Rule was applied in consideration of present and future water needs related to water supply planning.

Table 4.1-23. GSA BBASC Environmental Flow Regime Recommendation – San Antonio River near Elmendorf[59,60]

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Overbank Flows		Qp: 11,500 cfs with Frequency 1 per season Duration is 2 *										
		Qp: 8,000 cfs with Frequency 1 per season Duration is 2 *										
High Flow Pulses					Qp: 4,000 cfs with Frequency 2 per season Duration is 2 *		Qp: 4,000 cfs with Frequency 2 per season Duration is 2 *					
				Qp: 3,000 cfs with Frequency 3 per season Duration is 2 *								
	Qp: 830 cfs with Average Frequency 1 per season Duration is 14 Regressed Volume is 6,210			Qp: 1560 cfs with Average Frequency 1 per season Duration is 16 Regressed Volume is 10,700			Qp: 1110 cfs with Average Frequency 1 per season Duration is 12 Regressed Volume is 6,460			Qp: 1010 cfs with Average Frequency 1 per season Duration is 13 Regressed Volume is 6,570		
Base Flows (cfs)	328			364			341			367		
	262			237			178			223		
	115			106			87			92		
Subsistence Flows (cfs)	60			60			60			60		
	Winter			Spring			Summer			Fall		

Table 4.1-24. GSA BBEST Environmental Flow Regime Recommendation – San Antonio River near Elmendorf[61]

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Overbank Flows	Qp: 12,200 cfs with Average Frequency 1 per 5 years Regressed Volume is 123,000 Duration Bound is 52											
High Flow Pulses	Qp: 5,640 cfs with Average Frequency 1 per 2 years Regressed Volume is 49,400 Duration Bound is 34											
	Qp: 3,310 cfs with Average Frequency 1 per year Regressed Volume is 26,400 Duration Bound is 25											
	Qp: 830 cfs with Average Frequency 1 per season Regressed Volume is 6,210 Duration Bound is 14			Qp: 1,560 cfs with Average Frequency 1 per season Regressed Volume is 10,700 Duration Bound is 16			Qp: 1,110 cfs with Average Frequency 1 per season Regressed Volume is 6,460 Duration Bound is 12			Qp: 1,010 cfs with Average Frequency 1 per season Regressed Volume is 6,570 Duration Bound is 13		
	Qp: 440 cfs with Average Frequency 2 per season Regressed Volume is 2,940 Duration Bound is 10			Qp: 820 cfs with Average Frequency 2 per season Regressed Volume is 5,060 Duration Bound is 11			Qp: 540 cfs with Average Frequency 2 per season Regressed Volume is 2,870 Duration Bound is 9			Qp: 480 cfs with Average Frequency 2 per season Regressed Volume is 2,630 Duration Bound is 8		
Base Flows (cfs)	210			200			170			190		
	150			150			130			150		
	110			99			88			97		
Subsistence Flows (cfs)	61			50			49			56		
	Winter			Spring			Summer			Fall		

59 Pulses from the LSAR TIFP Interim Report (identified by *) are satisfied when the streamflow is greater than or equal to the pulse peak for the entire duration specified for the pulse.
60 Volumes are in acre-feet and durations are in days.
61 Volumes are in acre-feet and durations are in days.

Table 4.1-25. LSAR TIFP Environmental Flow Regime Interim Recommendation – San Antonio River near Elmendorf

ELMENDORF

Overbank Flow

Magnitude = 11,500 cfs
Frequency = 1 event
Duration = 2 days

Key Indicators:
Riparian: Inundates approx. 90% of hardwood forest community
Sediment transport: Channel maintenance

Magnitude = 8,000 cfs
Frequency = 1 event
Duration = 2 days

Key Indicators:
Riparian: Inundates approx. 75% of hardwood forest community
Sediment transport: Channel maintenance

High Flow Pulses

Magnitude = 4,000 cfs
Frequency = 2 events
Duration = 2-3 days
Key Indicators: Cottonwood

Magnitude = 4,000 cfs
Frequency = 2 events
Duration = 2-3 days
Key Indicators:
Riparian: Green Ash / Box Elder

Magnitude = 3,000 cfs
Frequency = 3 events
Duration = 2-5 days
Key Indicators: Riparian - Black Willow

BASE FLOWS (cfs) - Aquatic Habitat protection (intra- and interannual variability)							**Key Indicators: Aquatic Habitat, Water Quality**					
Base Wet	319	336	329	338	372	382	384	303	336	357	390	355
Base Average	264	268	256	235	259	216	177	160	195	220	226	225
Base Dry	119	113	114	109	113	98	90	90	107	90	91	101
SUBSISTENCE FLOWS (cfs) - Water quality protection and maintainence of limited aquatic habitat								**Key Indicators: Water Quality, Aquatic Habitat**				
Subsistence	80	80	80	80	80	80	80	80	80	80	80	80
MONTH	January	February	March	April	May	June	July	August	September	October	November	December

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4.1.14 San Antonio River near Falls City

The streamflow gaging station and recommended instream measurement point on the San Antonio River near Falls City (USGS #08183500) is located in northwestern Karnes County, has a drainage area of 2,113 square miles, and has records extending back in time through 1926. The environmental flow standard recommendation of the GSA BBASC for this location is summarized in Table 4.1-26. For reference, the environmental flow regime recommendation of the GSA BBEST and the LSAR TIFP Interim Report for this location are summarized in Tables 4.1-27 and 4.1-28, respectively.

As noted in Section 3.4, an interim report from the Texas Instream Flow Program on the Lower San Antonio River was submitted to the GSA BBASC during its deliberations. The GSA BBASC viewed the TIFP data as the best available science as it showed demonstrated links between instream flow levels and habitat responses both in the river and in the adjacent riparian area. The GSA BBASC considered this information alongside the GSA BBEST report and other data presented to formulate its recommendations.

The GSA BBASC flow recommendation is as follows:

a. Adopt a 60 cfs subsistence flow for all seasons which is a volume consistent with the GSA BBEST recommendation and consistent with the LSAR TIFP Interim Flow Recommendations of maintaining a consistent flow for all seasons to avoid conflicting with the natural flow pattern;
b. Maintain the LSAR TFIP base flows volumes which are higher than the GSA BBEST recommendations; maintain hydrologic conditions as recommended by both the GSA BBEST and the LSAR TFIP;
c. Maintain the 50 Percent Rule for diversions below dry base flow and above subsistence as recommended by the GSA BBEST to remain consistent with the other 15 gages;
d. Maintain the LSAR TIFP recommended pulses with the inclusion of an additional set of high flow pulses from the GSA BBEST Recommendation to bridge the gap between the three tiers of baseflows and the TIFP high flow pulses (*The GSA BBASC recognized that the LSAR TIFP final recommendations may include, based upon ongoing studies and analyses, a lower volume pulse to support seasonal habitat and sediment transport needs within the river system)*;
e. Applying the GSA BBASC Pulse Exemption Rule (Section 4.3.1) to remain consistent with the other 15 gages; and
f. Applying the Ten Percent Dedication to Environmental Flows (10% Rule) (Section 4.3.2).

The GSA BBASC did not engage in discussions pertinent to *present and future needs for water for other uses related to water supply planning* specifically relevant to this location.

Due to time and funding constraints, very limited or no detailed technical evaluations were conducted at this streamgage. The Pulse Exemption Rule was applied in consideration of present and future water needs related to water supply planning.

Table 4.1-26. GSA BBASC Environmental Flow Regime Recommendation – San Antonio River near Falls City[62,63]

<table>
<tr><th></th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><th></th><th colspan="3">Winter</th><th colspan="3">Spring</th><th colspan="3">Summer</th><th colspan="3">Fall</th></tr>
<tr><td rowspan="2">Overbank Flows</td><td></td><td colspan="9">Qp: 11,500 cfs with Frequency 1 per season Duration is 2 *</td><td colspan="2"></td></tr>
<tr><td></td><td colspan="9">Qp: 8,000 cfs with Frequency 1 per season Duration is 2 *</td><td colspan="2"></td></tr>
<tr><td rowspan="3">High Flow Pulses</td><td></td><td colspan="3">* Qp: 4,000 cfs with Frequency 2 per season Duration is 2</td><td colspan="2"></td><td colspan="5">Qp: 6,500 cfs with Frequency 2 per season Duration is 2 *</td><td></td></tr>
<tr><td colspan="3"></td><td colspan="3">Qp: 4,000 cfs with * Frequency 3 per season Duration is 2</td><td colspan="6"></td></tr>
<tr><td colspan="3">Qp: 830 cfs with Average Frequency 1 per season Duration is 16 Regressed Volume is 6,330</td><td colspan="3">Qp: 1670 cfs with Average Frequency 1 per season Duration is 19 Regressed Volume is 12,300</td><td colspan="3">Qp: 1030 cfs with Average Frequency 1 per season Duration is 14 Regressed Volume is 6,440</td><td colspan="3">Qp: 850 cfs with Average Frequency 1 per season Duration is 14 Regressed Volume is 5,690</td></tr>
<tr><td rowspan="3">Base Flows (cfs)</td><td colspan="3">424</td><td colspan="3">467</td><td colspan="3">430</td><td colspan="3">479</td></tr>
<tr><td colspan="3">292</td><td colspan="3">264</td><td colspan="3">199</td><td colspan="3">246</td></tr>
<tr><td colspan="3">152</td><td colspan="3">137</td><td colspan="3">113</td><td colspan="3">117</td></tr>
<tr><td>Subsistence Flows (cfs)</td><td colspan="3">60</td><td colspan="3">60</td><td colspan="3">60</td><td colspan="3">60</td></tr>
</table>

Table 4.1-27. GSA BBEST Environmental Flow Regime Recommendation – San Antonio River near Falls City[64]

<table>
<tr><th></th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><th></th><th colspan="3">Winter</th><th colspan="3">Spring</th><th colspan="3">Summer</th><th colspan="3">Fall</th></tr>
<tr><td rowspan="2">Overbank Flows</td><td colspan="12">Qp: 10,600 cfs with Average Frequency 1 per 5 years Regressed Volume is 110,000 Duration Bound is 57</td></tr>
<tr><td colspan="12">Qp: 6,000 cfs with Average Frequency 1 per 2 years Regressed Volume is 56,500 Duration Bound is 41</td></tr>
<tr><td rowspan="3">High Flow Pulses</td><td colspan="12">Qp: 3,160 cfs with Average Frequency 1 per year Regressed Volume is 26,600 Duration Bound is 29</td></tr>
<tr><td colspan="3">Qp: 830 cfs with Average Frequency 1 per season Regressed Volume is 6,330 Duration Bound is 16</td><td colspan="3">Qp: 1,670 cfs with Average Frequency 1 per season Regressed Volume is 12,300 Duration Bound is 19</td><td colspan="3">Qp: 1,030 cfs with Average Frequency 1 per season Regressed Volume is 6,440 Duration Bound is 14</td><td colspan="3">Qp: 850 cfs with Average Frequency 1 per season Regressed Volume is 5,690 Duration Bound is 14</td></tr>
<tr><td colspan="3">Qp: 420 cfs with Average Frequency 2 per season Regressed Volume is 2,740 Duration Bound is 10</td><td colspan="3">Qp: 840 cfs with Average Frequency 2 per season Regressed Volume is 5,630 Duration Bound is 13</td><td colspan="3">Qp: 470 cfs with Average Frequency 2 per season Regressed Volume is 2,650 Duration Bound is 10</td><td colspan="3">Qp: 440 cfs with Average Frequency 2 per season Regressed Volume is 2,520 Duration Bound is 9</td></tr>
<tr><td rowspan="3">Base Flows (cfs)</td><td colspan="3">200</td><td colspan="3">200</td><td colspan="3">170</td><td colspan="3">190</td></tr>
<tr><td colspan="3">140</td><td colspan="3">140</td><td colspan="3">110</td><td colspan="3">120</td></tr>
<tr><td colspan="3">110</td><td colspan="3">95</td><td colspan="3">85</td><td colspan="3">92</td></tr>
<tr><td>Subsistence Flows (cfs)</td><td colspan="3">60</td><td colspan="3">52</td><td colspan="3">52</td><td colspan="3">58</td></tr>
</table>

[62] Pulses from the LSAR TIFP Interim Report (identified by *) are satisfied when the streamflow is greater than or equal to the pulse peak for the entire duration specified for the pulse.
[63] Volumes are in acre-feet and durations are in days.
[64] Volumes are in acre-feet and durations are in days.

Table 4.1-28. LSAR TIFP Environmental Flow Regime Interim Recommendation – San Antonio River near Falls City

FALLS CITY	January	February	March	April	May	June	July	August	September	October	November	December
Overbank Flow		Magnitude = 11,500 cfs Frequency = 1 event Duration = 2 days *Key Indicators:* *Riparian: Inundates approx. 90% of hardwood forest community* *Sediment transport: Channel maintenance*										
Overbank Flow		Magnitude = 8,000 cfs Frequency = 1 event Duration = 2 days *Key Indicators:* *Riparian: Inundates approx. 80% of hardwood forest community* *Sediment transport: Channel maintenance*										
High Flow Pulses		*Key Indicators: Riparian - Sycamore* Magnitude = 4,000 cfs Frequency = 2 events Duration = 2-5 days		Magnitude = 4,000 cfs Frequency = 3 events Duration = 2-5 days *Key Indicators: Riparian - Black Willow*			Magnitude = 6,500 cfs Frequency = 2 events Duration = 2-3 days *Key Indicators:* *Riparian: Green Ash / Box Elder*					
BASE FLOWS (cfs) - Aquatic Habitat protection (intra- and interannual variability)							**Key Indicators: Aquatic Habitat, Water Quality**					
Base Wet	429	429	413	427	487	489	489	380	422	459	511	466
Base Average	292	296	288	261	281	249	200	177	218	242	244	251
Base Dry	152	158	147	142	145	125	103	96	141	105	119	127
SUBSISTENCE FLOWS (cfs) - Water quality protection and maintainence of limited aquatic habitat								**Key Indicators: Water Quality, Aquatic Habitat**				
Subsistence	80	80	80	80	80	80	80	80	80	80	80	80
MONTH	January	February	March	April	May	June	July	August	September	October	November	December

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4.1.15 Cibolo Creek near Falls City

The streamflow gaging station and recommended instream measurement point on the Cibolo Creek near Falls City (USGS #08185000) is located on the Bexar-Guadalupe County Line, has a drainage area of 274 square miles, and has records extending back in time through 1931. The environmental flow standard recommendation of the GSA BBASC for this location is summarized in Table 4.1-29. For reference, the environmental flow regime recommendation of the GSA BBEST and the LSAR TIFP Interim Report for this location are summarized in Tables 4.1-30 and 4.1-31, respectively.

As noted in Section 3.4, an interim report from the Texas Instream Flow Program on the Lower San Antonio River was submitted to the GSA BBASC during its deliberations. The GSA BBASC viewed the TIFP data as the best available science as it showed demonstrated links between instream flow levels and habitat responses both in the river and in the adjacent riparian area. The GSA BBASC considered this information alongside the GSA BBEST report and other data presented to formulate its recommendations.

The GSA BBASC flow recommendation is as follows:

a. Adopt the LSAR TIFP Interim Flow Recommendations for subsistence and base flows and hydrologic conditions as recommended by both the GSA BBEST and the LSAR TFIP;
b. Maintain the 50 Percent Rule for diversions below dry base flow and above subsistence as recommended by the GSA BBEST to remain consistent with the other 15 gages;
c. Maintain the LSAR TIFP recommended pulses with the inclusion of an additional set of high flow pulses from the GSA BBEST Recommendation to bridge the gap between the three tiers of baseflows and the TIFP high flow pulses (*The GSA BBASC recognized that the LSAR TIFP final recommendations may include, based upon ongoing studies and analyses, a lower volume pulse to support seasonal habitat and sediment transport needs within the river system)*;
d. Applying the GSA BBASC Pulse Exemption Rule (Section 4.3.1) to remain consistent with the other 15 gages; and
e. Applying the Ten Percent Dedication to Environmental Flows (10% Rule) (Section 4.3.2).

GSA BBASC discussions pertinent to *present and future needs for water for other uses related to water supply planning* specifically relevant to this location included the following subject:

a. The 2011 South Central Texas Regional Water Plan includes the CRWA Siesta Project as a recommended water management strategy with an estimated firm yield of 5,042 acft/yr subject to CCEFN.

An evaluation of a hypothetical new 10,000 acft/yr run-of-river appropriation was performed at the Cibolo Creek near Falls City site. The results of this analysis are summarized in Section 3.3.2 of this report. The Pulse Exemption Rule was applied in consideration of present and future water needs related to water supply planning.

Table 4.1-29. GSA BBASC Environmental Flow Regime Recommendation – Cibolo Creek near Falls City[65,66]

<table>
<tr><td rowspan="2">Overbank Flows</td><td></td><td colspan="9">Qp: 8,000 cfs with
Frequency 1 per season
Duration is 2 *</td><td colspan="2"></td></tr>
<tr><td></td><td colspan="9">Qp: 5,000 cfs with
Frequency 1 per season
Duration is 2 *</td><td colspan="2"></td></tr>
<tr><td rowspan="3">High Flow Pulses</td><td colspan="6"></td><td colspan="5">Qp: 2,500 cfs with
Frequency 2 per season
Duration Bound is 2 *</td><td></td></tr>
<tr><td colspan="3"></td><td colspan="3">Qp: 1,000 cfs with
Frequency 3 per season
Duration is 2 *</td><td colspan="4">Qp: 1,000 cfs with
Frequency 2 per season
Duration is 2 *</td><td colspan="2"></td></tr>
<tr><td colspan="3">Qp: 570 cfs with Average
Frequency 1 per season
Duration is 20
Regressed Volume is 3,200</td><td colspan="3"></td><td colspan="3">Qp: 390 cfs with Average
Frequency 1 per season
Duration is 15
Regressed Volume is 1,990</td><td colspan="3">Qp: 190 cfs with Average
Frequency 2 per season
Duration is 13
Regressed Volume is 1,000</td></tr>
<tr><td rowspan="3">Base Flows (cfs)</td><td colspan="3">39</td><td colspan="3">44</td><td colspan="3">37</td><td colspan="3">40</td></tr>
<tr><td colspan="3">28</td><td colspan="3">28</td><td colspan="3">20</td><td colspan="3">24</td></tr>
<tr><td colspan="3">20</td><td colspan="3">16</td><td colspan="3">11</td><td colspan="3">13</td></tr>
<tr><td>Subsistence Flows (cfs)</td><td colspan="3">7.5</td><td colspan="3">7.5</td><td colspan="3">7.5</td><td colspan="3">7.5</td></tr>
<tr><td></td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr>
<tr><td></td><td colspan="3">Winter</td><td colspan="3">Spring</td><td colspan="3">Summer</td><td colspan="3">Fall</td></tr>
</table>

Table 4.1-30. GSA BBEST Environmental Flow Regime Recommendation – Cibolo Creek near Falls City[67]

<table>
<tr><td rowspan="3">Overbank Flows</td><td colspan="12">Qp: 13,500 cfs with Average Frequency 1 per 5 years
Regressed Volume is 62,800
Duration Bound is 42</td></tr>
<tr><td colspan="12">Qp: 7,220 cfs with Average Frequency 1 per 2 years
Regressed Volume is 34,200
Duration Bound is 35</td></tr>
<tr><td colspan="12">Qp: 5,160 cfs with Average Frequency 1 per year
Regressed Volume is 24,700
Duration Bound is 32</td></tr>
<tr><td rowspan="2">High Flow Pulses</td><td colspan="3">Qp: 570 cfs with Average
Frequency 1 per season
Regressed Volume is 3,200
Duration Bound is 20</td><td colspan="3">Qp: 2,280* cfs with Average
Frequency 1 per season
Regressed Volume is 10,400
Duration Bound is 21</td><td colspan="3">Qp: 390 cfs with Average
Frequency 1 per season
Regressed Volume is 1,990
Duration Bound is 15</td><td colspan="3">Qp: 1,000* cfs with Average
Frequency 1 per season
Regressed Volume is 5,000
Duration Bound is 22</td></tr>
<tr><td colspan="3">Qp: 140 cfs with Average
Frequency 2 per season
Regressed Volume is 820
Duration Bound is 13</td><td colspan="3">Qp: 670 cfs with Average
Frequency 2 per season
Regressed Volume is 3,230
Duration Bound is 16</td><td colspan="3">Qp: 110 cfs with Average
Frequency 2 per season
Regressed Volume is 580
Duration Bound is 10</td><td colspan="3">Qp: 190 cfs with Average
Frequency 2 per season
Regressed Volume is 1,000
Duration Bound is 13</td></tr>
<tr><td rowspan="3">Base Flows (cfs)</td><td colspan="3">29</td><td colspan="3">27</td><td colspan="3">22</td><td colspan="3">27</td></tr>
<tr><td colspan="3">23</td><td colspan="3">19</td><td colspan="3">15</td><td colspan="3">20</td></tr>
<tr><td colspan="3">17</td><td colspan="3">13</td><td colspan="3">11</td><td colspan="3">13</td></tr>
<tr><td>Subsistence Flows (cfs)</td><td colspan="3">6.0</td><td colspan="3">4.9</td><td colspan="3">5.0</td><td colspan="3">6.5</td></tr>
<tr><td></td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr>
<tr><td></td><td colspan="3">Winter</td><td colspan="3">Spring</td><td colspan="3">Summer</td><td colspan="3">Fall</td></tr>
</table>

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[65] Pulses from the LSAR TIFP Interim Report (identified by *) are satisfied when the streamflow is greater than or equal to the pulse peak for the entire duration specified for the pulse.
[66] Volumes are in acre-feet and durations are in days.
[67] Volumes are in acre-feet and durations are in days.

Table 4.1-31. LSAR TIFP Environmental Flow Regime Interim Recommendation – Cibolo Creek near Falls City

CIBOLO CREEK	January	February	March	April	May	June	July	August	September	October	November	December
Overbank Flow		(February–October) Magnitude = 8,000 cfs Frequency = 1 event Duration = 2 days *Key Indicators:* *Riparian: Inundates approx. 90% of hardwood forest community* *Sediment transport: Channel maintenance*										
		(February–October) Magnitude = 5,000 cfs Frequency = 1 event Duration = 2 days *Key Indicators:* *Riparian: Inundates approx. 75% of hardwood forest community* *Sediment transport: Channel maintenance*										
High Flow Pulses							(July–November) Magnitude = 2,500 cfs Frequency = 2 events Duration = 2-3 days *Key Indicators:* *Riparian: Green Ash / Box Elder*					
				(April–June) Magnitude = 1,000 cfs Frequency = 3 events Duration = 2-5 days *Key Indicators: Riparian - Black Willow*			(July–October) Magnitude = 1,000 cfs Frequency = 2 events Duration = 2-3 days *Key Indictors: Riparian - Buttonbush*					
BASE FLOWS (cfs) - Aquatic Habitat protection (intra- and interannual variability)							**Key Indicators: Aquatic Habitat, Water Quality**					
Base Wet	39	41	38	38	48	45	44	31	35	35	43	42
Base Average	29	28	27	26	29	28	21	17	20	23	25	25
Base Dry	19	20	19	18	17	14	11	9	12	13	13	15
SUBSISTENCE FLOWS (cfs) - Water quality protection and maintainence of limited aquatic habitat								**Key Indicators: Water Quality, Aquatic Habitat**				
Subsistence	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
MONTH	January	February	March	April	May	June	July	August	September	October	November	December

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4.1.16 San Antonio River at Goliad

The streamflow gaging station and recommended instream measurement point on the San Antonio River at Goliad (USGS #08188500) is located in northwestern Karnes County, has a drainage area of 3,921 square miles, and has records extending back in time through 1940. The environmental flow standard recommendation of the GSA BBASC for this location is summarized in Table 4.1-32. For reference, the environmental flow regime recommendation of the GSA BBEST and the LSAR TIFP Interim Report for this location are summarized in Tables 4.1-33 and 4.1-34, respectively.

As noted in Section 3.4, an interim report from the Texas Instream Flow Program on the Lower San Antonio River was submitted to the GSA BBASC during its deliberations. The GSA BBASC viewed the TIFP data as the best available science as it showed demonstrated links between instream flow levels and habitat responses both in the river and in the adjacent riparian area. The GSA BBASC considered this information alongside the GSA BBEST report and other data presented to formulate its recommendations.

The GSA BBASC flow recommendation is as follows:

a. Adopt a 60 cfs subsistence flow for all seasons which is a volume consistent with the GSA BBEST recommendation and consistent with the LSAR TIFP Interim Flow Recommendations of maintaining a consistent flow for all seasons to avoid conflicting with the natural flow pattern;
b. Maintain the LSAR TFIP base flows volumes which are higher than the GSA BBEST recommendations; maintain hydrologic conditions as recommended by both the GSA BBEST and the LSAR TFIP;
c. Maintain the 50 Percent Rule for diversions below dry base flow and above subsistence as recommended by the GSA BBEST to remain consistent with the other 15 gages;
d. Maintain the LSAR TIFP recommended pulses with the inclusion of an additional set of high flow pulses from the GSA BBEST Recommendation to bridge the gap between the three tiers of baseflows and the TIFP high flow pulses (*The GSA BBASC recognized that the LSAR TIFP final recommendations may include, based upon ongoing studies and analyses, a lower volume pulse to support seasonal habitat and sediment transport needs within the river system)*;
e. Applying the GSA BBASC Pulse Exemption Rule (Section 4.3.1) to remain consistent with the other 15 gages; and
f. Applying the Ten Percent Dedication to Environmental Flows (10% Rule) (Section 4.3.2).

GSA BBASC discussions pertinent to *present and future needs for water for other uses related to water supply planning* specifically relevant to this location included detailed technical evaluations of an example run-of-river diversion project with off-channel storage to quantitatively address effects of potential environmental flow standard recommendations on firm yield, instream flows, suitable instream habitat availability, geomorphology, freshwater inflows to the Guadalupe Estuary, and compliance with GSA BBEST freshwater inflow attainment criteria for *Rangia* and oysters. Information regarding these analyses is presented in Section 3.3 of this report. The Pulse Exemption Rule was applied in consideration of present and future water needs related to water supply planning.

Table 4.1-32. GSA BBASC Environmental Flow Regime Recommendation – San Antonio River at Goliad[68,69]

	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
Overbank Flows	Qp: 14,000 cfs with Frequency 1 per season Duration is 2 * (Feb–Oct)			
Overbank Flows	Qp: 11,500 cfs with Frequency 1 per season Duration is 2 * (Feb–Oct)			
High Flow Pulses	Qp: 4,000 cfs with Frequency 2 per season Duration is 2 * (Feb–Apr)		Qp: 8,000 cfs with Frequency 2 per season Duration is 2 * (Jul–Nov)	
High Flow Pulses		Qp: 4,000 cfs with Frequency 3 per season Duration is 2 *		
High Flow Pulses	Qp: 1520 cfs with Average Frequency 1 per season Duration is 19 Regressed Volume is 12,800	Qp: 1570 cfs with Average Frequency 2 per season Duration is 16 Regressed Volume is 11,300	Qp: 1640 cfs with Average Frequency 1 per season Duration is 16 Regressed Volume is 11,200	Qp: 2320 cfs with Average Frequency 1 per season Duration is 19 Regressed Volume is 17,600
Base Flows (cfs)	469	502	481	584
	329	313	237	280
	200	174	139	367
Subsistence Flows (cfs)	60	60	60	60

Table 4.1-33. GSA BBEST Environmental Flow Regime Recommendation – San Antonio River at Goliad[70]

	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
Overbank Flows	Qp: 23,600 cfs with Average Frequency 1 per 5 years Regressed Volume is 273,000 Duration Bound is 69			
Overbank Flows	Qp: 10,600 cfs with Average Frequency 1 per 2 years Regressed Volume is 107,000 Duration Bound is 45			
Overbank Flows	Qp: 7,680 cfs with Average Frequency 1 per year Regressed Volume is 73,500 Duration Bound is 38			
High Flow Pulses	Qp: 1,520 cfs with Average Frequency 1 per season Regressed Volume is 12,800 Duration Bound is 19	Qp: 3,540 cfs with Average Frequency 1 per season Regressed Volume is 30,000 Duration Bound is 24	Qp: 1,640 cfs with Average Frequency 1 per season Regressed Volume is 11,200 Duration Bound is 16	Qp: 2,320 cfs with Average Frequency 1 per season Regressed Volume is 17,600 Duration Bound is 19
High Flow Pulses	Qp: 550 cfs with Average Frequency 2 per season Regressed Volume is 3,940 Duration Bound is 11	Qp: 1,570 cfs with Average Frequency 2 per season Regressed Volume is 11,300 Duration Bound is 16	Qp: 750 cfs with Average Frequency 2 per season Regressed Volume is 4,450 Duration Bound is 10	Qp: 780 cfs with Average Frequency 2 per season Regressed Volume is 5,070 Duration Bound is 11
Base Flows (cfs)	290	280	220	270
	200	180	150	200
	140	130	120	130
Subsistence Flows (cfs)	76	60	54	66

[68] Pulses from the LSAR TIFP Interim Report (identified by *) are satisfied when the streamflow is greater than or equal to the pulse peak for the entire duration specified for the pulse.
[69] Volumes are in acre-feet and durations are in days.
[70] Volumes are in acre-feet and durations are in days.

Table 4.1-34. LSAR TIFP Environmental Flow Regime Interim Recommendation – San Antonio River at Goliad

GOLIAD												
Overbank Flow		Magnitude = 14,000 cfs Frequency = 1 event Duration = 2 days *Key Indicators:* *Riparian: Inundates approx. 90% of hardwood forest community* *Sediment transport: Channel maintenance*										
		Magnitude = 11,500 cfs Frequency = 1 event Duration = 2 days *Key Indicators:* *Riparian: Inundates approx. 65% of hardwood forest community* *Sediment transport: Channel maintenance*										
High Flow Pulses		*Key Indicators: Riparian - Sycamore* Magnitude = 4,000 cfs Frequency = 2 events Duration = 2-5 days		Magnitude = 4,000 cfs Frequency = 3 events Duration = 2-5 days *Key Indicators: Riparian - Black Willow*			Magnitude = 8,000 cfs Frequency = 2 events Duration = 2-3 days *Key Indicators:* *Riparian: Green Ash / Box Elder*					
BASE FLOWS (cfs) - Aquatic Habitat protection (intra- and interannual variability) Key Indicators: Aquatic Habitat, Water Quality												
Base Wet	475	460	471	470	538	498	503	434	507	531	579	535
Base Average	325	340	323	305	326	308	248	212	252	272	287	282
Base Dry	200	203	197	178	190	154	121	111	186	155	169	176
SUBSISTENCE FLOWS (cfs) - Water quality protection and maintainence of limited aquatic habitat Key Indicators: Water Quality, Aquatic Habitat												
Subsistence	80	80	80	80	80	80	80	80	80	80	80	80
MONTH	January	February	March	April	May	June	July	August	September	October	November	December

Note: In the original table, each box spans several months. The overbank flow boxes span February through October. The high flow pulse boxes span February–March (4,000 cfs, 2 events), April–June (4,000 cfs, 3 events) and July–November (8,000 cfs).

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4.1.17 Mission River at Refugio

The streamflow gaging station and recommended instream measurement point on Mission River at Refugio (USGS #08189500) is located in central Refugio County, has a drainage area of 690 square miles, and has records extending back in time through 1940. The environmental flow standard recommendation of the GSA BBASC for this location is summarized in Table 4.1-35. For reference, the environmental flow regime recommendation of the GSA BBEST for this location is summarized in Table 4.1-36. Differences between the GSA BBASC and GSA BBEST recommendations include the following:

a. Increasing the GSA BBEST Winter, Spring, and Fall seasonal subsistence flows to the seasonal Q95[71] values provided by TPWD;
b. Applying the GSA BBASC Pulse Exemption Rule (Section 4.3.1); and
c. Applying the Ten Percent Dedication to Environmental Flows (10% Rule) (Section 4.3.2).

It was brought to the attention of the GSA BBASC that several violations of the TCEQ stream standard for dissolved oxygen have been measured at this site. The primary rationales for the GSA BBASC increasing the seasonal subsistence flows are these violations and a “high” level of concern expressed by TPWD. The bases for this level of concern are summarized in Appendix C which was prepared by TPWD in response to a GSA BBASC request for their technical review.

The GSA BBASC did not engage in discussions pertinent to *present and future needs for water for other uses related to water supply planning* specifically relevant to this location.

An evaluation of a hypothetical new 10,000 acft/yr run-of-river appropriation was performed at the Mission River at Refugio site. The results of this analysis are summarized in Section 3.3.2 of this report. The Pulse Exemption Rule was applied in consideration of present and future water needs related to water supply planning.

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[71] Seasonal Q95 is defined to be the daily average flow rate exceeded 95 percent of the time within a selected season. GSA BBEST seasonal subsistence flow values were calculated as the median of the lowest 10 percent of base flows within a selected season.

Table 4.1-35. GSA BBASC Environmental Flow Regime Recommendation – Mission River at Refugio[72]

Overbank Flows	Qp: 11,500 cfs with Average Frequency 1 per 5 years Regressed Volume is 66,200 Duration Bound is 44			
	Qp: 6,830 cfs with Average Frequency 1 per 2 years Regressed Volume is 38,400 Duration Bound is 36			
	Qp: 4,160 cfs with Average Frequency 1 per year Regressed Volume is 22,800 Duration Bound is 30			
High Flow Pulses	Qp: 450 cfs with Average Frequency 1 per season Regressed Volume is 2,340 Duration Bound is 15	Qp: 1,560 cfs with Average Frequency 1 per season Regressed Volume is 7,910 Duration Bound is 18	Qp: 420 cfs with Average Frequency 1 per season Regressed Volume is 2,010 Duration Bound is 12	Qp: 410 cfs with Average Frequency 1 per season Regressed Volume is 2,090 Duration Bound is 14
	Qp: 60 cfs with Average Frequency 2 per season Regressed Volume is 310 Duration Bound is 8	Qp: 320 cfs with Average Frequency 2 per season Regressed Volume is 1,440 Duration Bound is 10	Qp: 57 cfs with Average Frequency 2 per season Regressed Volume is 240 Duration Bound is 6	Qp: 45 cfs with Average Frequency 2 per season Regressed Volume is 200 Duration Bound is 6
Base Flows (cfs)	15	14	12	15
	8.6	8.3	7.0	7.8
	4.7	4.5	3.8	4.5
Subsistence Flows (cfs)	2.5	1.5	1.0	1.8
	Jan Feb Mar	Apr May Jun	Jul Aug Sep	Oct Nov Dec
	Winter	Spring	Summer	Fall

Table 4.1-36. GSA BBEST Environmental Flow Regime Recommendation – Mission River at Refugio[73]

Overbank Flows	Qp: 11,500 cfs with Average Frequency 1 per 5 years Regressed Volume is 66,200 Duration Bound is 44			
	Qp: 6,830 cfs with Average Frequency 1 per 2 years Regressed Volume is 38,400 Duration Bound is 36			
	Qp: 4,160 cfs with Average Frequency 1 per year Regressed Volume is 22,800 Duration Bound is 30			
High Flow Pulses	Qp: 450 cfs with Average Frequency 1 per season Regressed Volume is 2,340 Duration Bound is 15	Qp: 1,560 cfs with Average Frequency 1 per season Regressed Volume is 7,910 Duration Bound is 18	Qp: 420 cfs with Average Frequency 1 per season Regressed Volume is 2,010 Duration Bound is 12	Qp: 410 cfs with Average Frequency 1 per season Regressed Volume is 2,090 Duration Bound is 14
	Qp: 60 cfs with Average Frequency 2 per season Regressed Volume is 310 Duration Bound is 8	Qp: 320 cfs with Average Frequency 2 per season Regressed Volume is 1,440 Duration Bound is 10	Qp: 57 cfs with Average Frequency 2 per season Regressed Volume is 240 Duration Bound is 6	Qp: 45 cfs with Average Frequency 2 per season Regressed Volume is 200 Duration Bound is 6
Base Flows (cfs)	15	14	12	15
	8.6	8.3	7.0	7.8
	4.7	4.5	3.8	4.5
Subsistence Flows (cfs)	1.0	1.3	1.0	1.3
	Jan Feb Mar	Apr May Jun	Jul Aug Sep	Oct Nov Dec
	Winter	Spring	Summer	Fall

[72] Volumes are in acre-feet and durations are in days.
[73] Volumes are in acre-feet and durations are in days.

4.2 GSA BBASC Recommendations for Estuary Freshwater Inflow Standards

The GSA BBASC recognizes the need for specific bay and estuary inflow standards. The GSA BBASC recommends that the GSA BBEST bay and estuary inflow volume recommendations be adopted as these inflow standards, but that the attainment frequency goals, or how often those volumes are to be met, are modified to accommodate stakeholder efforts to balance environmental and water supply needs so that water supply projects might be permitted. The recognized need for specific inflow standards was adopted by the GSA BBASC by a vote of 19 to 3. GSA BBASC recommendations associated with the Environmental Flow Standards for the Guadalupe and Mission-Aransas Estuaries were adopted by a vote of 21 to 1 with two abstentions. The GSA BBASC recommendation regarding the creation of a consensus-based stakeholder advisory group was adopted by a vote of 23 to 1 (see Permit Requirement 3 on page 119).

A simplified, but equivalent structure of the GSA BBEST recommended seasonal criteria and inflow volumes is presented below in Tables 4.2-1, 4.2-3, and 4.2-5 for the Spring (G1) and Summer (G2 and MA2) seasons. Attainment frequency goals, i.e. how often the stated volumes in Tables 4.2-1, 4.2-3, and 4.2-5, need to met, are spelled out in Tables 4.2-2, 4.2-4, and 4.2-6, respectively.

Table 4.2-1. Summary of Guadalupe Estuary Recommended Inflow Volumes for the Spring Period (February –May)

Criteria level	**Inflow Volumes[1] (1000 acft)**	
	February	**March – May**
G1-Aprime	n/a	550 – 925
G1-A	n/a	375 – 550
G1-B	n/a	275 – 375
G1-C	≥ 75	150 – 275
G1-CC	0 – 75	150 – 275
G1-D	n/a	0 – 150

[1] *Volume is defined as the monthly amount for February, as applicable or the total seasonal (three-month) amount for the March through May period*

Table 4.2-2. Summary of Guadalupe Estuary Attainment Goals for the Recommended Inflow volumes for the Spring Period (February – May)

Criteria level	Frequency of Attainment Requirements[1]	
	(A) Strategies Target [BBEST Recommendations]	**(B) New Permits Permitting Requirement [TCEQ Run3]**
G1-Aprime	at least 12% of years	at least 12% of years
G1-A	at least 12% of years	at least 12% of years
G1-A & G1-B combined	at least 17% of years	at least 17% of years
G1-C & G1-CC combined	G1-CC no more than 2/3 of total	G1-CC no more than 2/3 of total
G1-D	no more than 9% of years	no more than 31% of years

[1] *The frequency of attainment percentages refers to the number of years that the inflow volume was met or exceeded in a model simulation covering the 1941-1989 period as within the Guadalupe–San Antonio Water Availability Model*

Table 4.2-3. Summary of Guadalupe Estuary Recommended Inflow Volumes for the Summer Period (June – September)

Criteria level	Inflow Volumes[1] (1000 acft)	
	June	**July – September**
G2-Aprime	n/a	450 – 800
G2-A	n/a	275 – 450
G2-B	n/a	170 – 275
G2-C	≥ 40	75 – 170
G2-CC	0 – 40	75 – 170
G2-D	n/a	50 – 75
G2-DD	n/a	0 – 50

[1] *Volume is defined as the monthly amount for June, as applicable or the total seasonal (three-month) amount for the July through September period*

Table 4.2-4. Summary of Guadalupe Estuary Attainment Goals for the Recommended Inflow volumes for the Summer Period (June – September)

Criteria level	Frequency of Attainment Requirements[1] (A) Strategies Target [BBEST Recommendations]	(B) New Permits Permitting Requirement [TCEQ Run3]
G2-Aprime	at least 12% of years	at least 12% of years
G2-A	at least 17% of years	at least 17% of years
G2-A & G2-B	at least 30% of years	at least 30% of years
G2-C & G2-CC combined	G2-CC no more than 17% of total	G2-CC no more than 40% of total
G2-DD	no more than 6% of years	no more than 18% of years
G2-D &G 2-DD combined	no more than 9% of years	no more than 25% of years

[1] *The frequency of attainment percentages refers to the number of years that the inflow volume was met or exceeded in a model simulation covering the 1941-1989 period as within the Guadalupe–San Antonio Water Availability Model*

Table 4.2-5. Summary of Mission-Aransas Estuary Recommended Inflow Volumes for the Summer Period (June – September)

Criteria level	Inflow Volumes[1] (1000 acft) June	July – September
MA2-Aprime	n/a	500 – 1000

[1] *Volume is defined as the monthly amount for June, as applicable or the total seasonal (three-month) amount for the July through September period*

Table 4.2-6. Summary of Mission-Aransas Estuary Attainment Goals for the Recommended Inflow Volumes for the Summer Period (June – September)

Criteria level	Specification	Frequency of Attainment Requirements[1] Inflow Target Standard	Environmental Flow Permitting Baseline
MA2-Aprime	Attainment MA2-Aprime	at least 2% of years	at least 2% of years

[1] *The frequency of attainment percentages refers to the number of years that the inflow volume was met or exceeded in a model simulation covering the 1941-1989 period as within the Guadalupe–San Antonio Water Availability Model*

The values in the first column of attainment frequency goals (Column A) of Tables 4.2-2, 4.2-4, and 4.2-6 are those of the GSA BBEST. These represent a set of attainment goals that the GSA BBEST recommended to maintain a Sound Ecological Environment. As such, these provide the basis for pursuit of strategies to address indentified shortcomings in the ability to meet these goals. That is the extent to which the Column A values are recommended to be used by the GSA BBASC. The values in Column B represent the attainment frequencies calculated using the fixed in time TCEQ WAM Run 3 found in Appendix E3 with full use of existing water rights and no wastewater return flows.

Permitting of future new appropriations would utilize the attainment frequency goals of Columns B in Tables 4.2-2, 4.2-4, and 4.2-6.

The GSA BBASC recommends that TCEQ evaluate permit applications via a modeling process as the GSA BBEST recommended. The permit would have to meet the requirements proposed herein:

1. The first requirement is that a new authorization to increase the amount diverted or stored would not be allowed to make compliance with GSA BBEST criteria worse than under TCEQ WAM Run 3 with full use of existing water rights and no wastewater return flows. The WAM Run 3 is to be a fixed in time run as was used to generate Tables 4.2-2, 4.2-4, and 4.2-6. The fixed in time TCEQ WAM Run 3 is found in Appendix E3.

2. The second requirement is that the permit applicant shall undertake measures that provide an amount of water equivalent in benefit to the 10 percent dedication of annual diversion/firm yield to support attempts to move toward improving the frequency of attainment from the WAM Run 3 scenario to GSA BBEST recommendation (Column A of Tables 4.2-2, 4.2-4, and 4.2-6) with the following limitations:

   a. The amount of water required to improve these conditions, either as a portion of firm yield or as a portion of total annual diversion, cannot be required to be greater than the 10 percent environmental dedication defined in Section 4.3.2.
   b. An amount of water developed through strategies by the applicant that is equivalent in benefit to the 10 percent dedication of annual diversion/firm yield may be applied to satisfy the dedication.
   c. For a non-firm yield project, if the total amount of annual diversion is not available for a given year, the permit applicant is only required to dedicate 10 percent of the amount available during that year.
   d. An applicant is not penalized for downstream river channel losses. Water dedicated to the bays and estuaries through this process is considered applicable, even if the water does not actually reach the bays and estuaries due to evaporative downstream channel losses.
   e. The bay and estuary inflow criteria in Column B of Tables 4.2-2, 4.2-4, and 4.2-6 apply only to projects seeking to divert an amount greater or equal to 1,000 acft/yr or store an amount greater or equal to 10,000 acft.

3. TCEQ through rule-making will form a consensus-based stakeholder advisory group to advise TCEQ on the GSA BBASC 10 percent dedication regarding new appropriations through a comprehensive integrated approach addressing bay and estuary inflows to work towards achieving the GSA BBEST attainment frequency. The GSA BBASC Work Plan efforts will inform the operations of the advisory group.

4. All other frequency of attainment components of the GSA BBEST Bay and Estuary Inflow Recommendations apply:

- Criteria levels: G1-Aprime, G1-A, G1-A & G1-B combined, and G1-C & G1-CC combined
- Criteria levels : G2-Aprime, G2-A, and G2-A & G2-B
- Criteria levels : MA2-Aprime
- For months with no specified inflow criteria, instream flow regime recommendations serve in lieu of specific estuarine inflow criteria

4.3 Water Right Permit Conditions

4.3.1 Pulse Exemption Rule

From an ecological perspective, the GSA BBASC recognizes that available hydrologic, biological, geomorphologic, and riparian vegetation data and professional judgment suggest that high flow pulses are necessary to provide in-channel flows of varying magnitude and duration, recruitment events for organisms, lateral connectivity, channel and substrate maintenance, limitation of riparian vegetation encroachment, in-channel water quality restoration after prolonged low flow periods, and freshwater and sediment inflows to bays and estuaries as necessary for long-term support of sound ecological environments. Similarly, the GSA BBASC recognizes available hydrologic, biological, geomorphologic, and riparian vegetation data and professional judgment suggest that overbank flows are necessary to provide life phase cues for organisms, riparian vegetation diversity maintenance, conditions conducive to seedling development, floodplain connectivity, lateral channel movement, floodplain maintenance, recharge of floodplain water tables, flushing of organic material into the channel, nutrient deposition in the floodplain, restoration of water quality in isolated floodplain water bodies, and freshwater and sediment inflows to bays and estuaries as necessary for long-term support of a sound ecological environment.

From water supply planning and operations perspectives, it is recognized that pulses will occur naturally. The ability of a diverter to actually reduce the flow from of pulse is related to the rate of the diversion as a ratio of the volume of the pulse. A permit requirement to pass the pulse may place an administrative requirement on a project that could reduce the firm yield of the project without necessarily producing a quantifiable benefit to the environment.

With the exception of site specific data on a couple of gauges on the Guadalupe River and the analysis performed as part of the interim LSAR TIFP on the San Antonio River, quantitative demonstration of environmental benefits is limited. In addition, the multi-tiers of pulses are complex to the point of making administration, accounting, and operations difficult for both the TCEQ South Texas Watermaster and water suppliers up and down the river.

Evaluations of example run-of-river diversion projects with off-channel storage showed very small changes in instream sediment transport and/or compliance with the GSA BBEST freshwater inflow attainment criteria recommendations subject to pulse passage requirements ranging from none at all up to five tiers.

The GSA BBASC tried to honor both the above noted water supply and environmental considerations by developing a concept to exempt smaller diverters from high flow pulse requirements based on a ratio of their diversion rate to the pulse peak. To determine what percentage that should be, the technical consultants supplied the GSA BBASC with evaluations of the effects various ratios had on firm yield, sediment transport, and estuarine inflow. The cumulative effects of more than one or multiple projects were a noted concern. Although there was much discussion and analysis on this topic, the GSA BBASC discussions concluded that addressing cumulative impacts may reintroduce complexity or unduly favor specific projects.

After much deliberation, the GSA BBASC selected a Pulse Exemption Rule ratio of 20 percent. So if an applicant's maximum diversion rate is less than 20 percent of the specified peak flow associated with that pulse requirement, the permit is exempt from honoring that pulse because it was determined that the 20 percent would allow a balance toward water supply, and limit the effects on sediment transport and estuarine inflow. For example, an applicant on the Guadalupe River at Comfort (Table 4.1-1) seeking to divert at a maximum rate of 25 cfs would not be subject to any pulse requirements. An applicant seeking to divert at a maximum rate of 250 cfs, however, would be subject to all seasonal pulse requirements at this location. Similarly, an applicant seeking to impound 500 acft (~250 cfs for a day) behind a channel dam on the Guadalupe River at Comfort would be subject to all seasonal pulse requirements at this location.

For illustrative purposes, an example application of the Pulse Exemption Rule is presented in Table 4.3.1, where an applicant is seeking a new appropriation with a maximum diversion rate (MDR) of 100 cfs near the Guadalupe River at Comfort gage. In order to determine which pulses are exempt, TCEQ would use the following formula:

$$Qp > MDR \div 20\%$$, where Qp is the Pulse Peak.

Any pulse peaks that are less than or equal to the MDR divided by 20 percent would be applicable. Therefore, this example applicant would be required to honor any pulse in which the pulse peak is less than or equal to 500 cfs and be exempt from any pulse that are greater than 500 cfs, as presented in Table 4.3-1.

Table 4.3-1. Example Application of the Pulse Exemption Rule – Guadalupe River at Comfort[74]

	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
Overbank Flows	Qp: 15,900 cfs with Average Frequency 1 per 5 years Regressed Volume is 100,000 Duration Bound is 97 (all seasons)			
Overbank Flows	Qp: 7,420 cfs with Average Frequency 1 per 2 years Regressed Volume is 72,400 Duration Bound is 69 (all seasons)			
High Flow Pulses	Qp: 4,020 cfs with Average Frequency 1 per year Regressed Volume is 37,400 Duration Bound is 53 (all seasons)			
High Flow Pulses	Qp: 350 cfs with Average Frequency 1 per season Regressed Volume is 3,390 Duration Bound is 20	Qp: 1,190 cfs with Average Frequency 1 per season Regressed Volume is 8,950 Duration Bound is 26	Qp: 570 cfs with Average Frequency 1 per season Regressed Volume is 4,110 Duration Bound is 19	Qp: 500 cfs with Average Frequency 1 per season Regressed Volume is 4,060 Duration Bound is 24
High Flow Pulses	Qp: 140 cfs with Average Frequency 2 per season Regressed Volume is 1,030 Duration Bound is 11	Qp: 400 cfs with Average Frequency 2 per season Regressed Volume is 2,980 Duration Bound is 17	Qp: 160 cfs with Average Frequency 2 per season Regressed Volume is 1,130 Duration Bound is 12	Qp: 160 cfs with Average Frequency 2 per season Regressed Volume is 1,110 Duration Bound is 13
Base Flows (cfs)	110	100	75	110
Base Flows (cfs)	77	69	50	77
Base Flows (cfs)	54	35	25	48
Subsistence Flows (cfs)	31.0	18.0	2.0	25.0

The GSA BBASC recognizes that the impacts of its pulse and overbank environmental flow standard recommendations on firm yield are more significant for mainstem reservoir projects than for run-of-river diversions with off-channel storage. The GSA BBASC also recognizes that

[74] Volumes are in acre-feet and durations are in days.

the ecological consequences associated with mainstem reservoir projects are more significant than those for run-of-river diversions with off-channel storage. Although the GSA BBASC did not take specific action on the issue of mainstem reservoirs, comments of members would suggest that any future mainstem reservoir proposed for the basin would receive significant public scrutiny.

The recommended Pulse Exemption Rule ratio of 20 percent was selected by the GSA BBASC after much deliberation and consideration of effects on firm yield, sediment transport, and estuarine inflow for one or more example run-of-river diversion projects with off-channel storage. In association with this recommendation, the GSA BBASC also recommends that the TCEQ develop web-accessible, real-time water management and accounting software capable of advising water right holders subject to pulse passage requirements (and/or multi-tiered seasonal base and subsistence flow passage requirements) of authorized diversion rates at any time.

4.3.2 Ten Percent Dedication to Environmental Flows (10% Rule)

The GSA BBASC recommends that for new appropriations of water greater than 200 acft/yr, TCEQ require that the lesser of ten percent of a new project firm yield or ten percent of authorized annual diversion associated with a run-of-river diversion be dedicated to the environment. The GSA BBASC recommends that TCEQ provide a mechanism to allow such dedications to reach the Guadalupe Estuary. The dedication can be met through an amount equivalent to ten percent of a new project firm yield or ten percent of authorized annual diversion associated with a run-of-river diversion, through commitments and/or agreements not necessarily associated with the project. The GSA BBASC recommendation associated with the Ten Percent Dedication to Environmental Flows was adopted by a vote of 19 to 3.

In order to balance the needs of the environment and water supply needs, the Ten Percent Dedication to Environmental Flows permit condition was adopted by the GSA BBASC in lieu of a three-tier base flow structure during Fall and Winter for Guadalupe River at Gonzales, Guadalupe River at Cuero, and Guadalupe River at Victoria. A single-tier base flow was recommended for the Fall and Winter.

4.3.3 Geomorphology

During the August 16, 2011 GSA BBASC meeting, members of the stakeholders committee clearly stated that geomorphology plays a critically important role in the Guadalupe–San Antonio River Basin and that additional geomorphologic research should be highly prioritized in the Work Plan. Members of the GSA BBASC believe the SAC geomorphology guidance document that is currently under development (published August 31, 2011), may be helpful in informing a specific geomorphic GSA BBASC recommendation in the future. The GSA BBASC believes that further considerations of geomorphology standards are necessary to better understand, protect, and utilize the water in this basin and bay system.

4.4 Other GSA BBASC Recommendations

Throughout the deliberations of the GSA BBASC, several priority issues were identified that need to be addressed in order to effectively move forward with efforts of environmental flow protection, strategies to meet new environmental flow standards, and water supply planning within the basin/bay area. Some of these issues relate to data and information gaps that need to be filled in order to more accurately track water and its availability. Some are tools that need to be developed and made available as soon as possible that could substantially assist in the implementation and compliance with new standards. Additionally a need to address future water policies is identified.

Below is a list of several of these top priority items. Although these items are mentioned elsewhere in this report, the GSA BBASC thought it was important to highlight them in this “other recommendations” section. Some of these items will likely be expounded upon in the Work Plan, but these items are fairly time sensitive and particularly elemental to the other recommendations within this report.

4.4.1 Additional Support and Funding for TCEQ South Texas Watermaster Program

The Watermaster role is multifaceted. Duties include helping surface water permit holders correctly comply with their permit conditions as well as enforcement. Tasks that fall within the Watermaster’s staff purview are taking reservoir measurements and flow measurements of water diversion pipes, responding to complaints, setting stream flow markers, assessing water availability, overseeing diversions from rivers and tributaries at individual diversion points, and keeping data bases to document amounts of water authorized and used are all tasks that fall within the Watermaster’s purview.

The Watermaster staff for this basin/bay area has many duties and very limited funding. With the setting of environmental flow standards by TCEQ for this basin/bay area, there will be additional oversight of water diversion compliance and necessary record-keeping. In anticipation, the GSA BBASC recommends by a vote of 21-3 that funding for the Watermaster program be increased to accommodate the additional manpower and tools that will be necessary to support an increase in expected workload.

4.4.2 Web-based Technology to Facilitate Compliance with Environmental Flow Permit Conditions

The GSA BBASC recognizes that the recommended environmental flow regimes include complexities such as seasonal base flows determined by hydrologic conditions and several levels of pulse flows based on seasons. In order to address concerns about how permit holders would be able to comply with these more intricate permit conditions, the GSA BBASC recommends that TCEQ, potentially in partnership with others, consider developing a new water permit compliance tool. This might be a web-accessible tool that would draw real-time data from USGS gage locations to determine hydrologic conditions and calculate when a permit holder may divert based on permit conditions.

4.4.3 Mechanism to Protect Environmental Flows to the Bay and Estuaries

One of the recommended strategies in Section 5 is "Donation, Sale or Lease of New or Under-Utilized Water Permits." However, under current rules a downstream water right holder could divert water that was intended for such environmental flow protection. The GSA BBASC recommends by a vote of 22-2, as referenced in Section 4.3.2, that a mechanism be considered to dedicate flows downstream to the estuary.

4.4.4 Full Accounting of Water

The GSA BBASC is concerned about accounting of water within the bay/basin area. More complete, accessible and recent information is needed to ensure that the most current information is being used in the decision-making processes and to provide the information necessary for the pursuit of strategies to meet environmental flow needs. To that end, the GSA BBASC recommends that the TCEQ perform a full accounting of all existing surface water use within the basin. This should include:

A. Appropriated and Used surface water

More accurate information about actual usage of permitted water would assist in increasing the accuracy of water use projections and planning. More accurate information would also allow for voluntarily repurposed water rights to assist in meeting flow standards.

B. Estimation of Riparian and Domestic and Livestock (D&L) Use

Since these uses occur outside the water permitting process, there is little known about how much water is taken from the system and when for these purposes.

C. Improved access to and management of TCEQ data on wastewater return flows

More accurate and digitally accessible information on return flows will assist in determining water availability as well as the potential for wastewater's use as a strategy to meet environmental flow standards.

D. ***Measuring Flow Over the Salt Water Barrier to Guadalupe Estuary***

There is noted concern about the accuracy of information related to the measurement of water flowing over the salt water barrier due to its unique structural characteristics. Also, the addition of stream gages and potentially other measurement tools are needed in the lower basin to increase data to more accurately measure the contribution of river flows to the bay and estuary system. Additionally, this will help in further study on biological responses to freshwater inflows into the bay and estuary system.

E. Update the Guadalupe–San Antonio Water Availability Model (GSA WAM) used by TCEQ for permitting

The current period of record for the GSA WAM is 1934 through 1989 (56 years). The exclusion of the most recent 22 years of data in the model causes credibility issues with the data because many of the recent high flow and drought events are not included in the model.

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5.0 Recommendations Regarding Potential Strategies to Meet Environmental Flow Standards

Senate Bill 3 (SB3) mandates that each bay/basin area stakeholders committee: 1) develop recommendations on environmental flow standards, and 2) develop strategies to meet these standards. In the process of developing environmental flow standards recommendations for the Guadalupe, San Antonio Bay and Basin Area, the Bay and Basin Area Stakeholders Committee (GSA BBASC) reviewed the Bay and Basin Expert Science Team (GSA BBEST) report along with additional analysis and science that was commissioned by and presented to the stakeholders committee.

The GSA BBEST report recognizes that, based on the available science, with a few noted exceptions, a sound ecological environment exists in these rivers, bays and estuaries today. However, during the GSA BBASC deliberations, GSA BBEST members presented additional analysis regarding the potential impact full utilization of existing water rights could have on flows. The additional information raised concerns among GSA BBASC members that the "sound ecological environment" found today could change, particularly during lower flow times of the year, if all existing water rights are fully utilized as permitted.

The GSA BBASC recognized specific basin-wide flow recommendations were not in place prior to the SB3 process and would not have been included as water permit requirements. Both the GSA BBEST report and the GSA BBASC report will form the basis of new Texas Commission on Environmental Quality (TCEQ) environmental flow standards. The GSA BBASC developed and will submit its recommended instream and bay and estuary flow standards to the TCEQ for application to future permits, but also endorses the use of these same instream flow regime standards and bay and estuary seasonal attainment criteria as voluntary targets for current permit holders. The GSA BBASC recognizes that voluntary implementation of water use and management strategies will improve the effective use of limited surface water within the basin particularly during the driest times when water is in its highest demand and flow is at its lowest. Implementation of strategies is also a vital component toward reaching recommended flow attainment targets while achieving a balance between water supply and environmental needs.

The GSA BBASC requested the National Wildlife Federation (NWF), in association with Intera Geosciences & Engineering, to conduct a preliminary evaluation of three potential strategies: Wastewater Dedication, Dry Year Option and Purchase/Conversion of under-utilized water rights and a combination of these strategies. The report on this evaluation is included as Appendix H in the GSA BBASC report. In summary, the evaluation found that the strategies applied individually, or in combination, can produce additional beneficial flow to the bays and estuaries during the driest times.

During the development of the Adaptive Management Plan/Work Plan, the GSA BBASC will determine what additional science is needed to better link specific quantity of inflow to measurable improvements to the quality of the environment benefit in the rivers and bays. The GSA BBASC will also identify obstacles in State rules or laws that could impede the implementation of the strategy options listed and recommend steps to remove or modify these obstacles. In the interim, the GSA BBASC encourages the TCEQ, Texas Water Development Board (TWDB), Texas Parks and Wildlife Department (TPWD) and Region L, J and N Regional Water Planning Groups to aggressively promote the implementation of these or other water use and management strategies to help achieve the GSA BBASC recommended flow standards for the Guadalupe and San Antonio river basins, bays and estuaries.

It is noted that the GSA BBASC narrative regarding the Strategies Addressing Environmental Flow Standards was adopted by a vote of 23 to 1, while the *Data and Tools Needed for Achieving Environmental Flow Standards* and *Strategy Options for Achieving Environmental Flow Standards* (listed below) were adopted by consensus.

Data and Tools Needed for Achieving Environmental Flow Standards

The GSA BBASC were informed throughout its deliberations of gaps in data and information which exists today and serve as obstacles to accurately assessing current and future water use within the basin. These information gaps could also affect the ability to assess the effectiveness of environmental flow strategies toward meeting the instream flow regime and bay and estuary attainment criteria recommended by the GSA BBASC. Below is a list some of the data tools the GSA BBASC identified that should be explored by TCEQ. The GSA BBASC will also develop work on additional data needs during the upcoming work on the Adaptive Management Plan/Work Plan.

- **Secure agreement from TCEQ to perform a full accounting of all existing surface water use within the basin to allow for more accurate model projections of current and future water needs**
  - A more accurate accounting of actual surface water use, including an estimation of riparian and domestic and livestock (D&L) use will improve data used for water availability models while providing information to determine if existing water rights could be voluntarily repurposed to assist in meeting flow standards.

- **Improve access to and management of historical TCEQ data on wastewater return flows in order to improve understanding the role wastewater return flows have in providing flows for environmental purposes**

- **Explore the addition of streamgages in the lower basin to increase data to more accurately measure the contribution of river flows to the bay and estuary system**

- **Update the Guadalupe–San Antonio Water Availability Model (GSA WAM) used by TCEQ for permitting**
  - The current period of record for the GSA WAM is 1934 through 1989 (56 years). The exclusion of the most recent 22 years of data in the model causes credibility issues with the data because many of the recent high flow and drought events are not included in the model. Furthermore, a longer period of record would provide more complete data for the next round of GSA BBASC Recommendations regarding the attainment frequencies associated with the Environmental Flow Standards Recommendations for the Guadalupe and Mission-Aransas Estuaries (Section 4.2).

Strategy Options for Achieving Environmental Flow Standards

Below, the GSA BBASC has provided a list of potential strategies that can be voluntarily implemented by current and future water rights permit holders and applicants, state agencies or others to assist in meeting the instream and bay and estuary environmental flow standards recommended by the GSA BBASC. These strategies can also serve as a menu of options to meet the requirements of the proposed 10 percent dedication recommended by the GSA BBASC for the bay and estuary (refer to Section 4.3.2). This list of strategies is not intended to be exhaustive and many other options may exist. Members of the GSA BBASC will explore the feasibility of implementing specific strategies during upcoming work on the Adaptive Management Plan/Work Plan by the GSA BBASC.

- **Explore the donation, sale or lease of new or under-utilized water permits**
  - Willing water permit holders donate, sell or lease all or part of their permit so that that water could stay in the stream for environmental flow protection. Permit would be changed to add instream and/or bay and estuary use. To be most effective, these permits would need to be firm water that is fairly senior.
  - Use of a water trust can be helpful for keeping track of water dedicated for environmental flow purposes.

- **Dedication of wastewater return flows**
  - Dedication of permitted wastewater return flow toward environmental flow needs. The wastewater could be generated by a new permitted project, an existing project or through agreement or voluntary commitment of wastewater generated by a municipality. Water quality should be considered.

- **Dry Year Option (for Irrigation Permit)**
  - Agricultural water rights holders could be compensated for not diverting water during dry years. Priority should be given to agricultural water rights that have recent historical use. This approach reduces instream water use during critically dry periods in order to increase flows.

- **Increase storage of water for releases for environmental flows**
  - Additional storage could be added to projects to store water during higher flows to allow for releases to support the river/bay system during low flow periods when flow is needed.
  - Develop project to store surface water during higher flows (surface storage or aquifer storage and recovery) to have a solely dedicated source for environmental flows during drier times.

- **Dedication of Conserved Water from Current Permits to Environmental Flows**
  - Permit holders could voluntarily commit water that is saved through conservation methods to environmental flows. Most applicable to agricultural or municipal water permit holders.
  - Possible Environmental Quality Incentives Program (EQIP) funding for agricultural conservation practice/s and other available federal funding.

- **Facility Optimization to Enhance Environmental Flows**
  - Modify a facility's operation and/or schedule of releases can help provide environmental flows. The amount and timing of releases can attempt to better mimic the natural flow patterns of the river system, thereby protecting environmental flows. This can be done to an individual facility or to multiple facilities in a watershed for an additive effect.

- **Water Right Management**
  - The existing location and timing of diversions of water rights in the basin may inhibit opportunities for better resource management that could help support environmental flows.
  - Combinations of opportunities may exist whereby water right diversion points could be relocated, older rights used in conjunction with new water rights, or new water rights used in conjunction with currently unused rights to improve delivery efficiencies to both water users and the environment. Contractual agreements will be necessary.

- **Set-Asides of Unappropriated Water**
  - Some or all of unappropriated flow within the basins could be left in the river or removed from the amount of water available for future permitting. SB3 contemplates set-asides of unappropriated water by TCEQ.

- **Reduction of Groundwater Pumping**
  - Reducing groundwater pumping can allow springs to provide river baseflows.

- **Land Stewardship Programs**
  - Local, regional, state, and federal incentives for landowners to use good land management practices which will put more water into the water table.

  - ***Riparian Zone and Wetland Restoration and Stewardship***
    - Proper stewardship of riparian zones on the basin's creeks and rivers can build up the in-bank water holding capacities which serve to maintain base flows during dry periods and provide a healthy riparian habitat for both aquatic species and other wildlife. Flood attenuation and improved water quality are additional benefits resulting from proper stewardship of riparian zones.
    - Restored and healthy wetlands on the rivers or on the Gulf provide very productive wildlife habitat, filtering and cleansing actions desirable for inflows, and protection for inland communities from hurricanes.

  - ***Watershed or Catchment Stewardship***
    - A well-managed, healthy watershed not only provides a desirable livestock and wildlife environment, but increases groundwater penetration and recharge, reduces floods and provides other benefits.

    - Karst limestone watersheds are common across the Hill Country and Edwards Plateau, selective brush management and subsequent improved rangeland management has proven to sometimes increase ground recharge and springflows. Normally, ashe juniper (cedar, mountain cedar) has been the target brush species, but in other cases mesquite control has produced desirable hydrological benefits.

- **Water Dedication from Existing Permits**
  - Some permit holders may be willing to have conditions placed on their permits, such as a certain percent or set amount of the water being dedicated to provide environmental flows.

- **Municipal, Industrial, Mining and Agricultural Conservation to reduce water use and demand**
  - Each city, town and water utility, both large and small, should set goals to lower future surface and/or groundwater use using a conservation program which best fits their situation for both the utility and customers. The goal would be to reduce per capita water use and reduce demand for river diversions.
  - Effective conservation programs/strategies include: stringent leak detection, low water use appliances, inverted pyramid rate structures, customer education program, rainwater harvesting, use of recycled water and gray water, and others.
  - Agricultural irrigation conservation including installation of efficient of water delivery systems (canal, pipelines, etc.), improve center pivot systems, add in-ground moisture monitors, improve crop varieties and other farming methods.

- **Develop conjunctive use water projects**
  - To reduce reliance on surface water, water project developers should be encouraged to develop conjunctive use water projects using both groundwater and surface water. Better data on groundwater availability is now available for defined Groundwater Management Areas and modeled available groundwater reports to the TWDB increasing the certainty of groundwater use planning.

- **Develop alternate water supplies**
  - Alternative water supplies such as desalination of brackish groundwater or seawater desalination offer options to surface water usage and can provide additional water that could be stored and released for environmental flows.

- **Programs addressing logjam removal**
  - A logjam removal program could yield flow benefits to the bay and estuaries and improve stream bed conditions as well as riparian health in associated areas of the basin.

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6.0 Status of Work Plan

Pursuant to SB3 of the 80th Texas Legislature, as quoted below, the GSA BBASC is charged with development of a Work Plan to be submitted to the Environmental Flows Advisory Group (EFAG) for approval.

In recognition of the importance of adaptive management, after submitting its recommendations regarding environmental flow standards and strategies to meet the environmental flow standards to the commission, each basin and bay area stakeholders committee, with the assistance of the pertinent basin and bay expert science team, shall prepare and submit for approval by the advisory group a work plan. The work plan must:

(1) establish a periodic review of the basin and bay environmental flow analyses and environmental flow regime recommendations, environmental flow standards, and strategies, to occur at least once every 10 years;

(2) prescribe specific monitoring, studies, and activities; and

(3) establish a schedule for continuing the validation or refinement of the basin and bay environmental flow analyses and environmental flow regime recommendations, the environmental flow standards adopted by the commission, and the strategies to achieve those standards.

Although the Work Plan is not to be submitted until after the GSA BBASC submits its recommendations regarding environmental flow standards and strategies to meet them, the GSA BBASC has begun to identify subject areas deemed appropriate for monitoring, studies, and activities in the coming years. Although this list is not yet complete nor prioritized, the GSA BBASC thought that inclusion of work plan items gathered to date might be of some interest to the EFAG and others, and therefore a worthy inclusion. Similarly, Section 7 of the GSA BBEST Recommendations Report identifies monitoring, studies, and activities deemed appropriate to better inform, support, and adaptively manage environmental flow standards. Work Plan subjects identified by the GSA BBASC and/or the GSA BBEST are categorized here based on relevance to instream flows and freshwater inflows to bays and estuaries and listed in Tables 6.0-1 and 6.0-2, respectively. Also listed in Tables 6.0-1 and 6.0-2 are one or more GSA BBEST members with specific knowledge of a subject area, additional categorization ("X" shown in adjacent box or boxes) indicative of the relevant section or sections in which a subject is likely to appear in the Work Plan, and the source(s) that identified the subject.

As of the date of submittal of this GSA BBASC recommendations report, the members of the GSA BBEST are developing abbreviated draft "scopes of work" for the monitoring, studies, and activities relevant to the subjects of interest in accordance with guidance from the Science Advisory Committee (SAC). These "scopes of work" will successively focus on the what, why, where, when, who, and cost associated with each subject in order to facilitate prioritization and scheduling of monitoring, studies, and activities by the GSA BBASC in its forthcoming Work Plan. Additional Work Plan items may be identified through the Texas Instream Flow Program, Clean Rivers Program and other federal, state, regional and local activities and included in the forthcoming Work Plan.

Table 6.0-1. Work Plan Subjects for Adaptive Management – Instream Flows (Rivers, Streams, Tributaries, and Riparian Zones)

ID#	Subject	Primary BBEST Member(s)	Flow Regime Component			Hydrology	Source(s)
			Subsistence	Base	Pulse		
1	Impacts of Groundwater Use on Upper Basin Streamflows	Eckhardt				X	BBASC
2	Exempt Uses of Surface Water	Magin, Gonzales				X	BBASC
3	Riparian Diversions for Domestic & Livestock (D&L) Uses	Magin, Gonzales				X	BBASC
4	Effects of Conservation & Drought Management	Eckhardt				X	BBASC
5	Predictability in Surface Water Permitting	Vaugh				X	BBASC
6	Logjams & Related Flooding, Durations & Effects on Habitat	Vaugh			X		BBASC
7	Impacts of Invasive Species	Smith			X	X	BBASC
8	Impacts of Groundwater Withdrawn from Alluvial Gravels	Eckhardt	X	X		X	BBASC
9	Instream & Riparian Sediment Deposition	Hardy			X	X	BBASC
10	USGS Streamflow Gaging & Water Quality Monitoring	Magin, Gonzales	X	X	X	X	BBEST
11	TCEQ Clean Rivers Program Water Quality Monitoring	Gonzales, Magin	X	X	X		BBEST
12	Real Time Water Quality Monitoring System	Gonzales, Magin	X	X	X		BBEST
13	Biological Sampling & Monitoring	Bonner	X	X	X		BBEST
14	Texas Instream Flows Program	Vaugh	X	X	X	X	BBEST
15	Edwards Aquifer Recovery Implementation Program	Vaugh	X	X		X	BBASC/BBEST
16	Environmental Flow Collaboration Forum	Smith	X	X	X	X	BBEST
17	Geomorphic Studies & Monitoring	Hardy			X	X	BBEST
18	Riparian Vegetation Mapping & Monitoring	Smith			X		BBEST
19	Groundwater Monitoring in the Riparian Corridor	Smith	X	X	X	X	BBEST
20	Fish Community Use of Floodplain Environments	Bonner			X		BBEST
21	Expanded Gauge and Onsite Studies to Improve Understanding of Lowest Stretches of San Antonio and Guadalupe Rivers		X	X	X		BBASC

Table 6.0-2. Work Plan Subjects for Adaptive Management – Bays and Estuaries

ID#	Subject	Primary BBEST Member(s)	Flora/Fauna	Sediment	Nutrients	Inflow	Source(s)
1	Scouring of Passes & Impacts on Estuarine Ecology	Buskey	X				BBASC
2	Marine Wetland Effects on Commercial & Recreational Fishing	Pulich	X				BBASC
3	Impacts of Levees	Vaugh		X		X	BBASC
4	Impacts of Saltwater Barrier	Vaugh		X		X	BBASC
5	Sediment Transport Affecting Guadalupe Delta	Pulich		X		X	BBASC/BBEST
6	Sea Level Rise Associated with Climate Change	Johns				X	BBASC
7	Hydrodynamic & Salinity Modeling Improvements	Johns				X	BBEST
8	Bay & Marsh Salinity & Water Level Data Collection & Monitoring	Johns				X	BBEST
9	Diversion & Return Flow Data for Freshwater Inflow Estimates	Vaugh				X	BBEST
10	Rangia Clam & Eastern Oyster Investigations	Johns, Buskey, Holt	X				BBEST
11	Delta Inundation & Salinity Modeling	Pulich				X	BBEST
12	Life Cycle Habitat & Salinity Studies for Key Faunal Species	Buskey, Pulich, Holt	X				BBEST
13	Salinity Sensitive Plant Monitoring	Pulich	X				BBEST
14	Habitat Suitability Models for Oysters, Blue Crabs, & White Shrimp	Johns	X				BBEST
15	Nutrient Load & Concentration Monitoring	Buskey			X		BBEST

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