

September 12, 2012

The Honorable Troy Fraser, Co-Chair
Environmental Flows Advisory Group
P. O. Box 12068 – Capitol Station
Austin, TX 78711

The Honorable Allan Ritter, Co-Chair
Environmental Flows Advisory Group
P. O. Box 2910
Austin, TX 78768-2910

Dear Senator Fraser and Representative Ritter:

The Basin and Bay Expert Science Team (BBEST) for the Rio Grande River basin completed their environmental flow recommendation report on July 27, 2012. The report was submitted to the Environmental Flows Advisory Group (EFAG), the Texas Commission on Environmental Quality (TCEQ), and their Basin and Bay Area Stakeholder Committee.

The report is comprehensive and considers a wealth of scientific literature and data. The report clearly represents a substantial effort by the members of the science team to address their charge as stipulated in Senate Bill 3. The state can be proud we have so many dedicated scientists willing to participate in this program. The unique nature of the Rio Grande River, in particular the international and multi-state institutional framework which significantly affects water rights in the basin, led the basin stakeholder group to direct their BBEST to focus their attention on specific segments of the basin. Hence, the BBEST was divided into two groups: one which focused on environmental flow recommendations in the upper basin, specifically the Rio Grande and its tributaries above Amistad Reservoir to Presidio; and a second group that developed recommendations for the lower Rio Grande below Anzalduas dam, and the estuarine system including the Lower Laguna Madre.

Attached are review comments prepared and adopted by the Texas Environmental Flows Science Advisory Committee (SAC) pursuant to Texas Water Code **Sec. 11.02362(q)**, as added by Senate Bill 3 in the 80th Texas Legislature, 2007. The statute calls for the SAC to provide input to the EFAG for its use in reviewing the BBEST environmental flow analyses and environmental flow regime recommendations. The attached review follows a modified framework adopted by the SAC in December 2010, and reflects the consensus opinion of the SAC members. Should the advisory group deem it appropriate to submit comments to the TCEQ as they undertake rulemaking for this basin, the SAC trusts that you will find the enclosed review helpful, and we stand ready to support your preparation of comments in any way you deem appropriate.

Sincerely,



Robert J. Huston
SAC Chairman

CC: Tony Reisinger, Rio Grande River Basin and Bay Area Stakeholder Committee Chair
Kevin Urbanczyk and Hudson DeYoe, Rio Grande River and Bay BBEST Co-Chairs
Zak Covar, Executive Director, Texas Commission on Environmental Quality

Memorandum

To: Environmental Flows Advisory Group (EFAG)
From: Texas Environmental Flows Science Advisory Committee (SAC)
Date: September 12, 2012
Re: Review comments on Rio Grande, Rio Grande Estuary, and Lower Laguna Madre Environmental Flows Recommendations Report by Basin and Bay Expert Science Team (BBEST) dated July 27, 2012

INTRODUCTION

The Rio Grande, Rio Grande Estuary, and Lower Laguna Madre BBEST submitted its environmental flow analyses and environmental flow regime recommendations to its Basin and Bay Area Stakeholders Committee (BBASC), the Environmental Flows Advisory Group (EFAG) and the Texas Commission on Environmental Quality (TCEQ) on July 27, 2012. Texas Water Code Sec. 11.02362 (q), as added by Senate Bill 3 (SB3) in the 80th Texas Legislature, 2007 (SB 3), provides that “In accordance with the applicable schedule...the advisory group, with input from the science advisory committee, shall review the environmental flow analyses and environmental flow regime recommendations submitted by each basin and bay expert science team. If appropriate the advisory group shall submit comments on the analyses and recommendations to the commission for use by the commission in adopting rules under Section 11.1471. Comments must be submitted not later than six months after the date of receipt of the analyses and recommendations.” This memorandum represents the SAC’s input to the EFAG based on our review of the BBEST report.

Because of the vastness of the Rio Grande basin in Texas, the distinct differences in the aquatic environments across the Texas Rio Grande system, the associated different needs with regard to protecting environmental flows, the unique water rights, water availability and institutional aspects of this system, and the early uncertainty regarding funding for BBEST activities, the BBASC agreed that the SB3 work for the Rio Grande basin should be conducted by two BBEST subgroups addressing two different study areas defined as follows:

Upper Rio Grande (URG): Includes the Texas portion of the Rio Grande basin from Amistad Reservoir upstream along the Rio Grande to the town of Presidio, which includes the Big Bend region and the Pecos and Devils Rivers.

Lower Rio Grande (LRG): Includes the Texas portion of the Rio Grande basin below Anzalduas Reservoir near the city of McAllen, most of which is confined within levees along the river; the Lower Laguna Madre and the watershed and waterways that contribute inflows to the Lower Laguna Madre, including the Arroyo Colorado which parallels the Rio Grande; the system of resacas in Cameron County in and around the city of Brownsville; various bays and coastal lakes adjacent to the Lower Laguna Madre; and the Rio Grande estuary below Brownsville.

Accordingly, the Rio Grande BBEST report includes two separate reports, one for each of the two study areas. The SAC review comments that follow are also presented in two sections, one for each of the BBEST subgroup reports. These comments are organized following the *Framework for SAC review of BBEST work products (2nd ed. 12/17/2010)*, and conclude with a summary. The SAC also had the opportunity to visit with BBEST members and ask for further explanation of their work at the SAC's meeting in Austin on August 7, 2012.

The timeframe dictated by SB 3 presents a challenge to the BBEST. They have only 12 months from their appointment to organize themselves, develop their agenda for addressing the requirements placed on them under the statute, conduct their analyses and report their results. Fortunately, many of the Rio Grande BBEST members had previous experience with a broad range of scientific disciplines important to environmental flow analyses, including some members in each subgroup with prior BBEST experience. In addition, the BBEST was provided staff support from the state agencies, namely the TCEQ, Texas Water Development Board (TWDB), and Texas Parks and Wildlife Department (TPWD).

With a programmed start date of March 1, 2011, both of the BBEST subgroups had their first meeting in late April, 2011, following delays in getting appointed and organized by the BBASC. This left only about ten months for the BBEST subgroups to conduct analyses and make environmental flow recommendations. Consequently, both subgroups had difficulty completing their work by the original March 1, 2012 deadline, and both were granted an extension by the EFAG to June 1, 2012, with a corresponding adjustment to December 1, 2012 for submission of BBASC's environmental flow standards recommendations. It was made clear, however, that there would be no further extension of the due date for the BBASC recommendations. Although draft reports were available a few weeks earlier, the final combined report containing the individual reports from the two BBEST subgroups was delivered to the BBASC, EFAG and TCEQ on July 27, 2012, leaving approximately four months for the BBASC to prepare and submit its recommendations.

UNIQUENESS OF THE RIO GRANDE

The Texas Rio Grande system as defined by SB3 covers a large geographical area characterized by extremely varied climatic and hydrologic conditions and correspondingly varied aquatic biological resources extending from the humid subtropical coastal environment on the lower end to the semi-arid middle basin and finally to the upper basin Big Bend desert region. In total, this system covers approximately 50,000 square miles within Texas and is the largest river basin in Texas. The Rio Grande itself extends over 1,200 river miles along the international border between the United States and Mexico from near El Paso, Texas to the Gulf of Mexico.

Downstream of Fort Quitman, Texas, to the Gulf of Mexico, the flows in the Rio Grande are divided between the United States and Mexico by the provisions of the 1944 Treaty between the two countries, with portions of the inflows from some of Mexico's tributaries assigned to the United States. Upstream of Fort Quitman, the Convention of 1906 defines the ownership of flows in the Rio Grande between the United States and Mexico. The United States and Mexico Sections of the International Boundary and Water Commission jointly administer these treaties. The Rio Grande Compact between Texas, New Mexico and Colorado divides the inflows to the

upper portion of the Rio Grande among these states. These multiple institutional arrangements and the various agencies and entities involved in their implementation can complicate the management of the flows in the river for purposes of environmental protection, and as noted in Section 11.02362(m) of SB3, it is specifically acknowledged that "For the Rio Grande below Fort Quitman, any uses attributable to Mexican water flows must be excluded from environmental flow regime recommendations".

In Texas, there are over 1,500 surface water rights within the Texas Rio Grande system that authorize the diversion of about 3.5 million acre-feet of water per year for a variety of uses including domestic, municipal, industrial, mining and irrigation. Water rights on the middle and lower portions of the Rio Grande are supplied with stored water from Amistad and Falcon Reservoirs based on a system of water rights administration that prioritizes the available supplies based on type of use, with domestic, municipal and industrial uses assigned the highest priority. Currently, the combined authorized annual diversion from Amistad and Falcon Reservoirs for these middle and lower Rio Grande water rights is about 2.15 million acre-feet per year, whereas the combined firm annual yield of these reservoirs is only about 1.05 million acre-feet per year. This creates a situation of substantial over-appropriation and periodic shortages for many of the lower-priority water rights, i.e., irrigation and mining. Other water rights in the Texas Rio Grande system that do not rely on Amistad and Falcon Reservoirs for their supplies are subject to the prior appropriation doctrine for the allocation of available streamflows during dry periods. Under this system of water rights administration, the older water rights are allocated available streamflows first before the more junior priority rights, which again results in significant supply shortages for many water rights holders.

Because of the significant over-appropriation of available surface water supplies in the Texas Rio Grande system, the TCEQ, which is the water rights regulatory agency for Texas, generally considers that no unappropriated water is available within the system for the issuance of new water rights permits. Since the environmental flow standards adopted by the TCEQ under authority of SB3 apply only to new permits or certain water rights amendments issued by the TCEQ on or after September 1, 2007, there appears to be little or no applicability of specific recommendations for environmental flow regimes from the BBEST or environmental flow standards from the BBASC or the TCEQ *solely* for new appropriations of water within the Texas Rio Grande system.

Still, there is need to understand the aquatic biological resources that exist and have existed within key portions of the Texas Rio Grande system and their relationships to streamflows. For example, in the upper Big Bend portion of the Rio Grande basin, efforts are underway to acquire existing water rights that then can be dedicated to protecting environmental flows – the question is how much water is needed and how could it best be applied to maximize environmental benefits. The timing and magnitude of releases from Luis L. Leon Reservoir on the Rio Conchos near Presidio to meet treaty delivery requirements to the United States also could potentially be adjusted to maximize the beneficial effects of various flow patterns on maintaining channel features and biological integrity downstream along the Rio Grande, but more information on the flow patterns most likely to accomplish these purposes is needed. In the lower basin, studies are underway to assess the role of seagrasses in the Laguna Madre for supporting a wide variety of marine organisms and processes, and one of the key aspects of this research is the relevance of freshwater inflows from the Arroyo Colorado and other watersheds for maintaining conditions conducive to supporting these seagrasses.

Indeed, the Rio Grande basin is unique compared to other basins with regard to the scope, need and scientific basis for developing environmental flow regimes and/or environmental flow standards. This uniqueness and the compressed schedule, complicated by the early uncertainty of funding available for the BBEST's studies, led the BBASC to decide to limit the geographical scope of the BBEST's work and to address environmental flow issues with different subgroups for the upper and lower Rio Grande systems. Furthermore, since there are no major surface water projects being proposed in the basin, neither new reservoirs nor diversions, and no new water rights permits likely to be issued by the TCEQ, there is no real opportunity for the BBASC to examine the effects of the BBEST's environmental flow recommendations or its own proposed standards on potential water supply projects as contemplated in its SB3 charge to consider ".....the present and future needs for water for other uses related to water supply planning" when developing recommendations to the TCEQ for environmental flow standards. Consequently, when the BBASC is considering the BBEST's recommendations for environmental flow regimes, its role may be more to consider the practicality of implementing the BBEST's recommendations and strategies for doing so, rather than assessing the impacts of the BBEST's recommendations on proposed new surface water supplies for the basin.

UPPER RIO GRANDE BBEST REPORT - SAC REVIEW AND COMMENTS

1. Do the environmental flow analyses conducted by the BBEST appear to be based on a consideration of all reasonably available science, without regard to the need for water for other uses?

1.1 Has the BBEST identified and considered available literature and data? Were relevant scientific data and/or analyses discounted by the BBEST?

The literature reviews and references are extensive and include relevant sources of available information dealing with all aspects of environmental instream flows. The organization and presentation of the physical and biological systems encompassed in the study area are very well done. The segregation of the study area into sub-basins with similar geographic and ecological features is considered to be a logical approach for the Upper Rio Grande study area and facilitates the discussion of existing environmental conditions and the environmental flow recommendations. Comprehensive literature sources pertaining to the Rio Grande and the tributary streams regarding fish and aquatic organisms, water quality, salinity, groundwater, geology, geomorphology, hydrology, springs, climate, exotic and non-native plants, riparian biology, and instream environmental flows are discussed.

1.2 Are the data sources and methods adequately documented?

Data sources are very well described and documented. The concept of "natural flow regime" involving consideration of flow magnitude, frequency, duration, timing and rate of change was adopted at the outset of the URG BBEST's studies as the guiding principle for instream flow analyses and the recommended environmental flow regimes. By definition, such flow regimes include multiple levels of flow components reflecting existing variations in flow characteristics. It is noted, that few, if any, scientific investigations or monitoring efforts to date have been designed to relate physical or biological processes to flow in the upper Rio Grande basin.

Methods employed by the BBEST followed SAC guidance with: 1) recommended flow regime locations selected based on historical gage records with due consideration of geographic scope; 2) hydrology-based tools employed to extract historical flow statistics; and 3) biological, water quality and geomorphology overlays applied to confirm or refine the hydrology-based statistics. Because of different levels of available scientific data and research, overlays used in the development of individual environmental flow recommendations for each stream vary widely in scope and are used to much different degrees depending on the stream. The HEFR program was relied upon extensively for establishing flow statistics and, in most cases, the flow components of the recommended environmental flow regimes.

The significance of groundwater interactions with surface water in different streams in the upper Rio Grande study area is recognized by the URG BBEST and reflected in assessing the different stream segments with respect to a sound ecological environment.

1.3 To what extent has the BBEST considered factors extraneous to the ecosystem, especially societal constraints, such as other water needs?

External societal factors did not appear to play any role in the scientific issues addressed or in the methodologies employed in developing the URG BBEST's environmental flow recommendations. However, it was recognized by the URG BBEST that the Rio Grande is an international river subject to influences in Mexico and the provisions of the 1944 Treaty between the United States and Mexico, particularly with regard to Mexico's impoundment and use of flow in the Rio Conchos that enters the Rio Grande just upstream of the town of Presidio. These inflows from Mexico provide the vast majority of flow in the downstream reach of the Rio Grande. The URG BBEST also acknowledged that flows in the Pecos River entering Texas are subject to the Rio Grande Compact between New Mexico and Texas and regulation in Red Bluff Reservoir immediately upstream in New Mexico. The Pecos River Watershed Protection Plan also was recognized as a multi-agency program directed at restoring water quality in the Pecos River and generally improving watershed health.

2. Did the BBEST perform an environmental flow analysis that resulted in a recommended environmental flow regime 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?

2.1 How is a sound environment defined and assessed for both riverine (lotic) and estuarine systems? What metrics of ecosystem health were used?

The report contains thorough discussions of the important characteristics and features that reflect an ecologically sound environment. Each of the stream reaches in the URG study area designated by the URG BBEST for consideration of soundness was thoroughly discussed with regard to the essential requirements adopted by the SAC for a sound ecological environment, namely that it:

- Sustains the full complement of the current suite of native species in perpetuity,
- Sustains key habitat features required by these species,

- Retains key features of the natural flow regime, such as water quality, required by these species to complete their life cycles, and
- Sustains key ecosystem process and services, such as elemental cycling and the productivity of important plant and animal populations.

As such, the overall discussion of ecological soundness of individual stream reaches is very well thought out and addressed in the report.

2.2 How were locations selected for environmental flow analysis? Are these shown to be representative of and adequate to protect the basin? Was the process and rationale for selection adequately described? Were environmental flow regimes recommended for each selected site? Was a procedure presented by which the flow regime at other locations could be estimated?

Existing streamflow gages and historical flow records were used as the basis for selecting locations for environmental flow analysis and flow regime recommendations within the stream reaches designated by the URG BBEST for consideration of soundness assessments. The assessment of gage locations was based upon distribution, period of record and the representativeness of the gage for stream conditions. The presentation was very well done, including a good survey of available gage records and photographs of gage sites. The process and rationale for gage selection for use in the environmental flow analyses reflected data availability and need for environmental flow regimes. At 13 of 20 streamflow gage locations, HEFR-type flow regimes were initially defined and subsequently considered and evaluated as potential BBEST recommended environmental flow regimes.

As with previous BBESTs, a procedure for flow regime determination at locations other than at the gages where environmental flow recommendations are presented is not described.

2.3 How were the historical flow periods defined and evaluated? How was a particular period selected as the basis for determining the flow regime?

Historical periods of record for each gage were selected, to the extent possible, based on historical impacts on flow such as those caused by upstream impoundments and human intervention, e.g., upstream reservoirs and streamflow diversions. Generally, the full period of record was considered, with multiple periods analyzed for some gages depending on historical changes. In some cases, simply the available streamflow records were used to establish initial hydrology-based environmental flow regimes. In all cases, the HEFR model was applied to establish initial hydrology-based environmental flow regimes.

For gages on the Rio Grande below the Rio Conchos and at Johnson's Ranch, the influence of construction of the Luis Leon Reservoir on the Rio Conchos in 1967, which substantially altered downstream flows, dictated that historical flow records prior to that time be used for establishing the initial hydrology-based environmental flow regimes. This was considered appropriate in order to establish the pre-Luis Leon higher flow conditions in this reach of the Rio Grande which would help restore and support a sound ecological environment where presently the URG BBEST determined it does not exist. Downstream at the Foster's Ranch gage on the Rio Grande, the entire period of record

was used because pre-Luis Leon records were not sufficiently available and because groundwater inputs and occasional large tributary inflows to this reach of the river help maintain it in its currently-declared sound ecological condition. For the major upper tributaries to the Rio Grande, Alamito and Terlingua Creeks, the full periods of record for their respective gages were used since these streams have not undergone significant hydrologic changes due to anthropogenic impacts.

For the Pecos River basin, varying periods of record were used for establishing the hydrology-based environmental flow regimes with the HEFR model. For the Pecos River gage near Pecos, only historical flow records prior to the construction of Red Bluff Reservoir upstream were used in an effort to incorporate these pre-impoundment conditions into the environmental flow regimes for this reach of the river determined by the URG BBEST to be ecologically unsound. For other Pecos gages, it appears that the entire period of record was used, or some subset, but the justification for adopting these periods is not readily apparent in the report.

For the Devils River, it appears that the full periods of record were used at three gage locations for establishing hydrology-based environmental flow regimes. These records covered the last 50 years or so at two of the locations (Langtry and Pafford's Crossing), but at the Juno gage, only records covering about 45 years prior to 1972 were available and these were used for establishing hydrology-based environmental flow regime at this site. There is little discussion in the report as to the applicability of using these two different periods for environmental flow analysis; although, it is recognized that the Devils River is considered one of the most pristine aquatic systems in the state, with little anthropogenic influences, so using the different periods may adequately support the development of appropriate environmental flow regimes.

Missing records were filled in for some gages by repeating daily flow data from other periods, which seems somewhat arbitrary.

2.4 Was a sound ecological environment determined to exist at each selected site during the selected period? If not, were the underlying causes and/or modifications needed identified?

No, a sound ecological environment was not determined to exist at each selected site during the selected period of record for the HEFR analyses, namely the Rio Grande above La Linda and the Pecos River above Independence Creek. All other stream segments in the URG study area were determined to be ecologically sound. The underlying causes and reasons for the designation of unsound ecological environments were identified and thoroughly discussed, as were those for the sound ecological determinations.

The URG BBEST recognizes that modifications necessary to restore conditions to achieve a sound ecological environment vary considerably depending on different causes. For example, upstream reservoirs on the Rio Conchos in Mexico and minimal groundwater inflows for the Rio Grande above La Linda reflect conditions that are difficult to change in order to improve an unsound ecological environment in the Rio Grande. Similarly Red Bluff Reservoir on the Pecos River in New Mexico, minimal groundwater inflows, and naturally high salinity loadings present equally difficult

obstacles for improving the Pecos River above Independence Creek. It is recognized by the URG BBEST that most of the modifications necessary to restore conditions to achieve a sound ecological environment would be very difficult to implement.

2.5 Was a functional relationship between flow regimes and ecological health developed? Or, were proxy or intermediate variables used? Are assumptions underlying the methodology clearly stated? To what extent were overlay considerations (sediment transport, water quality, nutrients, etc.) addressed?

For the most part, the historical hydrology-based HEFR results were used as the primary basis for establishing the URG BBEST's recommended environmental flow regimes. However, various aspects of water quality, biology, including flow-habitat modeling, and geomorphology overlays are discussed for the Rio Grande, Pecos and Devils Rivers and Independence Creek, and where considered appropriate by the URG BBEST, modifications of the HEFR-based flow regimes were incorporated into the recommended environmental flow regimes.

As noted, for some stream segments in the URG study area, namely Independence Creek near Sheffield, the Pecos River at Brotherton Ranch near Sheffield, and the Devils River at Juno, flow-habitat modeling based on 10 fish species was utilized to define relationships between flow regime components and fish habitat, and these results were used in some cases to refine the hydrology-based HEFR results. While this work is well presented and thoroughly described in the report, the interpretation of the results raises several questions.

The "enoughness" thresholds used to quantify certain instream flow requirements (75% for base-low flow, 90% or 75% for base-medium flow, and 20% for subsistence flow) for selected fish species are subjective estimates, obviously based on the professional judgment of some or all of the URG BBEST members – a point that should have been more directly recognized in the report. Also, using enoughness thresholds above 75% or 90% of maximum for all three levels of base flow seems to contradict the fundamental "natural flow regime" objective of having three tiers of variable base flow to support differing levels of habitat availability.

As noted by the URG BBEST, the Devils River is considered pristine, and as such, it should be the poster child for the natural flow paradigm and the use of unaltered HEFR flow numbers for establishing environmental flow recommendations. Yet, the URG BBEST notes in Section 3.8.3 that for three of the selected fish species, one or more of the enoughness thresholds of percent of maximum weighted unit area (WUA) from the flow-habitat modeling were not maintained by the HEFR-based flows. This begs the question as to how much is enough for maintaining instream habitats, which leads back to the enoughness thresholds. Apparently, in these situations, either 75% or 90% of the maximum available habitat was not being met, which suggests, considering that the Devils River is pristine, that maybe the adopted enoughness thresholds are overly conservative, rather than the HEFR-based flows being too low. Nonetheless, this information was used by the URG BBEST to increase the base-flow requirements in their recommendations above what HEFR generated.

While the URG BBEST did elect to simplify the three-tiered base-flow regime from HEFR for Independence Creek near Sheffield to two flow levels, a base-low flow and a base-normal flow, adjustments nonetheless were made to increase the HEFR-derived base-medium flow up to 40 cfs because results from the flow-habitat modeling for some of the selected fish species did not fully satisfy the adopted 90% enoughness thresholds. Similar adjustments also were made for the Pecos River at Brotherton Ranch site. In all cases, these adjustments were completely driven by the enoughness threshold evaluation, and not by the actual flow-habitat modeling results (WUA curves), which often suggest that adjustments in the other direction may, in fact, be acceptable.

One particular point worthy of note pertains to the upper reach of the Pecos River that was determined by the URG BBEST to be unsound ecologically. While the SAC has no concern with this determination, the fact that an environmental flow regime was recommended by the URG BEST for this reach based solely on HEFR analysis of recent and available historical flows seems contrary to the BBEST's charge. As stated in Section 4.1.3.2 of the report, "Thus, we make the current base flow recommendations resulting from HEFR analysis with the objective of maintaining current conditions and mitigating against further deterioration of instream habitats, biological communities and other factors. The base flows needed to restore this reach to a sound ecological environment would then be developed in the adaptive management phase." So, even though the URG BBEST has determined the upper reach of the Pecos River to be unsound, environmental flow recommendations were still made based on HEFR to essentially maintain the unsoundness of the stream. In the SAC's opinion, it may have been more appropriate to not make a flow recommendation at all, recognizing the paucity of meaningful data, in order to avoid misuse of the flow recommendation in the future until a more rigorous assessment can be undertaken.

With regard to data limitations, in Section 4.1.4.2, the URG BBEST states that "No attempt was made to determine suitable high pulse flows to restore a sound ecological environment in the Upper Pecos since the only available data is from gages established after the Red Bluff Reservoir was constructed". This points to a general observation pertaining to all BBESTs that specific environmental flow recommendations at a given location (pulses or otherwise) have not been developed unless there is historical hydrologic information available. In fact, it may have been possible to use data for a particular fish species that was extirpated from this reach of the Pecos (such as the blue sucker) – likely because of flow alterations due to Red Bluff Reservoir – and look at the life-history needs of that species and how they are being satisfied by flows and pulses in other systems where they are currently thriving. This would provide insight as to how an appropriate flow regime might be structured for the Pecos that would lend itself to restoration. In fairness, the SAC recognizes that this approach can involve considerable time and effort, likely well beyond the short timeframe and limited resources of the URG BBEST.

One last point to note is the fact that the URG BBEST intentionally excluded overbank flows in its recommended environmental flow regimes for the unsound reach of the Rio Grande below Rio Conchos near Presidio and at Johnson's Ranch based solely on environmental reasons related to overbank sedimentation and floodplain accretion, both contributors to channel narrowing. This is a demonstration of recommending what a

particular system needs in terms of environmental flows, as opposed to what it has seen historically, a pleasant departure from the recommendations of past BBESTs.

2.6 Was a sound ecological environment demonstrated to be achieved at each selected site under conditions of the recommended flow regime?

No, not for those stream segments determined to presently exhibit unsound ecological environments. It is recognized that the HEFR-based recommended environmental flow regimes, although modified, are based on historical hydrology for the stream segments determined to be unsound, and that these flow recommendations will merely maintain these segments as being unsound and not provide for restoration.

Otherwise, for the most part, it has been assumed that the historical hydrology-based HEFR flow regimes, with some distinct and meaningful modifications, would be adequate to sustain a sound ecological environment for those stream segments already considered to have a sound ecological environment.

2.7 Is uncertainty in the analyses described or quantified? Where models were employed, was the extent of validation and associated predictive errors described and quantified?

The URG BBEST recognizes the uncertainties inherent in their analyses and environmental flow recommendations, but has not attempted to quantify the effect of these uncertainties on their recommendations. The URG BBEST has provided a useful outline of future research and monitoring needs for possible inclusion in the BBASC's Work Plan that will help to address uncertainties in the BBEST recommendations.

Summary

Overall, the URG BBEST is to be commended for all the hard work conducted and for advancing the understanding of ecological conditions in the Upper Rio Grande study area. The report is a detailed presentation with well-documented science, contains a focused approach, and takes on the difficult but necessary issue of sound ecological environment in a thoughtful way. Section 5 which addresses Adaptive Management is an excellent addition to this report. It is thorough, its presentation succinct, and it establishes a good foundation for the Work Plan to be developed by the BBASC.

For those stream segments determined by the URG BBEST to be characterized by sound ecological environments, the environmental flow recommendations generally conform to the natural flow paradigm, with numerical components based primarily on analyses of historical hydrology using the HEFR program. Various aspects of water quality, biology, including flow-habitat modeling, and geomorphology overlays are discussed, and in some cases used for modifying flow regime recommendations for the Rio Grande, Pecos, including Independence Creek, and Devils Rivers.

While the flow-habitat modeling work undertaken by the URG BBEST is well presented and thoroughly described in the report, the interpretation of the results and subsequent modifications of HEFR-generated flow regimes rely almost extensively on the enoughness thresholds, which were formulated based on professional judgment. In certain cases as described in 2.5 above, the

use of these enoughness thresholds seems to contradict the fundamental "natural flow regime" objective of having base flows that support differing levels of habitat availability. While the URG BBEST is to be commended for making adjustments to the HEFR-based flow regimes and not merely adopting them per se, their reasoning for doing so in some cases seems over-reaching and somewhat inconsistent with the flow-habitat modeling results.

For the most part, the URG BBEST has assumed that the historical hydrology-based HEFR flow regimes, with some distinct and meaningful modifications, would be adequate to sustain a sound ecological environment for those stream segments already considered to have a sound ecological environment. However, as has been the case with most other BBEST recommendations, it has not been demonstrated that all of the flow components of the recommended instream flow regimes, including multiple levels of base flow, up to four levels of high-flow pulses with different seasonal characteristics and additional overbank flows, are necessary to protect a sound ecological environment.

Two stream segments within the Upper Rio Grande study area were determined to be ecologically unsound by the URG BBEST. These are the Rio Grande above La Linda upstream to Presidio and the upper reach of the Pecos River above the confluence with Independence Creek. Streamflows in both of these segments are highly regulated by upstream reservoirs, there are minimal groundwater inflows, and, in the case of the Pecos, flows are subject to naturally high salinity loadings. The BBEST's environmental flow recommendations for this unsound segment of the Rio Grande reflect hydrology-based HEFR results using flow records prior to the construction of Luis Leon Reservoir on the Rio Conchos in Mexico (pre-1967), with additional high-flow adjustments to reflect flows required for restoring and maintaining channel characteristics similar to pre-Luis Leon conditions, a welcome departure from merely adopting the HEFR flow regime. For the Upper Pecos River, however, the BBEST environmental flow recommendations represent merely results from HEFR based on recent and available flow records. Consequently, the effect of these flow recommendations is essentially to maintain the unsoundness of the stream reach. In the SAC's opinion, it may have been more appropriate to not make a flow recommendation at all until a more rigorous assessment can be undertaken.

LOWER RIO GRANDE BBEST REPORT - SAC REVIEW AND COMMENTS

1. Do the environmental flow analyses conducted by the BBEST appear to be based on a consideration of all reasonably available science, without regard to the need for water for other uses?

1.1 Has the BBEST identified and considered available literature and data? Were relevant scientific data and/or analyses discounted by the BBEST?

The literature reviews are excellent, with one exception (see 1.2 below). The BBEST subdivided its charge into six watercourses: (1) the Rio Grande channel from Anzalduas Dam to Brownsville (i.e., the reach of the Lower Rio Grande Valley, LRGV), (2) the Arroyo Colorado including the North Floodway and the ship channel, (3) the Rio Grande tidal, viz. that reach below El Jardin Weir at Brownsville, (4) the resacas below Brownsville, (5) the bahias adjacent to the Brownsville Ship Channel, (6) the Lower

Laguna Madre, generally from the Land Bridge to Brazos Santiago, including the distributaries of the Arroyo Colorado. This is an expansion in geographic scope, undertaken by mutual agreement between BBASC and BBEST. From the standpoint of attempting to address all of the watercourses within the range of potential influence of the Rio Grande, this is commendable. However, since freshwater inflow is irrelevant to several of these watercourses (e.g., the Bahia Grande and San Martin bahias), the SAC questions whether this was an unnecessary diversion of limited time and resources.

The members of this BBEST employed published information, gray literature, agency data, and unpublished data in their analyses. To the SAC's knowledge, no relevant data or analyses were discounted by the BBEST. However, the BBEST overlooked a two-volume set of documents prepared for the proposed Brownsville Weir and Reservoir [R.J. Brandes Company and Horizon Environmental Services, Inc., 2003]. This report was apparently not reviewed but contains considerable information on the Rio Grande from Falcón through the tidal reach. It also contains a review of the biota, water quality, and sediment in the Arroyo Colorado.

The organization and presentation of the physical and biological systems encompassed in this basin are very well done. Commendably, the BBEST confronted several unique aspects of this basin, and developed a different type of analysis than employed in the other estuaries treated thus far in the SB 3 process.

1.2 Are the data sources and methods adequately documented?

Because of these unique features of the Lower Rio Grande and associated estuary, the compilation of literature and scientific results of the BBEST is particularly important for future workers. It is not surprising that in the short time available to all of the BBESTs for preparation of their reports, this BBEST included, several citations from their texts do not appear in the list of references. In this report, however, the incompleteness of the references is especially egregious, so much so that the SAC felt compelled to compile a list of citations in the text for which there is no entry in Section 12 "References Cited". This is included as an Appendix to this review. It is strongly recommended that Section 12 be revised to include bibliographic citations for all of these missing references.

A detailed water balance (or budget) for the period 1999-2008 was carried out to quantify the volumes and transports of water through the Rio Grande "plumbing", see Fig. 2.6.1 (a very helpful figure). Some of the terms in this balance are notoriously difficult to quantify, such as withdrawals and agricultural runoff. The BBEST and its contractors employed a mix of data sources, including reports, SWAT modeling, TxRR modeling, and extrapolations. The 1999-2008 water balance was used to characterize "existing flow" conditions. A "natural flow" condition was also developed. This was compared to the "natural" scenario of the 2003 WAM for the two years in the respective analysis periods that overlap, 1999-2000. The comparison was not favorable, the WAM value being a factor of two to three higher than the water-balance value. The BBEST does not comment on this, leaving the reader to perhaps infer that one (or both) water budgets are significantly in error. It appears that the discrepancy may arise from the water-balance

method removing only withdrawals and return flows, while the WAM “natural” removes dams and floodways as well.

1.3 To what extent has the BBEST considered factors extraneous to the ecosystem, especially societal constraints, such as other water needs?

External societal factors did not play any explicit role in the scientific issues addressed or in the methodologies. However, this basin has been extensively modified by human development over the past century, to the point that the hydrology and transport of water to the coast are largely artificial constructs. This led the BBEST to acknowledge in several places in the report that data do not exist to characterize the system in its natural state, and even if such data did exist, it is unlikely that a realizable flow regime can be specified to simulate it. This begins in the report with the observation that the LRGV is over-appropriated (by at least a factor of two), so that any new diversion permits (to which SB 3 flow standards are applicable) are physically prohibited. Nevertheless, the BBEST argues, “There are specific needs in some portions of the Texas Rio Grande system for pursuing SB3 environmental flow studies to investigate environmental flow requirements.” (p. 1-4). It would have been desirable that the BBEST elaborate on these “specific needs”.

2. Did the BBEST perform an environmental flow analysis that resulted in a recommended environmental flow regime 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?

2.1 How is a sound environment defined and assessed for both riverine (lotic) and estuarine systems? What metrics of ecosystem health were used?

The unusual features of this highly modified basin led the BBEST to modify the definition of a “sound ecological environment” suggested by the guidance of the 2006 SAC. This is offered as a “comprehensive definition” that includes the four criteria of the SAC (2006) and the associated observation that “sound” is not equivalent to “natural” or “pristine”, and may in fact yield different results according to the interpretation of “full complement of native species” and “key ecosystem processes and services”. In this BBEST’s work, a sound ecological environment satisfies three criteria:

- (i) native species are maintained
- (ii) the environmental state is sustainable
- (iii) the environmental state is a current condition

Criteria (i) and (ii) basically subsume the more specific criteria articulated by the SAC (2006). The last, criterion (iii), however, is novel and curious, and raises some logical questions. A current condition is defined by the BBEST to represent recent time history, i.e., the cumulative data from some point in the recent past to the present. No *current* condition can be inferred to not be sound because it fails (iii), by definition, only if it fails (i) or (ii). Using the SAC (2006) criteria, a historical condition can be inferred to be sound, provided sufficient information exists to characterize the species present and satisfaction of their habitat requirements. Criterion (iii) of this BBEST definition would explicitly *exclude* the judgment that such a historical condition is sound (unless, of course, it is presently extant). It can be argued that (iii) is not really a criterion in the

sense of (i) and (ii), but rather a proscription on the application of (i) and (ii), that they cannot be applied to any condition other than current (as defined above). It can also be argued that (iii) is strictly unnecessary: that (i) and (ii) suffice to determine whether a condition is sound.

The intent of (iii) does not appear to imply that any condition other than the current state of a watercourse is unsound, but rather that condition is simply excluded from being used as a standard of a “sound” environment: it is neither “sound” nor “unsound”. Therefore the prescription of a flow regime to maintain such a condition is basically mooted. This definition evidently is a device enabling this BBEST to sidestep the difficult (and potentially impossible) task of identifying a past condition, and associated flow regime, that may have been “sound”, but which is irrelevant to the Rio Grande in its present state. Indeed, for several watercourses determined by the BBEST to not be sound ecological environments in their current conditions, no flow recommendations were developed.

2.2 How were locations selected for environmental flow analysis? Are these shown to be representative of and adequate to protect the basin? Was the process and rationale for selection adequately described? Were environmental flow regimes recommended for each selected site? Was a procedure presented by which the flow regime at other locations could be estimated?

In the estuary, as was the case for the previous BBESTs, locations are generalized to large segments of the system. A total of six different geographic regions were identified downstream of the Falcon Dam.

In the Lower Rio Grande and the Arroyo Colorado, flow analyses were limited to the few long-period gauges in existence, notably the Rio Grande gauge below Anzalduas, the Rio Grande at Brownsville, just upstream from El Jardin weir, and the Arroyo Colorado at Harlingen. The inflow regime for the Lower Laguna was based upon the water balance for the entire Lower Rio Grande system including the Lower Rio Grande Valley and Arroyo Colorado, and water transports among these (see 1.2).

Inflow regimes were not recommended for several segments of the estuarine system, *viz.* the Arroyo Colorado and the bahias, nor for the Rio Grande nontidal (LRGV), see 2.4 below.

2.3 How were the historical flow periods defined and evaluated? How was a particular period selected as the basis for determining the flow regime?

Different historical flow periods were employed depending upon the specific watercourse, availability of data, and analysis objectives for that watercourse. The period of record for each of the gauges at Anzalduas, El Jardin weir (Brownsville) and the Arroyo (Harlingen) were analyzed to illustrate the effect of the various major alterations to the hydrology. The combined period of record was limited by the Arroyo, whose record begins in 1977. A water-budget evaluation including withdrawals, return flows, and nongauged runoff (see 1.2, above) was performed for the period 1999-2008.

Flows into the Brownsville resacas are not gauged. Inflows were estimated using the TxRR model of Texas Water Development Board, for which a 1977-2010 simulation was

performed by TWDB staff. However, the study evaluation was limited to the 1999-2008 period, consistent with that employed for the Rio Grande system (above).

The Bahia Grande and San Martin bahia complex received only qualitative hydrological evaluation, apparently because the freshwater input is considered minor. Given this, one might question why the geographic scope was extended to include the bahias.

The period of record upon which Rio Grande estuary (i.e., Rio Grande tidal) hydrology was evaluated was 2000-2009. It is assumed that the Rio Grande estuary inflow is dominated by that overtopping the El Jardin weir, and therefore the record at this station (Rio Grande Brownsville) was the single hydrological parameter. Sonde data for 2007-2008 was used to establish a salinity-versus-flow relation.

For the Lower Laguna Madre, inflows from the Rio Grande nontidal (i.e., LRGV), Arroyo Colorado and ungauged areas adjacent to the Laguna Madre were evaluated. Period-of-record flows and seagrass status were used to summarize the recent evolution of these systems. TxBLEND salinity modeling was carried out for the period of 1978-2009. Hydrographic, water chemistry, and biology data were compiled for the period 1977-2010.

2.4 Was a sound ecological environment determined to exist at each selected site during the selected period? If not, were the underlying causes and/or modifications needed identified?

No. As noted in 2.1, this BBEST used an unusual definition of “sound ecological environment” that precluded such a determination for a historical but no longer extant condition. This is not to say that historical information was not employed. On the contrary, where historical native species and their associated habitats were documented, this was employed as a standard to determine whether (i) and (ii) of the criteria (Paragraph 2.1, above) were satisfied.

On this basis, the Rio Grande above tidal (LRGV), the Bahia Grande, and the Arroyo Colorado (above tidal and the upper half of the estuary reach) were determined to *not* be sound ecological environments. For the LRGV, the successive hydrological alterations to the river were summarized, and the status of historical organisms, mainly fish, was presented. The presence of species summarized in Table 5.5.1, although not reflecting abundance or diversity, seems to portray a considerable “complement” of mainly native species. The BBEST translates its criteria of 2.1 (above) into the following (see pg 5-1 of the BBEST report):

- Diverse community of native riparian plants & absence of invasive exotic aquatics,
- Inclusion of one or more threatened amphibians, & two or more native turtles, and
- Mixed community of native fish, specified in detail on pg 5-1 of the report.

Apparently, at least one of these criteria is not satisfied, leading to a judgment of a nonsound condition. The case is not well-made, however. Data are not presented demonstrating the failure of the above conditions, nor, for that matter, how these conditions are extrapolated from criteria (i) and (ii), see 2.1 above and pg 1-6 in the

BBEST report. In the updated Environmental Assessment Section (Section 5.7) of the document for the Brownsville Weir and Reservoir Project, the report indicates that the list of species collected from the two riverine sample areas (near Anzalduas and near Brownsville) represented a good cross-section of the species generally expected to occur in those reaches of the Rio Grande. Collections by Trevino (1959) were reasonably consistent with the 1990 collections made for the Brownsville Weir and Reservoir Project.

With respect to the Bahia Grande, the BBEST notes that with proposed projects to improve the exchange of this system with the Lower Laguna and Ship Channel there is the prospect that it may become a sound environment.

The Arroyo is not a sound environment because of degraded water quality. This, it should be noted, is not purely a consequence of the volume of flow; indeed, the flow in the Arroyo has increased over the past half century.

No opinion was offered on the San Martin complex because of lack of data.

The BBEST states that the lower third (*sic*) of the Arroyo estuarine reach “might be considered a sound environment on the basis of its estuarine character and diversity of species.” The BBEST then refers to its historical condition “which probably had little or no freshwater inflow for extended periods”, and does not consider it further.

No assessment of the soundness of the Rio Grande tidal is given by the BBEST, though there is an extensive and well-presented summary of its present ecology, drawing particular attention to the effects of the mouth closure in the early 1990's. It seems to be implicit that with sufficient flows to maintain a salinity gradient and keep the mouth open for exchange with the Gulf, the estuary would be sound, though such an explicit statement is not made. The BBEST does, however, prescribe a recommended flow “regime” consisting of three categories: minimum flow (60 cfs) to maintain the salinity gradient, pulse flow “to keep mouth open” (175 cfs once every 2 months), and daily average flow (880 cfs once per year). The last is really a pulse flow, and should be so-named.

The judgment of the BBEST on resacas is equivocal. On page 7-5, the BBEST concludes, “Resacas should not be considered sound ecological environments when compared to their historical conditions before the early 1800's.” No data exist to substantiate this statement. Rather it is inferred because, “their hydrology has been substantially altered.” This is a curious inconsistency compared to the BBEST application of its “soundness” criteria to the LRGV, which was evaluated solely on the basis of whether it can *presently* support a sustainable population of native species. The BBEST proceeds to present an excellent summary of the ecological services provided by resacas, noting that they “may be the key to the high biodiversity” of the region. No recommended flow regime is presented, but the BBEST pleads for “human intervention” to preserve these watercourses.

The Lower Laguna Madre is judged to be a sound ecosystem based upon a single focal class of organism, *viz.* four (4) species of marine seagrasses, but the BBEST notes that

this status may be changing due to recent declines in seagrasses. The underlying causes were determined to be increased nutrients and increased inflows resulting in reduced salinity and water clarity. The resulting recommendations include an upper bound on inflows.

- 2.5 Was a functional relationship between flow regimes and ecological health developed? Or, were proxy or intermediate variables used? Are assumptions underlying the methodology clearly stated? To what extent were overlay considerations (sediment transport, water quality, nutrients, etc.) addressed?**

For the Lower Laguna Madre, the functional relationships were between the recommended flow regimes and the resultant salinity distribution in the Laguna Madre and the inferred nutrient concentration, and were largely qualitative. For the Rio Grande tidal, the functional relationship was between the position of the salinity gradient and flow, and the ability of certain historical pulse flows to keep the channel open to the Gulf.

- 2.6 Was a sound ecological environment demonstrated to be achieved at each selected site under conditions of the recommended flow regime?**

To do so was probably unnecessary because the judgments of required flows in the Rio Grande tidal were based upon achieving an open estuary with mid-reach salinity gradient, and in the Laguna on maintaining a salinity range suitable for seagrasses and a reduction of nutrient loads. Both responses were relatively qualitative, given the limited data available.

- 2.7 Is uncertainty in the analyses described or quantified? Where models were employed, was the extent of validation and associated predictive errors described and quantified?**

The issue of uncertainty permeates the BBEST report. However, no inferences are drawn as to quantitative uncertainty. In several places, this might have been useful. For example, the statistics underlying Fig 9.4.1 might have been used to determine the ability of the $\delta^{15}\text{N}$ studies to differentiate the sources of nitrogen to the system.

The salinity-flow relations in the estuary were based on modeled salinities, not data. No assessments are presented quantifying the accuracy of the TxBLEND model for the Lower Laguna

Summary

Throughout this report, the BBEST presents a huge amount of technical data. The compilation of this information in report format is an important contribution to the study of the Rio Grande system. However, in most cases, it does not appear that the majority of this information is used to support the formulation of a flow recommendation.

As discussed in the report, there have been major modifications to the system. The GIWW and the Port Mansfield Channel, which allows a wind-driven northerly flow in the Laguna Madre and largely prevents hypersaline conditions, is viewed as positive. Extensive seagrass beds were documented in the Laguna Madre with a maximum abundance in the 1960s. On the other hand,

the twentieth century development of extensive irrigated agriculture to the north of the Rio Grande, along with wastewater from urban development, has increased flows to the Arroyo Colorado and associated floodways. These flows are viewed as a possible detriment to the seagrass in Lower Laguna Madre (LLM), due to reducing salinities below those preferred by seagrasses, and stimulating algal growth in response to high nutrient concentrations.

A related effect is the reduction in flow in the lower Rio Grande. While some reduction in river flow might be viewed as a positive in that it allows saline intrusion and the formation of an estuary, it has gotten to the point that the flow is so low that the mouth has been closed off by sand moving in the longshore system.

Clearly, this is a heavily modified system. As discussed in section 2.1, the BBEST struggled with the Sound Ecological Environment (SEE) status of the area. It recognized that while improvements were possible, it would not be possible to achieve pre-development conditions. As noted in the report, the river is over-appropriated so there is no water available for permitting in the area. As a consequence, the environmental flow standards (ranges) recommended, which would only apply to new permits, would not have any direct effect on existing water management and permits.

While the environmental flow recommendations in the BBEST report would not have any direct effect even if they were adopted by the BBASC and TCEQ, they are nevertheless a valuable contribution to water resource management. The qualitative and quantitative flow recommendations identify parts of the area, LLM and the Arroyo Colorado, that receive more water and nutrients than they need to maintain a sound environment, while other parts like some resacas and the Rio Grande tidal, would be healthier environments if they received more water or less sediment. These recommendations lay the foundation for the stakeholders and TCEQ to actively explore strategies for reducing waste and nutrient loads and for moving water to systems that need more water from systems receiving more water than they need for ecological health. The BBEST therefore performed many analyses, much of which may fall outside the SB3 process. This is not meant as a criticism since the system is so highly modified it is helpful to seek alternative solutions. Section 11 is an excellent start for a Workplan.

Reference

R.J. Brandes Company and Horizon Environmental Services, Inc., 2003: *Reference document for the Brownsville Weir and Reservoir Project Volumes 1 and 2*. Prepared for the US Army Corps of Engineers Galveston District

APPENDIX

Citations from text missing from *Section 12 References Cited*

<i>Citation</i>	<i>page in report</i>
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