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August 19, 2010

Mr. Ron Ellis
Texas Commission on Environmental Quality
P.O. Box 13087
MC 160
Austin, TX 78711-3087

Re: Senate Bill 3 Rulemaking; Creation of 30 Texas Administrative Code, Chapter 298, Environmental Flows, Subchapter A, Sabine and Neches Rivers and Sabine Lake and Subchapter B, Trinity and San Jacinto Rivers and Galveston Bay

Dear Mr. Ellis:

Texas Parks and Wildlife Department (TPWD) appreciates the opportunity to provide input during the process to develop environmental flow standards for the Sabine and Neches Rivers and Sabine Lake and the Trinity and San Jacinto Rivers and Galveston Bay systems. In addition to these comments, TPWD respectfully requests you consider the attached February 5, 2010 comments TPWD submitted in response to the Basin and Bay Expert Science Teams' (BBESTs) environmental flow regime recommendations.

Environmental Flow Standard Components

In Senate Bill 3 of the 80th Texas Legislature, the enabling legislation for environmental flow standard rulemaking, environmental flow protection is measured against a standard of adequate to support a sound ecological environment. In Texas Water Code Section 11.002(16), an environmental flow regime is defined as "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." In turn, Texas Water Code Section 11.1471(c) provides that the TCEQ environmental flow standards must be "adequate to support a sound ecological environment, to the maximum extent reasonable considering other public interests and other relevant factors." The standards must consist of "a schedule of flow quantities, reflecting seasonal and yearly fluctuations that may vary geographically by specific location in a river basin and bay system."

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In constructing environmental flow standards, TPWD recommends the Texas Commission on Environmental Quality (TCEQ) closely follow the technical guidance documents authored by the Texas Environmental Flows Science Advisory Committee (SAC) regarding environmental flow regimes. Senate Bill 3 created the SAC to serve as an objective scientific advisory body on issues relating to the science of environmental flow protection, and the SAC is tasked to provide overall direction, coordination, and consistency relating to environmental flow methodologies for bay and estuary studies and instream flow studies and the work of the BBESTs. The SAC documents draw from a number of sources on issues related to hydrology, biology, geographic extent, water quality, and geomorphology. TPWD also recommends that environmental flow standards reflect the regime components endorsed in *The Science of Instream Flows, A Review of the Texas Instream Flow Program*, National Research Council of the National Academies, National Academies Press, 2005. These components include biology, hydraulics and hydrology, geomorphology, and water quality. For bays and estuaries, key components are inter and intra-annual variation of freshwater inflow volumes necessary to maintain important estuarine habitats and biological communities which in some cases are represented by one or more indicator species.

Suggested Environmental Flow Standard Framework

The definition of an environmental flow regime in Texas Water Code Section 11.002(16) implies a schedule of flow quantities that includes flow magnitudes and frequencies reflective of seasonal and yearly fluctuations. TPWD staff believes that a matrix of magnitudes (which may include flow, duration, and/or volume) and frequencies of flows expected to support a sound ecological environment provides for the most straightforward framework for environmental flow standards that can be applied state-wide. This framework also provides maximum flexibility for future inclusion of Senate Bill 2 Texas Instream Flow Program study results and for permit applicants to tailor project characteristics for consistency with such flow standards.

A matrix of flow magnitudes with prescriptive rules in lieu of associated frequencies of occurrence (such as the Sabine-Neches BBEST recommended flow regime) provides less certainty for providing a sound ecological environment and potentially over-constrains future water development projects. TPWD staff recommends that the TCEQ follow the conceptual framework taken by the Trinity-San Jacinto BBEST "Regime" group with additional language to specify interpretation of pulse recommendations based on long-term (i.e. period of record) rather than short-term (i.e. season) behavior. The distinction between the Trinity-San Jacinto "Regime" group

recommendation and the Sabine-Neches recommendation is somewhat analogous to the difference between water quality standards based on chemical concentrations (e.g., a dissolved oxygen concentration of 5.0 mg/L or greater, occurring not less than 85% of the time) and those based on best available technology. The former focuses on the salient environmental factor (namely dissolved oxygen), whereas the latter focuses on a practical approach that may or may not achieve the environmental goal.

TPWD staff believes that it is advantageous for all involved for TCEQ to promulgate straightforward, environmentally-focused standards that do not unnecessarily constrain future permit applications by using overly prescriptive rules. To promote state-wide consistency, prescriptive rules such as recommended by the Sabine-Neches BBEST can be converted to magnitudes and frequencies by running their spreadsheet model (which incorporates the rules agreed by the BBEST to protect a sound ecological environment) and calculating the predicted occurrence frequencies of the various recommended flow values. This conversion allows for the described conceptual framework to be used in both the Sabine-Neches and Trinity-San Jacinto basins and throughout Texas. This approach also provides more guidance for entities to use in assessing voluntary strategies that may be needed to provide flows beyond the unappropriated amounts that may be available.

Regarding the integration of instream flow recommendations with estuarine freshwater inflow recommendations, TPWD agrees with SAC guidance suggesting that, when in conflict, the greater recommendation (instream vs. estuarine) should prevail.

Narrative Environmental Flow Standards

Recognizing the diversity and geographic expanse of the stream systems and bays and estuaries of Texas and their alterations, TPWD suggests that there may be portions of a basin where an environmental flow standard consisting of a detailed prescriptive flow matrix may not be practical. This question has already been raised in the context of how to develop environmental flow regimes for every location of a large river basin, including ungaged tributaries. Some recommendations by science teams and stakeholders have focused on a small number of control points. In the absence of a populated flow matrix for a particular location, it may be necessary for TCEQ to develop narrative standards to lay out how environmental flows may be protected at that location. The narrative may describe the methodology for spatially translating detailed flow standards from one location or control point to another, with appropriate adjustment for specific biological and hydrological differences in locations. However, caution should be used in

adopting a simplified approach strictly for purposes of expediency rather than for explicit ecological reasons.

Evaluating Impacts of Flow Standards on Projects

At the August 12, 2010 TCEQ Stakeholder meeting on environmental flow standard rulemaking, TCEQ staff discussed the idea of using a WAM to analyze the impacts of flow standards on projects likely to be permitted within ten years. TPWD asserts that the regulatory impacts to projects from application of an environmental flow standard cannot be fairly assessed by contrasting those impacts to projects with no environmental flow protections. It should be acknowledged that the Texas Water Code Section 11.147 required consideration of environmental flow effects and the imposition of flow protection to the extent practicable before the passage of Senate Bill 3. A fair analysis of how a flow standard impacts a project requires a comparison to how the project might have been conditioned using environmental flow requirements imposed under pre-existing law. TPWD recommends the TCEQ make its impacts analyses transparent to the public as part of the rulemaking process.

Permit Conditions Related to Environmental Flow Standards

Texas Water Code Section 11.147(e-3) directs the TCEQ to determine the flow conditions necessary to maintain freshwater inflows and instream uses when it applies an environmental flow standard. Nothing in Senate Bill 3 requires that a specific permit condition be identical to the applicable environmental flow standard. In practice, TPWD believes that the nature of a proposed water right project will dictate the extent and complexity of permit conditions necessary to comply with a flow standard. As an example, the TCEQ recently developed Draft Permit No. 5851 for the complex Brazos River Authority (BRA) System Operation project that includes specific protective environmental flow regime special conditions at control points (prescriptive rules) throughout the Brazos basin. The complexity of the environmental flow permit conditions is suitable for the BRA project as it seeks to appropriate a large amount of water, including return flows, throughout a large area of the river basin. Assuming an environmental flow standard exists in the Brazos basin, a hypothetical irrigation permit for 1000 acre-feet per year would not have the same impact on environmental flows as the BRA project. In order to comply with the flow standard, the irrigation permit may require a base flow restriction on diversions but no restrictions related to the protection of high flow pulses. In all instances, existing conditions and the ability of the proposed project to impact environmental flows should drive permit provisions.

Environmental Flow Set-Asides

Texas Water Code Section 11.1471(a)(2) requires the TCEQ by rule to establish an amount of unappropriated water, if available, to be set aside to satisfy the environmental flow standards to the maximum extent reasonable when considering human water needs. TPWD recommends a two step process for establishing a set-aside: 1) identify environmental flow standards, and 2) calculate the amount of unappropriated water available to satisfy the environmental flow standards. The amount of unappropriated water available will vary by location and by existing water development and water rights permits, environmental flow standard quantity and structure, climatic condition, and season. The SAC has created a Water Availability Model (WAM) subcommittee to tackle some of the tough technical issues inherent in looking at the relationship between environmental flow regimes and water availability and to develop analytical recommendations. The work of the WAM subcommittee should guide the TCEQ in determining unappropriated water available for set-asides.

Given the range of flows expected in an environmental flow standard, it may be appropriate to consider the environmental flow set-aside as an interruptible supply not subject to the same reliability requirements as TCEQ typically applies to consumptive uses of water. Depending on the methodology used to calculate available unappropriated water at a location, it may be possible to describe the set aside as a variable monthly or seasonal flow rate (cubic feet per second) with a maximum annual amount (acre-feet).

It should be noted that environmental flow standards do not create water or mechanisms for the standards to be achieved. By design, the environmental flow standard is independent of water availability. Senate Bill 3 allows the commission to establish set-asides of unappropriated water, where available, to meet flow standards, but it also tasks stakeholders and others to develop strategies to find water for environmental flows. These strategies will likely include an array of actions such as the voluntary management of water projects and leases or donations of water rights for environmental flow uses. As the Senate Bill 3 process moves west, it is less likely that there will be unappropriated water available to meet environmental flow standards and, indeed, there may be few new appropriations that have the potential for being managed to help meet flow standards. The commission should develop environmental flow standards to maintain a sound ecological environment and then allow the Senate Bill 3 stakeholder process to develop strategies to meet the flow standards.

Balancing Water Needs

The TCEQ has a twenty five year regulatory history of balancing environmental needs with other water needs in water rights permitting. In 1985, the Texas Water Code introduced new requirements for the TCEQ to consider impacts to instream uses, freshwater inflows, water quality, and fish and wildlife habitat from certain water projects. To address environmental impacts, the commission developed special permit conditions to minimize impacts and to provide protection to maintain existing instream uses and beneficial freshwater inflows. In creating those special permit conditions, the TCEQ had to consider other public interests, including the need for both consumptive and non-consumptive water for a variety of uses including municipal, industrial, and agricultural.

The balancing process in Senate Bill 3 does not differ dramatically from the commission's historical balancing of the environment with other water uses. Texas Water Code Section 11.1471(b) continues TCEQ practice with a directive to adopt standards "to the maximum extent reasonable considering other public interests and other relevant factors." The commission must consider economic factors and the human and other competing water needs in the river basin and bay system. The practical regulatory change created by Senate Bill 3 and the application of a flow standard is that the environmental flow protection level is created by rule for a complete river and bay system rather than on a case by case basis for individual permits. The rule also provides a measure of certainty for water right applicants in that applicants can assess proposed projects by applying a known environmental flow requirement in advance of the filing of a permit application.

Under Senate Bill 3, the TCEQ gains additional tools to help it fairly balance water needs through the use of adaptive management, the periodic review and possible revision of environmental flow standards and set-asides, and the authority to adjust (within a limited range) permit conditions to comply with flow standards. While these are significant changes in water rights administration, these changes benefit all water users and the environment, and they extend the ability of the TCEQ to balance competing needs; the commission is no longer constrained by a one-time decision implemented in perpetuity. The TCEQ now has the ability to reconsider relationships between the environment and other water users through the examination of years of additional data and advanced science and technology.

Hydrology-based Environmental Flow Regime Tool

The BBESTs utilized the Hydrology-based Environmental Flow Regime (HEFR) tool as a starting point in the development of flow regime recommendations. TPWD is aware of several public comments questioning the use of the HEFR tool to derive a schedule of environmental flows and the perception that HEFR results did not occur in the historical record. HEFR is

a statistical tool like many others with a number of pre-processing and post-processing decision points that shape the final output. Any hydrology-based methodology needs to be refined using information and data from other disciplines including biology, ecology, water quality, and geomorphology. Hydrology-based tools such as HEFR provide information for developing flow regimes using statistics such as average frequencies. Unless tightly defined, hydrology-based recommendations consequently are not expected to occur each and every year but represent a statistically modeled range of flows or occurrences. Interpretation of regime recommendation behavior should be evaluated over long time periods. TPWD addresses additional hydrology-based methodology questions in our attached comment letters on the BBESTs' recommendations.

Thank you for your consideration of these comments. Texas Parks and Wildlife Department looks forward to continuing to work with the TCEQ and others as we strive to ensure that the needs of the state's fish and wildlife resources are considered and addressed across the state. Should you have any questions, please contact me at 512-389-8715.

Sincerely,

Cindy Loeffler

Cindy Loeffler, Chief
Water Resources Branch Chief

CL:ms

Attachments

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Carter P. Smith
Executive Director

Date: February 5, 2010

To: The Honorable Karen J. Hixon
Executive Director Carter Smith
Deputy Executive Director Ross Melinchuk

From: Ms. Cindy Loeffler
Ms. Colette Barron Bradsby
Mr. David Bradsby
Ms. Lynne Hamlin
Mr. Nathan Kuhn
Dr. Wen Lee
Mr. Kevin Mayes
Dr. Dan Opdyke
Mr. Clint Robertson
Ms. Angela Schrift
Mr. Terry Stelly

Re: Texas Parks and Wildlife Department Staff Perspectives on the Sabine-Neches Basin and Bay Expert Science Team Report

Senate Bill 3, Article 1 (SB 3), as passed by the 80th Texas Legislature in 2007, created a statewide process for identifying and protecting environmental flow needs. As part of this process, Basin and Bay Area Expert Science Teams (BBESTs) were formed in the Sabine-Neches and Trinity-San Jacinto River Basins. The Sabine-Neches BBEST submitted its final report on November 30, 2009 documenting science-based recommendations for an environmental flow regime for the applicable river and bay system. SB 3 directs each BBEST to develop an environmental flow regime recommendation:

> *...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.*

Having worked on numerous instream flow and freshwater inflow recommendations over many years, Texas Parks and Wildlife Department (TPWD) staff is familiar with the uncertainty embedded in such efforts, cognizant of the challenges faced by the BBEST, appreciative of the efforts expended by the members, and grateful for the many opportunities to provide input throughout the process. Each BBEST had approximately twelve months and a limited budget for outside services to meet the SB 3 charge. The difficulty of the challenge cannot be overstated and the progress of the BBEST is commendable. It is widely recognized that the science of environmental flows is not an exact one, and the BBESTs did not have the time, data, directive, or

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budget to perform a definitive analysis. This memorandum contains general comments regarding the Sabine-Neches BBEST report and the SB 3 charge to develop an environmental flow regime, and it contains specific comments addressing instream flows and freshwater inflows. More detailed technical comments are provided as an appendix. These comments are intended to assist the Environmental Flows Advisory Group, the Texas Commission on Environmental Quality, and the Sabine-Neches Basin and Bay Area Stakeholder Committee in reviewing the BBEST recommendations.

General Comments

TPWD staff commends the Sabine - Neches BBEST for its efforts to address the requirements set forth by SB 3. In general (with exceptions described below), the BBEST followed guidance provided by the Texas Environmental Flows Science Advisory Committee (SAC) and addressed the requirements set forth by SB 3.

Definitions and discussions of environmental flow regimes and a sound ecological environment from the SAC, the National Academy of Science, and the Texas Instream Flow Program are reasonably consistent and can be used to guide efforts to comply with the requirements of SB 3. The development of an environmental flow regime is a multi-disciplinary process that requires input from a wide range of sciences including biology, ecology, chemistry, hydrology, and engineering. However, the charge to the BBEST is, by its very nature, weighted to an outcome based largely upon ecological considerations. The SB 3 definition of an environmental flow regime requires a regime 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. As per SB 3, the BBEST environmental flow recommendation is to be made without regard to the need for the water for other uses and must be based solely on the best science available. The SB 3 directive protects the BBEST scientists from having to wrestle with implementation and policy issues in addition to complex and difficult scientific issues.

The Sabine - Neches BBEST considered certain water use and water right implementation issues when developing its recommendations; this action may ultimately compromise the likelihood that the flow regime recommendations will protect a sound ecological environment. In the opinion of TPWD staff, SB 3 intended the Basin and Bay Area Stakeholders Committee (BBASC) and the Texas Commission on Environmental Quality (TCEQ) to consider water use policy and implementation issues rather than the BBEST. While TPWD does not endorse the use of implementation factors to develop flow regimes, TPWD comments address how such factors were applied by the BBEST.

The Sabine-Neches BBEST reached consensus that current conditions in the streams and associated bays and estuaries of the Sabine and Neches river basins constitute a sound ecological environment. As defined in the SAC guidance that the BBEST adopted, a sound ecological environment "sustains the full complement of native species in perpetuity." Unfortunately, some native species (e.g., paddlefish and various mussels) do not appear to be sustainable in these basins. In addition, Sabine Lake has experienced significant loss of important wetlands, largely due to salt water intrusion caused by channelization and subsidence. While TPWD does not propose fully restoring natural hydrologic conditions, TPWD does encourage acknowledgment of flow related changes to the ecological condition of river and bay systems including habitat losses and decreasing viability of certain native species.

Unique to the Sabine-Neches BBEST effort was the collection and analysis of data and information on *Rangia* clam (common in Sabine Lake) and the analysis of floodplain inundation under different flow rates using digital topographic data provided by TPWD. Both of these efforts were initiated by the National Wildlife Federation (NWF), with direction from the BBEST and assistance from contractors. TPWD staff appreciates NWF taking the initiative to pursue and successfully complete this important work in a timely manner.

Finally, SB 3 provides that, in order to meet environmental flow standards, affected water rights are subject to adjustment of environmental flow permit conditions. This adjustment is capped at a 12.5% increase of the annualized total of water required by the permit for protection of instream flows and freshwater inflows. Because the first promulgated environmental flow standard in a given permit defines the limits of the 12.5% adjustment cap for that permit, TPWD staff believes every effort should be made to identify a complete environmental flow regime for a full basin and bay system to serve as the foundation of the initial flow standard and subsequent permit conditions.

Instream Flow Recommendations

The BBEST focused primarily on rivers and streams, identifying instream flow components at twelve locations in the Sabine and Neches River basins. Analyses were performed in support of freshwater inflows to Sabine Lake, but the BBEST largely felt that if instream flows at the downstream ends of major inflow sources were appropriately specified, then the environment of Sabine Lake would be protected. The BBEST used the Hydrology-based Environmental Flow Regime (HEFR) approach, a statistical hydrology software package developed by TPWD and supported by the SAC, to generate a set of initial flow components (subsistence, base, high flow pulse and overbank flows) for dry, average and wet conditions. The initial flow recommendations were then adjusted based mainly on water quality and implementation considerations.

The BBEST did not provide recommended attainment frequencies for these flows but rather viewed the flows as permit constraints and developed a suggested suite of rules for implementing the flows in future water right permits. This action resulted in implementation rules being embedded in the flow regime recommendations, which TPWD staff considers inconsistent with the BBEST's charge under SB 3.

The BBEST opted to use the entire period of record at all locations including locations where instream flows have been substantially altered by reservoir impoundment. For this reason, TPWD staff believes that the use of the pre-impoundment period of record would have been more appropriate for some locations in the Sabine and Neches basins.

In its use of HEFR, the BBEST tuned the hydrographic separation algorithm in a manner that resulted in extremely low flow recommendations, especially for subsistence flows. TPWD staff believes that the hydrographic separation should have been performed with a greater emphasis on ecological function, as recommended by the SAC. TPWD staff has concerns that the reduced flows produced by the BBEST may not be sufficient to protect a sound ecological environment.

In particular, TPWD staff remains very concerned about the extremely low subsistence flows recommended by the BBEST. The BBEST declined to use the seven day, two year recurrence interval flow (7Q2) as the subsistence flow because repeated water quality violations have not historically occurred at low flows. The Q95 flow (i.e., the 5^{th} percentile flow) was endorsed by most members of the BBEST Biology Subcommittee, a group comprised of ecologists and biologists. The remaining BBEST members did not accept the Q95 flow values but instead recommended lower flows, generally in the $1^{st} - 3^{rd}$ percentile ranges. As existing water rights are more fully used, an increase in the frequency of flows less than subsistence levels is expected. The proposed implementation approach would not further increase this frequency; however, this approach could lead to meaningful increases in the frequency of occurrence of flows at the subsistence level. Those changes, if realized, could lead to serious impacts to fish and wildlife resources and preclude a sound ecological environment in the basins. TPWD staff believes that additional constraints should be added to keep the frequency and duration of flows below, at, and immediately above subsistence levels as close to as historically occurred as possible.

The BBEST recognized the ecological importance of overbank flow events but declined to recommend them based on potential implementation and liability issues. TPWD staff believes that SB 3 intended the BBASC and TCEQ to consider policy and implementation issues related to ecologically-important overbank flow events rather than the BBEST. While TPWD does not

recommend flooding developed property, there are ecological benefits associated with overbank flows for in-channel and off-channel habitats and key riparian areas.

The BBEST employed the U.S. Army Corps of Engineers SAM computer program to estimate sediment transport based on river characteristics and specified flows. The conclusions state that the high flow pulses and overbank flows proposed by the BBEST "will provide sufficient flow to maintain the existing dynamic equilibrium within these two riverine basins." However, the overbank flows are not recommended by the BBEST, rather they are only "recognized," and it is unclear if this analysis fully considered the duration and frequency of events. TPWD staff agrees with the BBEST Geomorphology Overlay document statement that overbank events are a key component of adequate sediment transport.

In its interpretation of flow recommendations, the BBEST chose to use a conceptual model wherein the flow values are interpreted as flow or, equivalently, permit restrictions (e.g., if the recommendation is 100 cfs and the flow in the river is 110 cfs, one may divert 10 cfs). TPWD staff respectfully disagrees with this approach at the BBEST level. First and foremost, because the flows are interpreted as restrictions, there is no way to estimate their future frequency of occurrence without making assumptions about future infrastructure and implementation. This increases the difficulty of judging whether or not a sound ecological environment is likely to be protected, which is already a challenging task. Secondly, this level of implementation and infrastructure consideration is more appropriately addressed by the BBASC and TCEQ as they fulfill their SB 3 charges. TPWD staff understands the practical advantages of specifying flow restrictions but thinks that the SB 3 directive that a BBEST make its analyses and recommendations based solely upon the best available science insulates the scientists from having to weigh implementation factors. Should actual implementation or infrastructure diverge from the BBEST assumptions, a re-evaluation of the expected protection of a sound ecological environment may be necessary. The Trinity-San Jacinto BBEST report provided cleaner, stand-alone flow recommendations comprised of magnitudes and attainment frequencies. That approach allows implementation issues to be addressed in the future, as needed, while providing a simpler flow recommendation. The Trinity San-Jacinto BBEST conceptual model of flow regimes appears more suited to the SB 3 directed environmental flow regime development than the Sabine-Neches BBEST conceptual model of flow restrictions.

In summary, TPWD staff believes that the instream flow recommendations are too low and too intimately linked to implementation assumptions to confidently protect a sound ecological environment.

Freshwater Inflow Recommendations

Freese and Nichols, Inc. (FNI) and NWF estuarine analyses were used to support the BBEST freshwater inflow recommendations for Sabine Lake. More specifically, the BBEST interpreted the results of these analyses as corroboration for the instream flow recommendations. However, these analyses were performed using preliminary instream flow recommendations and were never updated with the final instream flow recommendations. The final flow recommendations are lower than the preliminary flow recommendations. Because of these inconsistencies, it is difficult to gage the efficacy of the final flow recommendations for Sabine Lake. Indeed, even the somewhat higher inflow recommendations used in the NWF report predict marsh habitat short of what is necessary to protect a sound ecological environment. In order to understand the ecological implications of lowering the preliminarily recommended inflow values, TPWD recommends a reevaluation of the final freshwater inflow recommendations using the FNI and NWF analyses and a comparison to TPWD's freshwater inflow recommendations developed using the State Methodology.

In general, the flow recommendations proposed by the BBEST could result in inflows substantially lower than those experienced historically and could subsequently increase salinities farther upstream, with *Rangia* populations moving upstream in a like manner. The proposed deepening and widening of the ship channel will further accentuate the *Rangia* movement. A possible end result would be that *Rangia* habitat in Sabine Lake would be significantly restricted, compressing their available habitat to the much smaller riverine portions of the estuary.

CL:ch

Attachment

Appendix of Detailed Comments (listed by page number)

Page x, Recommendation #7: In calculating subsistence flow recommendations, the statement is made that in some instances, "MBFIT/HEFR failed to calculate a value." This is caused by the absence of subsistence flow days in that particular season, based on the hydrographic separation procedure in MBFIT. This behavior is not an error, and the hydrographic separation could be modified to reduce and/or eliminate this behavior (e.g., by having seasonally-adjustable parameters in the hydrographic separation) or, more simply, different parameters could have been selected in MBFIT. TPWD staff welcomes the input of the Sabine-Neches BBEST and others on how to best improve HEFR.

Page 15-16: TPWD staff believes that the best available science, as documented in the Biological Overlay report (Appendix XIII of the BBEST report), shows support for using the 5th percentile as the subsistence flow recommendation. However, the BBEST decided to use the much lower HEFR values that are based on an MBFIT parameterization that overemphasizes the high flow pulse category (page 58 of HEFR memo, Appendix X) and consequently lowers base and subsistence flows. No evidence supports using the lowest recorded seasonal flow value where MBFIT/HEFR fails to calculate a value (meaning that subsistence flow values, as defined using the MBFIT parameter set selected by the user, have never occurred in that season during the analyzed period of record). While there is discussion of risk associated with this decision (page 65), TPWD staff believes that a better approach would have been to use the 5th percentile.

Page 16-17: While reservoir storage level may be an option to determine hydrologic conditions, it should be recognized that reservoir levels are managed for water supply purposes and may not always represent naturally occurring hydrologic conditions. This potential disconnect may arise when a water right holder's management of water in an upstream reservoir may affect when an environmental flow condition applies to that water right holder's downstream junior water diversion right. Streamflow attainment frequencies, alternative criteria for hydrologic condition, or rules that limit the possibility of storage level manipulation should be considered.

Page 17-18: HEFR can calculate a variety of high flow pulse events. The BBEST implementation rules (page 107) provide for passage of one of the historical two per season high flow pulses in March-May and one of the historical two per season high flow pulses in June-August during dry hydrologic conditions. During average conditions, the implementation rules provide for passage of two of the two per season pulses during all seasons. During wet conditions, the implementation rules provide for passage of one of the one per season pulses during all seasons. TPWD staff could not find justification for this schedule of pulses, beyond the one sentence statement on page 18. Many other pulse sizes exist and could have been recommended. Under the implementation rules recommended by the BBEST, smaller pulses could be wholly diverted and larger pulses could be scalped. In seasons where a high number of pulses occur relative to the historical frequency, the entirety of the extra pulses could be diverted. The rationale for the selection of this important part of the flow regime and the potential ecological consequences was not clearly documented, and thus it is difficult to discern the basis for selecting the pulse flow recommendations.

Page 19: Although it is recognized that overbank events are ecologically beneficial, the BBEST does not recommend them as part of the environmental flow regime. Based on its legislative charge, because the BBEST determined that overbank events are necessary to maintain a sound ecological environment, overbank events should be included in the environmental flow regime recommendation. Implementation issues regarding overbank events should be considered by the BBASC and the TCEQ.

Pages 52 and 55: In its hydrologic analyses, the BBEST chose to use the entire period of record for all gages. TPWD staff disagrees with this decision for those locations that are subject to significant regulation by upstream reservoirs or other human impacts. In TPWD staff's experience, it is exceedingly rare to calculate hydrologic statistics across such a significant change in hydrology, as the results generally reflect neither the early record, nor the late record, but rather a hybrid combination of uncertain relevance. For example, at the Bon Wier site, data are available from 1924 to the present. In its statistical analysis of this location, the USGS calculates flow statistics using only data from 1961 to the present[1], recognizing the change in hydrology resulting from the construction of Lake Tawakoni in 1960. Similarly, in their analysis of hydrology at this location, the USGS authors of TX-HAT (a statistical hydrology software package developed under contract with TCEQ) identified a change in hydrology in 1969. TPWD staff believes that a 37 year (1924-1960), relatively homogenous, period of record is more statistically meaningful than a longer period of record which spans two distinct hydrological periods. Where the pre-impoundment period of record is unacceptably short, another option, admittedly not without shortcomings, would be to use the naturalized flows from the WAM distributed to a daily time scale.

Page 55: Many of the hydrologic decisions described on this page are not well explained or documented; this makes it difficult to perform an informed review.

Page 55: In its application of the HEFR algorithm, the BBEST tuned the hydrographic separation routine to place nearly all runoff into the high flow pulse category. This decision is consistent with traditional hydrological principles, where the objective of base flow separation is to distinguish between water sources (i.e., storm-derived runoff versus groundwater-derived base flows). However, the objective of hydrographic separation in the context of environmental flows is different. As discussed in SAC guidance, hydrographic separation in the context of SB 3 should first and foremost distinguish between the ecological functions of flows. In this context, very small runoff events and the extended tails of larger runoff events are appropriately classified as base flows as they provide habitat commensurate with wet conditions rather than the sediment transport, spawning, and riparian functions of high flow pulses. This distinction is not academic. The classification of significant portions of the hydrograph as high flow pulses substantially reduces the base flow recommendations, but it does little to enhance high flow pulse recommendations as only a very limited set of high flow pulses were ultimately promulgated by the BBEST. The end result is a schedule of reduced flow recommendations.

Pages 57-58: Based on an inspection of the available water quality data, the BBEST did not find evidence of repeated water quality violations at low flows. Consequently, the BBEST declined to use the 7Q2 flow as a floor for subsistence flow recommendations. Rather, the BBEST used

[1] http://wdr.water.usgs.gov/wy2008/pdfs/08028500.2008.pdf

the HEFR default parameters, which, in large part because of the hydrographic separation approach taken by the BBEST, results in flows around the 2nd percentile. In some seasons, the hydrographic separation procedure did not identify any subsistence flows, and the BBEST ultimately recommended the minimum flow ever recorded in that season, or the summertime subsistence flow recommendation, whichever was larger. The end result is subsistence flows that are very low and generally represent flows lower than those where water quality data have been collected. These flows have no biological justification and very limited water quality justification. In the context of the BBEST analysis for the Sabine-Neches, TPWD staff supports the use of the 5th percentile of flows for subsistence flows. This statistic, while not based on site-specific data, has been used in several other instream flow studies around the world, including one in Texas, and was endorsed by most members of the BBEST biology committee (as documented in the BBEST biological overlay report, Appendix XIII, for example, Acreman et al., 2006; Hardy et al., 2006).

Page 58: The Sabine Lake inflows section of the report (§5.1.12) is not representative of the final flow recommendations. This section came from the HEFR memo prepared by the BBEST contractors FNI, dated September 17, 2009. Since the time the memo was completed, the BBEST made different decisions related to subsistence flows, high flow pulses, and overbank flow events. Also, the numbers in the memo were developed using total Sabine Lake inflows (as one synthetic inflow dataset). The BBEST opted to promulgate flow recommendations for three riverine locations (Sabine River, Neches River, and Village Creek) only, thereby providing no protection for significant local drainages and lessened protection for Sabine Lake. In short, the HEFR-based flows used for §5.1.12 are more protective and substantially different from those that are actually recommended by the BBEST. These distinctions are undocumented, and this section was not updated. Unfortunately, this section appears to be the basis for the expectation that a sound ecological environment in Sabine Lake would be protected. Because the analysis was performed with flow values that are not recommended, it is impossible to gage the level of protection provided by the actual recommendations. Similarly, the NWF estuarine analysis is used to support the BBEST inflow recommendations, but the BBEST decreased the high flow pulse recommendations after the NWF report was complete. Therefore, the NWF analysis reflects different, and higher, inflows than are actually being recommended by the BBEST. Because of the inconsistencies between early reports that were used to justify protection of a sound ecological environment using specific flow values and the final flow recommendations, it is difficult to gage the efficacy of the final flow recommendations. Indeed, even the somewhat higher inflow recommendations used in the NWF report may arguably predict marsh habitat short of what is necessary to protect a sound ecological environment. The entire estuarine analysis would greatly benefit by being updated with the latest flow recommendations and expanded to better describe the comparison to the state methodology values (e.g., maxC).

Page 73: As indicated on page 73 of the Sabine-Neches BBEST report, the BIO-WEST Estuarine Focal Species Summary Report developed for the Sabine-Neches BBEST identified *Rangia cuneata* as a recommended "focal species." The Sabine-Neches BBEST report subsequently uses *Rangia* as an indicator species, while noting a contrary opinion from Dr. Richard Harrel. In addition, the Trinity-San Jacinto BBEST used *Rangia* as a key indicator species in its construction of recommended freshwater inflow values. TPWD staff agrees that *Rangia* is a useful indicator species for evaluating freshwater inflows due to the larval stage preference for

lower salinity water. TPWD staff recognizes that *Rangia* is an imperfect indicator species, a trait it shares with virtually all other indicator species, and commends the BBEST for its consideration of this estuarine species.

Page 73: *Rangia* habitat is defined by larval stage requirements related to salinity, which is dependent on freshwater inflows, geomorphology, tidal movement, and other factors. As appropriate salinity ranges move upstream, larvae move upstream. Any deepening of the Sabine-Neches Ship Channel will cause changes in salinity patterns in Sabine Lake and force *Rangia* to move farther upstream. Adults are dependent on salinity and temperature changes to trigger spawning, and salinity and temperature also impact shell and gamete growth. In an estuary, salinity and temperature changes occur frequently and the clam devotes more energy to gamete growth and shell growth is reduced. The opposite conditions occur in river populations with more shell growth and less gamete production. TPWD staff believes that the NWF study concepts have merit, but there are still some key biological information missing, e.g., shell age to identify flow conditions during larvae settlement and live versus dead shell from the various habitat areas. In general, the flow recommendations proposed by the BBEST could result in inflows substantially lower than experienced historically and could subsequently tend to increase upstream salinities, with *Rangia* populations moving upstream in a like manner. The proposed deepening and widening of the ship channel might further accentuate *Rangia* movement. A possible end result is that *Rangia* habitat in Sabine Lake would be significantly restricted, compressing their available habitat to the much smaller riverine portions of the estuary.

Page 73: TPWD staff appreciates the efforts expended by NWF and the BBEST to evaluate *Rangia* and other species' habitat suitability under different flows. The wetlands surrounding Sabine Lake are unique to the state of Texas. TPWD staff believes that greater emphasis should be placed on these wetlands in the inflow recommendations. Coastal marshes in the Sabine Lake area are part of the westernmost remnant of the chenier plain. As such, they differ in terms of their geologic origins and ecology from the tidal fringe wetlands which compose the bulk of coastal marshes along the Texas coast. The chenier plains developed under lower salinity conditions and typically have a higher organic content in their soils relative to tidal fringe wetlands situated at similar proximities to marine waters. Salinity intrusion into these wetlands causes a reduction in marsh plant growth and productivity due to the direct negative effects of increased salinity on plant health (Pezeshki et al. 1987, McKee and Mendelssohn 1989, Broome et al. 1995, Ewing et al. 1995). Furthermore, and more significantly, salinity intrusion results in the introduction of sulfate (from seawater) into these wetlands. Under flooded conditions, naturally occurring microbes in the soils use sulfate for respiration and produce sulfide, which can accumulate to the point where it causes impaired plant growth or even death (Allam and Hollis 1972, Bradley and Dunn 1989, Koch and Mendelssohn 1989, Bradley and Morris 1990). The sulfides not only negatively affect marsh plants, but also accelerate the rate of soil organic matter decomposition. Once the highly organic soils and the plants which hold them together have been compromised, these wetlands are easily eroded (Portnoy and Giblin 1997, Sexton 2002). Large scale marsh losses in the region have already occurred due to saltwater intrusion. It is incorrect to assume that wetland systems of the chenier plain will simply convert to a different more salt tolerant marsh type if increasing salinity conditions continue. Rather, the area will either require massive introductions of mineral sediment to offset wetland soil losses already occurring and may result in a different type of wetland more akin to a tidal fringe type marsh

being created, or the areas will continue to break up into open water as has happened in some marshes on the eastern shoreline of Sabine Lake in Louisiana.

TPWD staff believes that these unique characteristics of Sabine Lake wetlands should have been explicitly discussed by the BBEST and should be a focal aspect of the future BBASC/BBEST workplan.

Page 90: The text states that "In many cases, a healthy sediment regime can be associated either with overbank, high-pulse, or even base flows." This sentence also appears in the SAC Sediment Transport guidance document. Texas' rivers have historically experienced a variety of flows, and TPWD staff questions the possibility of a healthy sediment regime if only base flows were to exist in a river that historically had higher flow events.

Page 91: The BBEST employed the U.S. Army Corps of Engineers SAM computer program to evaluate sediment transport. This model, which estimates sediment transport based on river characteristics and specified flows, was used at seven locations to estimate effective discharge and sediment transport under the historical period of record, Water Availability Model (WAM) Run 8 (reflecting current conditions), and WAM Run 3 (reflecting full utilization of existing water rights). Significantly, none of these runs incorporated the proposed environmental flow recommendations. The conclusions state that the high flow pulses and overbank flows proposed by the BBEST "will provide sufficient flow to maintain the existing dynamic equilibrium within these two riverine basins." This conclusion was apparently based on a comparison of the peak flow and duration of HEFR high flow pulse and overbank events to the effective discharge and number of days in the effective discharge bin. TPWD staff has identified several issues that create obstacles to relying upon these analyses and conclusions. The width of the effective discharge bin is unstated, so the number of days in the bin is unknown. In addition, most of the days classified as HEFR high flow pulse and overbank events are well below the peaks of these events, therefore the duration of such events cannot be directly compared to the number of days in the effective discharge bin without performing an analysis of typical event shapes and number of dates within bins. Finally and most importantly, the BBEST did not recommend overbank events. The last sentence of the Geomorphology Overlay document (Appendix XIV of the BBEST report) reads:

> *In making this determination of the continued stability of channels, it is assumed that future permitting activities will protect the High Flow Pulses and Overbank Flows prescribed by the HEFR analysis at each gaging station.*

This key sentence is omitted in the final BBEST report. TPWD staff believes that to support the conclusions of the BBEST, more rigorous comparisons between sediment mobilizing recommended flows and historical flows are necessary, as well as actual recommendations of overbank events.

Page 105: The hydrologic condition is defined by the storage of upstream major reservoirs. It is unclear how the hydrologic condition would be determined for locations at which no upstream reservoirs exist. TPWD staff is not convinced that reservoir storage is the most appropriate metric (see comment above), but, should reservoir storage be used, TPWD staff recommends that

reservoir storage in multiple reservoirs in the same basin, even if located downstream, should be used to define hydrologic conditions. In addition, attainment frequencies for all elements of the recommended flow regime for each location should be specified.

Page 105: It is unclear if diversions are proposed to be constrained solely by the next most downstream flow recommendation location, or all downstream flow recommendation locations. TPWD staff recommends that to protect the sound ecological environment of these basins all downstream flow recommendations should be considered when determining allowable diversions.

Page 106: The implementation rules provide for passage of high flow pulses until the duration or volume recommendation is met. TPWD staff recommends that both duration and volume (which have separate ecological functions) be prescribed as part of the flow regime along with the peak magnitude.

Page 106: In this table, high flow pulse events are triggered when the flow exceeds the high flow pulse magnitude recommendation (Qp). This "definition" is different from how high flow pulses were defined in the hydrographic separation step. In essence, the proposed implementation of high flow pulses follows different rules than were used to statistically define high flow pulse recommendations. Because of this difference, the duration and volume of high flow pulses as defined using MBFIT and HEFR and as recommended by the BBEST will not be statistically the same as the duration and volume of high flow pulses as implemented (i.e., that begin simply when Q>Qp). TPWD staff recommends that high flow pulses be identified identically during implementation as they were during generation of the flow recommendations, i.e., by using the MBFIT hydrographic separation algorithm.

Page 116: The results of the Big Sandy Reservoir illustrative example are used to conclude that "this example suggests that flow regime application in accordance with recommendations presented herein will likely support a sound ecological environment at many locations." However, the Big Sandy Reservoir example includes numerous assumptions related to infrastructure and permitting. As just one example, the "red" line assumes no passage for downstream senior water rights. Also, no metric was proposed or used to assess the separation of the curves in Figure 22 in order to justify the claim of protection of a sound ecological environment. The reader is left with no understanding of the logical construct that led to the stated conclusion. The reader can only speculate how much separation between the curves would have led to the opposite conclusion, that is, that a sound ecological environment would not be expected to be supported.

Given that the goal of SB 3 is to identify flow regimes that protect a sound ecological environment, a determination of environmental protection that is partially dependent upon specific infrastructure assumptions is problematic. While it is unclear what criteria were used to judge the protection of a sound ecological environment, it is clear that this judgment was partially based on one of the assumed Big Sandy Reservoir scenarios. Thus, the protection of the expected sound ecological environment is partially dependent on these assumptions of infrastructure and water rights. This is inconsistent with the SB 3 charge to the BBEST.

Figure 22 of the report has a calculation error. An updated Figure 22 was presented by Sam Vaugh (BBEST member) to the Sabine-Neches BBASC on January 19, 2010. The updated Figure 22 shows a separation between the blue and green lines versus the red and purple lines in the 92nd to 98th percent exceedence range. While this separation appears small at the scale used in the figure, these diversions may be as high as 50% of the flows in the 10-20 cfs range. These low flows are critical to the maintenance of a sound ecological environment and are well within the ability of realistic future infrastructure to control. These predicted differences in low flows could have an important detrimental impact. Unfortunately, due in part to the calculation error, ramifications of the separation in the flow duration curves were not discussed by the BBEST.

These significant unknowns lead TPWD staff to conclude that the Big Sandy Reservoir illustrative example is of very limited usefulness for the main charge of the BBEST, namely the identification of an environmental flow regime to protect a sound ecological environment. Such examples are more useful to implementation deliberations, which are the purview of the BBASC and TCEQ.

Page 118 - 140: HEFR outputs produce flow recommendations with an implied high degree of precision (i.e., a large number of significant digits). Questions have been raised as to whether such precision is necessary for defining environmental flow regimes; TPWD staff does not believe that such precision is expected for regulatory standards. TPWD believes it is reasonable to apply an appropriate rounding method to the HEFR outputs.

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Date: February 5, 2010

To: The Honorable Karen J. Hixon
Executive Director Carter Smith
Deputy Executive Director Ross Melinchuk

From: Ms. Cindy Loeffler
Ms. Colette Barron Bradsby
Mr. John Botros
Mr. David Bradsby
Ms. Lynne Hamlin
Mr. Nathan Kuhn
Dr. Wen Lee
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Ms. Angela Schrift

Re: Texas Parks and Wildlife Department Staff Perspectives on the Trinity-San Jacinto Basin and Bay Area Expert Science Team Report

Senate Bill 3, Article 1 (SB 3), as passed by the 80th Texas Legislature in 2007, created a statewide process for identifying and protecting environmental flow needs. As part of this process, Basin and Bay Area Expert Science Teams (BBESTs) were formed in the Sabine-Neches and Trinity-San Jacinto River Basins. The Trinity-San Jacinto BBEST submitted a final report on December 1, 2009 documenting science-based recommendations for an environmental flow regime for the river and bay systems. SB 3 directs each BBEST to develop an environmental flow regime recommendation:

> *...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.*

Having worked on numerous instream flow and freshwater inflow recommendations over many years, Texas Parks & Wildlife Department (TPWD) staff is familiar with the uncertainty embedded in such efforts, cognizant of the challenges faced by the BBEST, appreciative of the efforts expended by the members, and grateful for the many opportunities to provide input throughout the process. Each BBEST had approximately twelve months and a limited budget for outside services to meet the SB 3 charge. The difficulty of the challenge cannot be overstated and the progress of the BBEST is commendable. It is widely recognized that the science of environmental flows is not an exact one, and the BBESTs did not have the time, data, directive, or budget to perform a definitive analysis. This memorandum contains general comments regarding the Trinity-

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San Jacinto BBEST report and the SB 3 charge to develop an environmental flow regime, and it contains specific comments addressing instream flows and freshwater inflows. More detailed technical comments are provided as an appendix. These comments are intended to assist the Environmental Flows Advisory Group, the Texas Commission on Environmental Quality, and the Basin and Bay Area Stakeholders Committee for the Trinity-San Jacinto River Basin and Bay Systems in reviewing the BBEST recommendations.

General Comments

TPWD staff commends the Trinity - San Jacinto BBEST for its efforts to address the requirements set forth by SB 3. In general (with exceptions described below), the BBEST followed guidance provided by the Texas Environmental Flows Science Advisory Committee (SAC) and addressed the requirements set forth by SB 3. Definitions and discussions of environmental flow regimes and a sound ecological environment from the SAC, the National Academy of Science, and the Texas Instream Flow Program are reasonably consistent and can be used to guide efforts to comply with the requirements of SB 3. The development of an environmental flow regime is a multi-disciplinary process that requires input from a wide range of sciences including biology, geology, ecology, chemistry, hydrology, and engineering. However, the charge to the BBEST is, by its very nature, weighted to an outcome based largely upon ecological considerations. The SB 3 definition of an environmental flow regime requires a 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. As per SB 3, the BBEST environmental flow recommendation is to be made without regard to the need for the water for other uses and must be based solely on the best science available. The SB 3 directive protects the BBEST scientists from having to wrestle with implementation and policy issues in addition to complex and difficult scientific issues. The Trinity-San Jacinto BBEST sections that TPWD staff support did not consider water use and water right implementation issues, with the exception of language tempering overbank event recommendations. TPWD staff appreciates the authors' attentiveness to the specific charges of the BBEST.

The BBEST reached consensus that current conditions in the rivers, streams and associated bays and estuaries of the Trinity-San Jacinto river basins are ecologically sound. As defined in the SAC guidance that the BBEST adopted, a sound ecological environment "sustains the full complement of native species in perpetuity." Unfortunately, some native species (e.g., paddlefish and various mussels) do not appear to be sustainable in these basins. While TPWD does not propose fully restoring natural hydrologic conditions, TPWD does encourage acknowledgment of flow related changes to the ecological condition of river and

bay systems including habitat losses and decreasing viability of certain native species.

Finally, SB 3 provides that, in order to meet environmental flow standards, affected water rights are subject to adjustment of environmental flow permit conditions. This adjustment is capped at a 12.5% increase of the annualized total of water required by the permit for protection of instream flows and freshwater inflows. Because the first promulgated environmental flow standard in a given permit defines the limits of the 12.5% adjustment cap for that permit, TPWD staff believes every effort should be made to identify a complete environmental flow regime for a full basin and bay system to serve as the foundation of the initial flow standard and subsequent permit conditions.

Instream Flow Recommendations

The BBEST did not achieve consensus on instream flow recommendations. Instead, two proposals were developed, with each BBEST member endorsing a single proposal. The dilemma of how to consider competing and disparate recommendations complicates the work of the BBASC and the TCEQ and their attempts to recommend or determine environmental flow standards for the basins.

Science Based Conditional Phased Approach

While TPWD staff understands the rationale provided in this approach, TPWD staff does not support the methodology or recommendations of the Science Based Conditional Phased Approach (Conditional Phased approach).

To summarize, the Conditional Phased approach used the Hydrology-based Environmental Flow Regime application (HEFR), a statistical hydrology software package developed by TPWD and endorsed by the SAC, combined with water quality data and modeling to identify recommended subsistence flows and base flows and associated recommended attainment frequencies. The recommendations were made for four locations in the two basins, two on the main stem of the Trinity River, one on the West Fork San Jacinto River and one on the East Fork San Jacinto River. Along with the limited geographic scope, the recommended flows are very low and based only on a small part of the entire flow spectrum. By making recommendations related only to subsistence and base flows, the Conditional Phased approach produces an incomplete flow regime that does not address the important ecological functions provided by higher flow events. This omission of flow components is also inconsistent with the concept of an environmental flow regime as defined by the SAC, the National Academy of Science, and the Texas Instream Flow Program. The absence of high flows is not reflective of the historical record; for example, at the Trinity River at Oakwood location, measured flows have exceeded the Conditional Phased approach flow

recommendations continuously since 1971. While additional flows are provided as "conditional flows," they are "**not provided as recommendations for instream flow targets**" (emphasis in the original). Overbank events are included in recommendation tables but the authors state that they "do not recommend actions be taken to produce such flows, nor should overbank flows be included as an environmental flow standard or future permit condition." While TPWD does not recommend flooding developed property, there are ecological benefits associated with overbank flows for in-channel and off-channel habitats as well as for riparian areas. TPWD staff believes the Conditional Phased approach falls short of recommending an adequate flow regime, in part because various levels of base flows, any/all potential levels of high flow pulses, and overbank flow events are omitted from the recommendations.

The Conditional Phased approach also provides for flow recommendations at an insufficient number of locations. By providing recommended flows at only two locations in each basin, not enough information is presented to guide decisions related to environmental flows throughout the full basins.

To paraphrase, the authors contend that insufficient data and information are available to defensibly recommend additional flow components (e.g., high flow pulses) at the four locations presented or to develop flow recommendations for additional locations. This raises a fundamental question of where to set the "scientific bar" for flow recommendations in the context of SB 3. The science of environmental flows is not exact. The correlation between flow and the ecological processes of rivers is not fully understood with existing data and scientific knowledge. The legislature passed Senate Bill 2 in 2001 to establish an extensive, multi-year scientific program to study the state's rivers and streams and quantify their instream flow needs. Subsequently, the legislature passed SB 3 in 2007 with specific deadlines to identify environmental flow regimes in advance of the completion of the SB 2 instream flow studies. In a clear recognition that SB 2 study results would not be available in most basins, SB 3 includes a directive to use the "best science available" to develop "environmental flow regime recommendations" and recognizes the lack of perfect science by including specific language describing adaptive management. TPWD staff respectfully agrees with the authors of the second proposal (discussed below) that the "best science available" can reasonably include data and information from other basins, fundamental biological principles, and the combined professional experience and judgment of the identified experts in the field (viz., the BBEST members). Thus, TPWD staff believes that a full flow regime can be reasonably specified by the BBEST using the best science available.

Science Based Environmental Flow Regime for the Trinity River, San Jacinto River, and Galveston Bay

This approach was endorsed by a majority of BBEST members. TPWD staff supports the Science Based Environmental Flow Regime approach (Flow Regime approach), with some reservations.

In the Flow Regime approach, the authors used HEFR combined with water quality, geomorphology, and biological information to recommend subsistence flows, three levels of base flows, and three levels of high flow pulses. The recommendations also include associated attainment frequencies. While the available information does not provide definitive flow-ecology relationships, the authors believe, and TPWD staff concurs, that existing information, including professional judgment where appropriate, is sufficient to meet the charge of SB 3 to use the "best science available."

Similar to the authors of the Conditional Phased approach, the authors of this section recognize the ecological benefits of overbank flow events yet state that "The BBEST does not, however, recommend that any action be taken to create or enhance overbank flows rather that future projects that may alter these events carefully consider the ecological health of the river." Based on its legislative charge, since the flow regime approach authors recognized that overbank flow events are required to maintain a sound ecological environment, overbank flow events should have been included in this science-based environmental flow regime recommendation, without implementation related caveats. SB 3 intended the BBASC and TCEQ to consider policy and implementation issues related to ecologically-important overbank flow events rather than the BBEST.

Both instream flow approaches used the "early period of record" for hydrologic analyses. As a consequence, flow recommendations are essentially based on an ecosystem that arguably no longer exists. Additionally, the flow recommendations are not necessarily consistent with the existing sound ecological environment that the BBEST identified as the goal of the flow regime recommendations. TPWD staff appreciates the ecological challenge posed by anthropogenic modifications to the natural flow regime (not least of which are significant return flows) as well as the need to make reasonable decisions quickly. For the gages used in both instream flow approaches, TPWD staff believes that this decision was reasonable and justified because current conditions are reasonably similar to the early record period. Additionally, the recommendations are consistent with the natural flow regime. However, it should be noted that choosing the period of record is a subjective and site-specific exercise; in other locations and basins, particularly those less impacted by human development, the early period of record may not be the best choice. Such decisions should be carefully considered on a case by case basis. TPWD staff suggests the TCEQ,

BBASCs, and future BBESTs discuss any potential incongruities posed by the combination of a contemporary sound ecological environment and flow recommendations based on an early period of record.

Although TPWD staff generally supports the approach taken in this section, the authors did not provide flow recommendations in tributaries. TPWD staff believes that tributaries are an integral part of a river basin, and they deserve and require environmental flow protection.

The recommendations proposed in both the Conditional Phased and Flow Regime methods are consistent in one important, conceptual, sense: they both recommend flow magnitudes and associated attainment frequencies, without any implementation factors suggested or required. TPWD staff believes that this approach is the most protective, straightforward, and appropriate approach in the context of the SB 3 charge. TPWD staff favors this approach over that taken by the Sabine-Neches BBEST, which requires numerous implementation assumptions and factors.

TPWD staff also notes that in the Trinity-San Jacinto framework, the concepts of wet, average, and dry are a lexical convenience to describe the 75^{th}, 50^{th}, and 25^{th} percentiles. The identification and use of wet, average, and dry hydrologic conditions is not necessary for determining an environmental flow regime in this conceptual model. In this context, wet, average, and dry hydrologic conditions could be regulatory triggers that may be developed later to implement environmental flow protection requirements in a particular water right.

Freshwater Inflow Recommendations

The BBEST did not achieve consensus on freshwater inflow recommendations for Galveston Bay. A majority of members endorsed an approach that was initially supported by a larger majority of members. A minority of members proposed an alternative approach that can be found in the comments section of the report. The minority alternative approach was not presented for discussion or consideration by the full BBEST.

Freshwater Inflow Recommendations for Galveston Bay

To summarize, this set of recommendations is based on a salinity zonation approach suggested by the SAC in its freshwater inflow regime guidance document. The approach uses the existing TXBLEND hydrodynamic-salinity model to estimate the acreage of suitable habitat of various species under different inflow volumes. In this context, suitable habitat (location and salinity niches of indicator species) was defined through a series of workshops that included numerous estuarine experts, including several TPWD staff. Based on statistical

regressions of TXBLEND model outputs, monthly flow volumes that were confidently expected to provide more than zero acres of suitable habitat for selected indicator species were set as flow recommendations.

TPWD staff sees merit in this approach and believes that the authors made significant progress. However, the final result is incomplete. Freshwater inflow requirements are not specified throughout the year. Key habitats are addressed by recommended flows only in some months, of some seasons, of some years. "Off" months, seasons, and years are provided no recommendations, implying that zero inflows in those periods would support a sound ecological environment. The high frequency of off months, seasons, and years may undermine the ability of the recommended flow regime, on the whole, to maintain a sound ecological environment.

Consolidated Comments on Freshwater Inflow Recommendations for Galveston Bay

In their consolidated comments on the above freshwater inflow approach, six BBEST members proposed an alternative approach. The alternative approach is identical to an approach previously proposed by the Galveston Bay Freshwater Inflows Group (GBFIG) and used in certain analyses by the Region H Regional Water Planning Group. In this approach, annual inflow volume recommendations based on the methodology developed jointly by TCEQ, TWDB, and TPWD in the early 1990s (Longley et al., 1994, "State Methodology") are recommended to occur in the future at frequencies less than historic. These recommended frequencies were identified through a stakeholder process, not a strictly science-based process.

An easily overlooked but key consideration in the use of State Methodology derived freshwater inflow volumes is the monthly pattern of flows. The proposal in these consolidated comments is to use annualized flow values based on the State Methodology. This is inconsistent with the basis of the State Methodology, which requires monthly patterns. The annual flow value is not a complete and effective surrogate for the pattern and distribution of monthly flows.

While TPWD staff was instrumental in developing the State Methodology, staff cannot endorse its use as described herein since it does not explicitly include monthly or seasonal freshwater inflow quantities.

TPWD Suggestion to Reconcile Freshwater Inflow Approaches

Both freshwater inflow approaches have strengths and weaknesses. TPWD staff believes that a combination using the strengths of these approaches could provide a viable inflow regime. The specific flow targets identified in the Inflow

Recommendation (i.e., the months, seasons, and years where flows are specified) could be carried forward in conjunction with annual and monthly flow recommendations of the State Methodology with the GBFIG frequencies. This would provide some level of protection in the months, seasons, and years where the Inflow Recommendation is silent. For months where there is overlap between the methods, the Inflow Recommendations could be used.

Concluding Comments

The BBEST report is silent with regard to potential differences between instream flow recommendations at downstream locations in the basins and freshwater inflow recommendations to Galveston Bay. The SAC considered this issue in its Freshwater Inflow Regime guidance document and concluded that "it would seem that the logical process for resolving inconsistencies in the flow requirements operationally would be to err on the conservative side by always implementing the more restrictive of the two." In other words, they recommend picking the larger of the two flow recommendations. The SAC then noted that modifications to this default procedure "should be addressed on a case by case basis." TPWD staff concurs that, barring specific information to the contrary, the appropriate procedure would be to apply the more protective flow recommendation.

Appendix of Detailed Comments (listed by page number)

Comments on the Conditional Phased Approach

Page 13: In the description of the Conditional Phased Approach, the text states, "The other three Recommended Stations were selected on the basis of there being adequate hydrological periods of record and the need to provide coverage for aiding the TCEQ in the permitting process." In essence, it appears the authors of this approach provided flow recommendations based on a perceived need to do so for TCEQ. They chose three locations, without a clear discussion of why these three are suitable and sufficient.

Page 13: Recognizing that their approach does not provide a definitive answer, the authors propose a suite of alternatives. Adaptive management, which is specifically provided for in SB 3, is proposed as a means to establish additional flow recommendations in the future. A problem with this approach is that the upper limit on adjustments to the amount of water available to meet environmental flow needs in permits authorized post-SB 3 is 12.5%. Given a low environmental flow volume to work from (i.e., subsistence and very low base flows only), it will be impossible to add meaningful higher flow recommendations at a later date. The authors also suggest: (1) monitoring (for which currently no funds exist), (2) permit specific analyses and site specific studies (which SB 3 recognized as likely unavailable), and (3) using drainage area adjustments (which, because of their coarse nature, are justified only when other, superior, data sources do not exist). All of these proposals serve to postpone decisions to a later time. TPWD staff believes that while a definitive answer will remain elusive, SB 3 explicitly acknowledges the need to make the best possible decisions now, rather than later, on protecting a full environmental flow regime. Indeed, the recognition that site-specific studies (as in those prescribed by SB 2) are multi-year, expensive, resource intensive endeavors played a role in the legislative decision to require flow regime recommendations quickly without the great delay and funding uncertainties that would be caused by mandating that flow decisions be postponed until site specific studies are completed. In passing SB 3, the legislature decided to set aggressive timelines for the adoption of environmental flow standards well in advance of the projected completion of the data intensive SB 2 Texas Instream Flow Program studies.

Page 23: Table 2 of this section of the report presents some basic biological assessment methodologies (from holistic to specific) identified by the National Research Council of the National Academy of Sciences. TPWD does not agree with the assertion made by the authors of the Conditional Phased approach that "any BBEST approach would likely fall on the far left of table" making it unusable as "best available science". It is TPWD staff's opinion that the authors discounted much of the best available science that was presented, especially in regard to biology. Dr. Guillen's (BBEST member) sub-contracted work included

habitat guilds and species habitat suitability criteria information that the group could have used. This type of information falls in the middle of the continuum presented in Table 2, thereby making it highly applicable for use in the SB3 process to formulate environmental flow regime recommendations.

Page 24: The text states

> *While it is feasible that flow recommendations developed by the BBEST as hypotheses could be experimentally tested through adaptive management, the BBEST maintains that such recommendations should be used solely as a means of validation through comparison with scientifically derived data that can be shown to support a sound ecological environment in the future.*

This approach seems misguided as SB 3 does not require or suggest that flow recommendations could or would be exactly replicated in the rivers, thereby allowing the flow conditions to be experimentally tested or validated. Rather, realistic predictions of future infrastructure and the exercise of existing water rights indicate that the state will not be able to control or affect many sections of rivers to such a prescribed extent, even if the desire existed. TPWD staff disagrees that the logical conclusion of the lack of ability to test flow regimes is to recommend little or no flows. TPWD staff believes that flow regimes can be developed and justified using the "best available science" obtained from reasonably similar systems and biological assemblages, including the professional judgment of experts with decades of experience in this topic.

Page 25: The first paragraph on this page contends that there is "insufficient information in the Trinity River Basin to perform a sound scientific assessment of flow regime impacts on aquatic life..." This statement is a professional opinion, with which TPWD staff respectfully disagrees. The paragraph then states that the Conditional Phased approach will use "what science is available to reach sound conclusions..." However, on page 31, the recommendations for the East and West Forks of the San Jacinto River are stated to be based on hydrology alone. It is unclear why hydrology alone was deemed sufficient to make flow recommendations at some locations, but not others, and why some stations were deemed to have sufficient information to be "conditional instream flow locations" but not sites for recommended flows.

Page 26: The text states that "These reference locations [i.e., recommended and conditional instream flow locations in Table 3] are, among other things, representative of major streams above and below existing reservoirs as well as tributary streams in the upper and lower portions of each river basin." This conclusion is an overstatement, as there are only four locations in the Trinity basin, all of which are on the main stem of the Trinity River. Additionally, the West Fork and Dallas sites are presented as conditional flows, rather than recommended flows (and therefore provide no environmental protection), and

there are only two locations in the San Jacinto Basin, one each on the West and East forks. This limited list does not represent both the upper and lower San Jacinto basin, and includes locations "above and below existing reservoirs" only in the general sense that any location can be described as above or below a reservoir. Also excluded are tributaries that require and deserve protection.

TPWD staff believes that this limited geographic scope is insufficient to describe an environmental flow regime for two full river basins. The text implicitly agrees, as subsequent sentences in the same paragraph describe a method for "interpolation of flow conditions applicable to future permits..." This interpolation, if used, would ignore the valuable hydrologic, biologic, and other real data at locations in favor of an interpolation based on drainage areas and largely unquantifiable factors such as channel losses and recharge zones. It is not clear why such interpolation is superior to using actual (albeit always limited) site-specific data. It is also not clear how this interpolation would be performed in the San Jacinto basin (where only one gage in each fork is listed in Table 3), or in tributaries in the Trinity basin, or at main stem locations in the Trinity basin upstream (or downstream) of all of the locations listed in Table 3. The text states that "a similar recommendation has been proffered by the Sabine-Neches BBEST." While this is factually true, there is an important distinction – the Sabine-Neches BBEST quantified a recommended flow regime at twelve locations, whereas the authors of the Conditional Phased approach include only four "recommended" locations. The interpolation suggested by the Sabine-Neches BBEST is intended for locations where hydrologic and other data are unavailable, whereas the Conditional Phased approach authors recommend interpolation even at locations where significant hydrologic and other data are available. TPWD staff believes that the available data should be used to its fullest extent and interpolation should be used only if site-specific data are clearly inadequate.

Page 27: The text states "There are four flow monitoring stations within this [mid-Trinity] reach, and hydrologic characteristics that support a sound ecological environment are very similar at each of these sites. The hydrology of all four stations is very similar and the available geomorphologic, water quality, and biologic information also indicates no differentiation between them." TPWD staff could not find documentation or analysis supporting these conclusions.

Page 27: The authors state that the four mid-Trinity flow gages are similar and thus only propose a flow recommendation at Oakwood. If the four locations are indeed similar, then the flow recommendation should be applied at the most downstream location where it is applicable (presumably Trinidad). Establishing the flow regime only at Oakwood provides no protection downstream of Oakwood, despite the stated similarity of the locations.

Page 27: The text states that MBFIT and IHA were used to separate the hydrograph into "base flow and runoff components." The text goes on to state

that "the amounts resulting from the MBFIT analyses and the IHA analyses are arbitrary in nature..." These statements, and the decisions made during the implementation of the MBFIT hydrographic separation, indicate that the authors have approached this task from more of a traditional, engineering/hydrology mindset than with a focus on the ecological goals of SB 3. As stated in the SAC Hydrologic Methods document, in the context of hydrographic separation to support environmental flows analyses, the source of water (e.g., runoff) is unimportant – it is the ecological function (or ecological role) of the water that is paramount. While site-specific data quantifying these ecological functions throughout the Trinity and San Jacinto basins are admittedly scarce, decisions related to hydrographic separation are not arbitrary, and certainly not "arbitrary in nature." These statements highlight two fundamental perspectives of the Conditional Phased Approach: (1) the task of identifying environmental flows should follow a traditional engineering and hydrology conceptual model, and (2) sufficient data and expertise is unavailable to make informed and reasonable decisions with respect to the range of natural variability that the vast majority of instream flow scientists support. The first perspective seems misguided, as SB 3 is clearly an environmental flows effort, and traditional engineering concepts of baseflow separation are not identical to hydrographic separation for identifying environmental flows. The second perspective is an opinion with which TPWD staff respectfully disagrees. TPWD staff believes that existing data and information are available to meet the objectives of SB 3.

Page 28: The text mentions a QUALTX model run in support of HEFR-generated subsistence flows but provides no information regarding the model run. This model run is seemingly the primary non-hydrological support for the proposed flow matrix at Oakwood. Without clear documentation, support for the conclusions of this proposal is diminished.

Page 28: The text states that "The possibility of having separate flow recommendations for "wet," "dry," and "average" conditions has been considered. While such conditions may exist, there has been no practical definition of these conditions other than some arbitrary statistical percentiles." The proposal then goes on to recommend a specific percentile for base flows (25^{th} percentile). The text does not provide support for why the 25^{th} percentile is deemed defensible, while other percentiles or conditions are described as arbitrary.

Page 29: When referring to the flow recommendation at Oakwood, the text lists four sources for the best available science: "extensive flow data, a significant amount of dissolved oxygen data, fishery conditions relative to dissolved oxygen conditions, and a calibrated QUALTX water quality model for the assessment of dissolved oxygen." Taking the four datasets listed in turn:

1. Extensive flow data: TPWD staff agrees that extensive flow data do exist at Oakwood, as they do at numerous other locations in the Trinity and San Jacinto basins and have been documented by the BBEST.

2. A significant amount of dissolved oxygen data: TPWD staff agrees that these data exist, but disagrees that they are relevant. The only analysis and discussion of dissolved oxygen data in the report is on pages 27 and 28. This analysis is qualitative ("dissolved oxygen conditions ....have been maintained at higher levels due to the improvements in discharge quality") and, more importantly, relates only to historical improvements in wastewater discharges. The report does not document contemporary relationships between flow and dissolved oxygen, which presumably would be the only dissolved oxygen relationship relevant to flow recommendations.

3. Fishery conditions relative to dissolved oxygen conditions: Again, TPWD staff does not believe that these data are relevant to the BBEST's task. This description of fishery conditions appears to refer to the qualitative relationship between historical dissolved oxygen levels and fish species discussed on page 28. These data largely reflect improvements in water quality due to significantly improved treatment of wastewater. TPWD staff cannot find support for the linkage of this relationship to the assignment of flow recommendations.

4. A calibrated QUALTX water quality model for the assessment of dissolved oxygen: As discussed above, the QUALTX model application to subsistence flows is undocumented. Because of this lack of documentation, the reader cannot judge if the model parameterization and calibration is appropriate for evaluating subsistence flows.

The authors of the Conditional Phased approach use the general lack of data at other locations related to items 2-4 above as rationalization for not assigning flow recommendations at these other locations. TPWD staff sees nothing unique or necessary in the data and information discussed in items 2-4. TPWD staff believes that other locations have data and information commensurate with Oakwood equally amenable to the development of instream flow regime recommendations.

Page 29: To put the proposed flow recommendations in context, TPWD staff downloaded the entire period of record of flow data at the Trinity River at Oakwood gage (one of the four locations with recommended flows proposed in this approach). Table 1 shows the seasons, flow recommendations, and last date at which a flow equal to or lower than the recommendation (in the given season) was recorded.

	Winter	Spring	Summer	Fall
Subsistence flow recommendation (cfs)	98	80	75	85
Last date observed	never	6/30/1925	9/11/1936	10/16/1956
Base flow recommendation (cfs)	265	322	186	162
Last date observed	1/23/1957	6/18/1971	9/30/1956	12/18/1956

Table 1. Summary of Conditional Phased Approach Flow Recommendations and Data at Oakwood.

This table shows that the flow recommendations at Oakwood are less than the lowest flows observed in the last several decades. A similar analysis for the other three gages was not performed, but the results can be expected to be similar based on the consistency of the method used to derive the flow recommendations at the four locations and the increasing volumes of returns flows at these locations. While this simple analysis does not invalidate the protection of a sound ecological environment that is proposed by this approach, it does provide some context for the recommendations.

Page 29: The text states that "lacking specific ecological data, only conditional flow amounts can be arbitrarily identified as a likely representation of high flow pulses." It is unclear what basis the authors rely upon to separate "arbitrary" flows from recommended flows. The ecological justification for the authors' assigned subsistence flows (median of bottom 10% of base flows) and base flows (25^{th} percentile of base flows) is primarily based on dissolved oxygen information that is largely irrelevant (historical dissolved oxygen relationships that are not relevant under contemporary wastewater discharge values) or undocumented (the application of QUALTX). TPWD staff contends that additional information, including professional judgment by environmental flow practitioners, is available and can be reasonably used to define high flow pulses within the context of SB 3.

Page 29: HEFR outputs produce flow recommendations with an implied high degree of precision (i.e., a large number of significant digits). Questions have been raised as to whether such precision is necessary for defining environmental flow regimes; TPWD staff does not believe that such precision is expected for regulatory standards. TPWD believes it is reasonable to apply an appropriate rounding method to the HEFR outputs.

Page 29: The text states that "No information can be brought to bear to identify what specific magnitudes of flow are necessary to support a sound ecological environment within the lower portion of the Trinity watershed." The Clean Rivers Program (the primary source of dissolved oxygen data in Texas) has stations throughout the Trinity basin. Thus, it appears that the only data that the authors used in the mid-basin that are lacking in the lower basin are the QUALTX results. QUALTX is a one-dimensional, steady-state model that has been

calibrated and used specifically for waste load allocations and Texas Pollutant Discharge Elimination System (TPDES) permitting. It appears that the presence of this model is considered the scientific bar to recommend a flow regime. This consideration is also at odds with the authors' finding that upstream segments, *with* QUALTX models, did *not* merit "recommended" instream flows. The text also notes, "However, in recognition of the importance of the lower Trinity basin, a characterization of similar flow components are provided as an instream flow recommendation for the Trinity River at Romayor..." The particular importance of the Romayor site is unclear. Again, TPWD staff is concerned about the limited geographic scope of the Conditional Phased approach and does not see a clear explanation of why some locations merited flow recommendations and others did not.

Page 29: The MBFIT and HEFR parameters used to develop flow recommendations in the Conditional Phased approach are not documented. Justification for the assignment periods (seasons) shown in these figures is not provided, and thus, an informed review cannot be made of the merits of these recommendations.

Page 30: The authors recommend a flow regime at two locations in the San Jacinto basin "based solely on historical hydrology." The text explains the relevance of these two stations, but there is no explanation for why additional stations were not selected. There are several others in the basin that have long hydrologic periods of record and could be justified as relevant.

Page 33: Water rights granted following the passage of SB 3 are subject to a maximum increase in water for environmental flow needs of 12.5%. The discussion on page 33 suggests that additional flow components or prescriptions could be added to future permits if they have been "justified scientifically (i.e. with data that can demonstrate a justifiable need for a magnitude, frequency, and/or duration of flow to support the ecology of the system)..." However, elsewhere in the document, the authors reject the utility of transferring information gleaned at one location to another. This approach would wait to add flow components or identify additional flow needs until after a permit has been issued and only upon a demonstration that the desired ecology is not supported at a location affected by that permit. In that instance, the ability to add environmental flows would be constrained by the 12.5% adjustment cap; it is foreseeable that the cap may prevent the recovery of the desired ecology. TPWD staff believes that this is inconsistent with the plain language and intent of SB 3. Because the first promulgated environmental flow standard sets the limits of the 12.5% adjustment cap, every effort should be made to develop a complete environmental flow regime for a full basin and bay system as the foundation to support the initial flow standard.

Page 35, Tables 9-14: These tables include a frequency of occurrence of high flow pulses but no description of how these frequencies should be interpreted. For

example, Table 13 has a Dec-Feb high flow pulse of 392 cfs occurring 89% of the time (over 30 years), but a base flow of 45 cfs occurring only 85% of the time over 30 years. This suggests that the 392 cfs is an expected peak flow, with the majority of days within pulse events having much less than this flow. Since the exceedence frequency of the high flow pulse is higher than the exceedence frequency of the 45 cfs base flow, some of the high flow pulse days are actually lower than the base flow. The correct interpretation of these values should be clearly explained. Furthermore, TPWD staff believe that significant questions and complexities arise when riverine management is expected to be based on episodic events (high flow pulses) 89% of the time. This high frequency of high flow pulses is largely based on a philosophy of hydrographic separation not supported by TPWD staff (see comments elsewhere in this letter).

Comments on the Flow Regime Approach

Page 41: The dry, average, and wet ecological base flows are described as occurring during dry, average, and wet years (or periods). However, in section §2.2.8.3 (page 99) the dry, average, and wet base flow frequency targets are proposed to be achieved over a long period of record, presumably with more dry-sized flows in dry years, and wet-sized flows in wet years, but not prohibiting the possibility of some wet-sized flows in dry years and vice versa. In this interpretation, periods of base flows between storm events could transition from wet levels, to average, to dry, thereby providing a range of habitats and environmental conditions, without prescribing only wet base flows during wet years, only average flows during average years, etc. TPWD staff recommends that the authors' desired interpretation of these flow recommendations be more clearly explained. TPWD staff further suggests that the second interpretation (page 99) is more protective and practicable than the first.

Page 50: TPWD staff appreciates and agrees with this discussion of "best available science."

Page 69: The text refers to water quality modeling performed by Alan Plummer and Associates and indicates that "water quality criteria for dissolved oxygen would be met at the identified subsistence flows." As noted previously, the water quality modeling referred to here is undocumented in the report which makes it difficult to verify this statement.

Page 99: The text states that "The 5th percentile flow at Dallas and Carrolton, based on the pre-impact flow record are often zero. Professional judgment suggests that zero flow is unlikely to maintain objectives of subsistence level flows at these locations, therefore the subsistence recommendations at these sites were replaced by the 5th percentile flows at the Grande Prairie site." TPWD staff agrees that a flow of zero does not, on its own, provide habitat objectives; however, intermittent and ephemeral streams are common in Texas and should be acknowledged in flow recommendations. TPWD staff believes that the key

element is the frequency of occurrence of zero flows and that recommendations should not increase the frequency of zero flows beyond what will continue to support a sound ecological environment. TPWD staff questions the replacement of zero flows at one location with non-zero flows calculated at another location without documented professional justification.

Page 114: Similar to the analysis above, an examination of the historical flow record at Oakwood was carried out by TPWD staff to evaluate the flow recommendations in the context of contemporary hydrology. As shown in Table 2, all of the subsistence and dry base flows, as well as the winter, summer, and fall average base flows, have not been observed for many years. The spring average base flow and the wet base flows have been observed in the recent past. Based on this simple analysis, the subsistence, dry base, and average base flow recommendations will have little relevance to contemporary water management, but the wet base flow recommendations will have some relevance. Realistically, these wet base flow recommendations would apply during wet conditions when the flows in the river most likely greatly exceed the recommendations. With that caveat and combined with the high flow pulse recommendations, the Flow Regime approach does provide some flow recommendations that are in the range of observed flows. This analysis does not presume to judge the biological efficacy of the flow recommendations but is merely used to put the flow recommendations in the context of the current state of streamflow in the basin.

	Winter	**Spring**	**Summer**	**Fall**
Subsistence flow recommendation (cfs)	196	280	70	101
Last date observed	12/21/1956	6/30/1956	9/11/1936	11/1/1956
Dry base flow recommendation (cfs)	340	458	257	265
Last date observed	1/30/1964	6/30/1978	9/2/1967	11/19/1963
Average base flow recommendation (cfs)	623	820	411	439
Last date observed	12/5/1980	3/10/2009	9/26/1980	10/24/1978
Wet base flow recommendation (cfs)	1110	1398	682	819
Last date observed	2/28/2009	6/30/2009	8/25/2006	11/8/2008

Table 2. Summary of the Flow Regime Approach Recommendations and Data at Oakwood.

While TPWD staff generally supports the approach taken in this section, the authors' decision to limit flow regime locations to the main stems of the Trinity and San Jacinto rivers is insufficient to address and protect the full river basins. This decision may have been a purely practical one based on schedules, resources, and funding. Regardless, tributaries deserve and require protection, and the methodologies should be extended to tributary locations.

Page 122: In the BBEST report, flow recommendations are associated with specific flow gages but are considered to be applicable to a relatively homogeneous segment or reach. Thus, future permitted diversions that exceed the flow recommendations and are located immediately downstream of the USGS flow gage would not be consistent with the textual recommendations and interpretation, even though they might be consistent with a strict interpretation of the flow regime matrices. This issue is particularly relevant when applying flow recommendations in the Water Availability Model. TPWD believes that instream flow regime recommendations should apply to identified stream reaches rather than strictly to the location of the USGS gage used to develop the recommendation.

Comments on the Freshwater Inflows Approach

Page 128: Due to incomplete documentation TPWD staff cannot make a fully informed review of the approach.

Page 130: The text states that "The committee discussed the weakness of the flow – salinity – ecology relationships when compared to flow – nutrients – ecology relationships, but determined that there is sufficient flow-salinity data and insufficient flow-nutrient data for our purposes. Nutrients in various forms have a more direct impact on the abundance of estuarine species than salinity." TPWD staff is unconvinced that relationships using salinity are inherently weaker than relationships using nutrients, in part because, as the first sentence states, relationships using nutrients are impossible to corroborate at the field scale in Texas due to a lack of data. Furthermore, while it is intuitive that nutrients play a key role in ecosystems, even if an optimal nutrient loading to support a sound ecological environment for Galveston Bay could be determined, it would not provide a basis upon which appropriate freshwater inflows could be defined.

Page 140: The text states that "Using the methods described above, the BBEST has arrived at a set of recommended freshwater inflow values." However, the "methods described above" simply describe how flows can be correlated to acreage of habitat for various species. No information is provided regarding how the final species were selected for each month, nor was information provided regarding potential habitat tradeoffs between species.

Page 140: No information is provided to explain the seasonal assignments (winter is December, January, and February, etc.). The salinity zonation method, as used by the authors, is highly dependent on wild celery (a perennial plant with highly seasonal growth patterns), *Rangia* (which spawn in the spring and sometimes fall), and incidents of dermo infestations (which are highly influenced by temperature). Thus, it is apparent that seasonality is important to all of these species and consequently important to the method.

Page 141: The life-cycle requirements of wild celery are stated without citations. It is unclear from the text whether these are based on professional judgment of the attendees of the workshops or other sources.

Page 143: Given the challenges faced by the BBEST, it is entirely appropriate that the freshwater inflow method would be significantly shaped by professional judgment. In this instance, the use of regression equations does not appear to have an advantage over professional judgment. The regressions provide a poor fit. For the most part, the quadratic equations fit the data poorly. The logistic equations often fit the data better (which is why they were used), but the confidence limits are largely unrealistic. For example, in Figure 37, at a flow above 0.5M ac-ft/mo, the data (i.e., TXBLEND model output) are constant at about 1300 hectares (this is the physical maximum of the area defined in Figure 31). Notably, the lower confidence limit is just above 800 hectares (i.e., well below all of the data in that range of flows) and the upper confidence limit (1700 hectares and higher) well exceeds the physical maximum of the data. It is questionable as to whether the regression adds useful information. This issue is not irrelevant, as the point where the lower confidence bound diverges from the x axis (i.e., is associated with a non-zero acreage on the y axis) is frequently used as the inflow recommendation. That places an enormous importance on a seemingly poorly behaved regression. While TPWD staff understands the desire to have quantitative, reproducible methods, this seems to be a case where well-documented professional judgment would be superior to the presented statistical methods.

Page 145: The text explains that while the flow recommendation based on *Vallisneria* is likely to not be protective of *Rangia*, the *Vallisneria* flow recommendation is used regardless. Based upon the BBEST work, the *Vallisneria* flow recommendation would provide zero habitat for *Rangia*. The justification stated is that, "the *Vallisneria* indicator is so intimately associated with the flow of the Trinity River." In essence, this is an example where two different species suggest different minimum flow levels that provide non-zero habitat, and the decision was not to go with the larger value (which would have provided habitat for both species) but to go with the species geographically located nearest the mouth of the river. TPWD staff believes the focal species needs, rather than geographic proximity, should be the driving force behind freshwater inflow recommendations intended to protect a sound ecological environment throughout the estuary.

Page 146: The Trinity River flow recommendations are based on *Vallisneria* (as is stated in the first sentence of §3.1). There are several other species in Table 33 whose relationship to Trinity River flows are not documented in the report. TPWD staff understands from presentations by the BBEST that some of these species were investigated and judged to be protected at the *Vallisneria*-derived flows; these additional analyses would assist in understanding the recommendations.

Page 146: The lack of a Trinity River inflow recommendation for winter is problematic as it hinders the development of a full environmental flow regime. Also, the lack of recommendations in off-months and off-years means that the inflow recommendation in Table 34 covers less than half of all possible months, providing no recommendation in the remaining months. TPWD staff questions whether a flow regime is complete or can be successful in protecting a sound ecological environment if no protection is provided more than half of the time.

Page 146: Documentation or justification is not provided for the decision to round down the historical "annual occurrence" to the recommended annual frequency. To support a conclusion that a flow frequency less than historic can still be protective of the environment, a clear explanation of how recommended annual frequencies are derived and calculated is necessary.

Page 146: The 6% adjustment is inappropriate, as has been recognized by numerous reviewers, including the lead author on page 208 of the report and in oral statements made at the January 13, 2010 SAC meeting. The freshwater inflow recommendations are based on biological needs, not historical hydrology. The flows that create suitable conditions (e.g., less than 10 ppt for *Vallisneria*) should not be decremented simply because they occurred slightly less frequently in the early period of record.

Page 148: Figure 41 only has six data points, indicating that the antecedent (i.e., summer) condition of "suitable" is relatively rare. TPWD staff suggests that the much more common antecedent condition of "salty" should be used to develop fall flow conditions suitable for *Rangia*.

Page 149: Market oysters take about three years to grow (Kraueter et al., 2007). TPWD staff is concerned that protection once every five years is insufficient to maintain healthy populations of this important organism.

Comments on the Comments Section of the BBEST Report

Page 164: In the consolidated comments related to instream flow recommendations endorsed by Espey et al., the text states "Without specific biological function data, these flow criteria are arbitrary and can be defined by any user based on their preference anywhere in the State and therefore, negate the importance of developing river basin based knowledge (BBEST)." TPWD staff respectfully disagrees with these conclusions. SB 3 was passed by the Texas legislature with full knowledge that significant data connecting instream flows to ecological function do not exist in most river segments in Texas. SB 3 includes aggressive timelines, limited budgets, and expressly charges the BBESTs to use the "best science available." It is clear that the legislature intended the BBEST (as a panel of expert scientists) to use available information to define a flow regime. Decisions by the BBEST using professional judgment are not arbitrary,

nor can they be automatically negated by "any user." The BBEST, by design, has significant expertise that other groups ("any user") do not have.

Page 191: The text states that the historical frequencies in the Freshwater Inflow Recommendations (Tables 34, 35, and 36) are incorrect. Should TCEQ adopt any of these flow values, TPWD staff encourages that all calculations be double-checked.

Page 193: The text states "Hence, it should be noted that a recommended attainment frequency associated with each seasonal freshwater inflow value would certainly be less than that based on the historical frequency of occurrence shown in Table 3." TPWD staff is unclear why this is so. It is understood that existing permits (which were not fully exercised historically) may cause reductions in the future frequency of recommended flows. However, recommended attainment frequencies to support a sound ecological environment are based on science rather than permitting. These scientifically-based recommended frequencies could be less than, equal to, or greater than historical frequencies, based on the best available science and judgment of the BBEST.

Page 195: With respect to freshwater inflows, the text states

> *Texas Parks and Wildlife Department has Recommended 5.2 million acre-feet per year as the freshwater inflow needed to achieve maximum productivity of the bay. GBFIG has recommended a schedule of targets, show in Table 4, which includes meeting the maximum productivity target in at least 50% of futre years.*

To clarify, the 5.2 million acre-feet is an annualization of a monthly schedule of flows (MaxH) that is expected to provide maximum productivity within numerous constraints on flows, balance of species, etc. MaxH is not a universal maximum, it is a constrained maximum. In addition, the constrained maximum productivity is based on the monthly schedule of flows, not the annualized value. Thus, the GBFIG recommendation, and, by extension, the recommendation proposed in the consolidated comments by Espey et al., does not meet the maximum productivity target in at least 50% of future years; it simply meets the annualized value of 5.2 million acre-feet in at least 50% of future years. There is no supporting information (whether provided by TPWD, TWDB, GBFIG or others) in the consolidated comments regarding the level of protection provided by an annualized flow of 5.2 million acre-feet.