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Implementing SB 3: Adopting Environmental Flows in Texas

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Introduction

Senate Bill 3 emerged from the Texas Legislature in 2007 as an attempt to create certainty over how the state deals with allocating water to environmental flows. [1] Senate Bill 3 created a process in the Water Code requiring regional stakeholder groups (referred to as Basin and Bay Area Stakeholder Committees or BBASCs) to develop consensus-based environmental flow standards and strategies to meet the environmental flow standards specific to the rivers and bay systems in a particular region.[2] The concept of "environmental flows" describes the flows of water necessary to protect the ecological health of rivers and of the bays and estuaries that are the ultimate recipients of these flows. The consensus of the scientific community is that for environmental flow standards to be adequate to support a sound ecological environment in a stream system, they must include minimum subsistence flows, varying levels of base flows, high flow pulses, and overbank pulses that vary throughout the year.[3] Environmental flow standards establish requirements that govern when a water right holder may remove water from a stream or a river (instream flow requirements), thus protecting that water for instream and bay or estuary environmental needs.

The Water Code directs the Texas Commission on Environmental Quality (TCEQ), after considering the stakeholder committees' recommendations, to adopt environmental flow standards "adequate to support a sound ecological environment, to the maximum extent reasonable considering other public interests and other relevant factors."[4] This paper summarizes the environmental flow standard and strategy recommendations made by the six stakeholder committees that submitted reports to the TCEQ and compares these to the standards the TCEQ ultimately adopted.[5] The adopted standards only apply to permits seeking a new appropriation of water or to an amendment to an existing water right that increases the amount of water authorized to be stored, taken, or diverted.[6]

Basin and Bay Area Stakeholder Committees

[1] The legislative findings, codified under Section 11.0235 (d-2) of the Water Code, state, "The legislature finds that to provide certainty in water management and development and to provide adequate protection of the state's streams, rivers, and bays and estuaries, the state must have a process with specific timelines for prompt action to address environmental flow issues in the state's major basin and bay systems, especially those systems in which unappropriated water is still available."
[2] Tex. Water Code **§** 11.02362(o). Stakeholder committees are appointed by the Environmental Flows Advisory Group (EFAG), a nine-member committee created under Tex. Water Code **§**11.0236. *See* Tex. Water Code **§**11.02362 (d) & (f). The EFAG also appoints members of the Science Advisory Committee (SAC). Members of the SAC provide recommendations and advice to the EFAG regarding environmental flow methodologies and other science based issues. *See* Tex. Water Code **§**11.02361 (a) & (e).
[3] Science Advisory Committee Discussion Paper: Moving from Instream Flow Regime Matrix Development to Environmental Flow Standard Recommendations 2-3 (February 16, 2010), *available at* http://www.tceq.texas.gov/assets/public/permitting/watersupply/water_rights/eflows/sac_discussionpaper.pdf.
[4] Tex. Water Code §11.1471(a)(1).
[5] As of the date of this paper, the Rio Grande BBASC has not submitted its report.
[6] 30 Tex. Admin. Code **§** 298.10.

Six stakeholder committees have submitted recommendation reports to the TCEQ: the stakeholder committees for the Sabine and Neches Rivers and Sabine Lake Bay (Sabine-Neches BBASC), the Trinity and San Jacinto River Basins and Galveston Bay (Trinity-San Jacinto BBASC), the Colorado and Lavaca River Basins and Matagorda and Lavaca Bays (Colorado-Lavaca BBASC), the Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas and San Antonio Bays (Guadalupe-San Antonio BBASC), the Brazos and San Bernard River Basins and Estuaries (Brazos BBASC), the Nueces River Basin and Nueces and Corpus Christi Bay Area (Nueces BBASC)[7]

The reports are unique and make recommendations that specifically address concerns relevant to each stakeholder committees' study area. With the exception of the Trinity-San Jacinto BBASC and specific proposals in some reports, in general the recommendations submitted by the stakeholder committees were reached in consensus.[8] The Trinity-San Jacinto BBASC, however, was divided and submitted a recommendations report to the TCEQ with two sets of proposed standards. One set is referred to as the "Science-Based Conditional Phased Approach," (Conditional Recommendation or Conditional Group) and the other is referred to as the "Science-Based Environmental Flow Regime" recommendations (Regime Recommendation or Regime Group).[9]

The majority of the stakeholder committees proposed specific instream flow and inflow standards, discussed below. The only exception is the Sabine-Neches BBASC, which submitted general recommendations to the TCEQ proposing further analysis and study before development of specific standards.

The Texas Commission on Environmental Quality (the TCEQ)

The Texas Commission on Environmental Quality (TCEQ) considers the stakeholder recommendations and subsequently, adopts environmental flow standards "adequate to support a sound ecological environment, to the maximum extent reasonable considering other public interests and other relevant factors."[10]

Currently, the TCEQ has adopted rules for four systems, the Trinity and San Jacinto River Basins and Galveston Bay, the Sabine and Neches Rivers and Sabine Lake Bay, the Colorado and Lavaca Rivers and Matagorda and Lavaca Bay, and the Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas and San Antonio Bays.[11] The TCEQ adopted many of the recommendations proposed by the stakeholder committees, but it also made many alternations. The TCEQ adjusted specific flow standards for various measurement points from basin to basin, did not adopt overbank flow standards for any of the basins

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[7] The BBASC reports are available at: http://www.tceq.texas.gov/permitting/water_rights/eflows/rulemaking.
[8] The Guadalupe-San Antonio BBASC did not reach consensus on certain proposed rules. *See* Guadalupe-San Antonio BBASC Recommendations Report at iii (September 1, 2011) [hereinafter Guadalupe-San Antonio BBASC Report], *available at* http://www.tceq.texas.gov/permitting/water_rights/eflows/guadalupe-sanantonio-bbsc. The Brazos BBASC was unable to reach consensus on pulse flow standards for points on the upper Brazos River. *See* Brazos BBASC Recommendations Report 10, 42 (2012) [hereinafter Brazos BBASC Report], *available at* http://www.tceq.texas.gov/permitting/water_rights/eflows/brazos-river-and-associated-bay-and-estuary-system-stakeholder-committee-and-expert-science-team.
[9] *See* the Trinity and San Jacinto and Galveston Bay and Basin and Bay Expert Science Team Environmental Flows Recommendations Report 12, 15 (November 30, 2009) [hereinafter Trinity-San Jacinto BBEST Report] (explaining the differences between the recommendations proposed by two facets of the Expert Science Team, ultimately leading to a divided stakeholder committee), *available at* http://www.tceq.texas.gov/permitting/water_rights/eflows/trinsanjacgalbaystake.html.
[10] Tex. Water Code § 11.1471(a)(1).
[11] *See* 30 Tex. Admin. Code Ch. 298, Subchapters B-E.

and removed or reduced many of the high pulse flow standards recommended by stakeholder committees. In developing rules for the Trinity and San Jacinto River Basins and Galveston Bay, the TCEQ pulled bits and pieces of recommendations proposed by both groups of the stakeholder committee.[12] Furthermore, if a stakeholder committee, like the Sabine-Neches BBASC, failed to recommend specific environmental flow standards, the TCEQ developed its own. A table summarizing the BBASC recommendations and the adopted rules can be found at the end of this paper.

Instream Flow Recommendations

Subsistence Flow

The TCEQ defines subsistence flow as "the minimum streamflow needed during critical drought periods to maintain tolerable water quality conditions and to provide minimal aquatic habitat space for the survival and recolonization of aquatic organisms.[13] In general, all stakeholder committees, with the exception of the Sabine-Neches BBASC, recommended that the TCEQ prohibit permit holders from diverting or impounding water if flows fall below the seasonal subsistence value at a particular location along a river, and the TCEQ adopted this basic subsistence flow standard for all basin and bay systems that have gone through a rulemaking.[14]

Base Flow

The TCEQ defines base flow as "the range of average flow conditions, in the absence of significant rainfall events, that may vary depending on current weather patterns."[15] All of the stakeholder committees but the Sabine-Neches BBASC recommended that the TCEQ prohibit diversions or impoundments of water that would result in streamflow falling below the base flow level. For all basins that have gone through rulemaking, the TCEQ adopted this rule.[16] The proposed regulations differ from committee to committee, as some stakeholder committees incorporated multiple levels of base flows that vary depending on the hydrologic condition.[17] In addition, when flows in a river fall below the base flow level, the stakeholder committees took different approaches. While the Colorado-Lavaca BBASC *prohibits* diversions of water if flows fall below the dry[18] base flow level, the Brazos BBASC and the Guadalupe BBASC allow a permit holder to divert or impound a certain

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[12] The Trinity-San Jacinto BBASC did not make a consensus recommendation, but rather provided two separate reports containing recommendations to the TCEQ.
[13] 30 Tex. Admin. Code §298.1(10).
[14] *See* Trinity-San Jacinto BBASC Regime Group Report at 15 (May 28, 2010) [hereinafter Trinity-San Jacinto BBASC Regime Group Report]; Trinity-San Jacinto BBASC Conditional Report at 9 (May 28, 2010) [hereinafter Trinity-San Jacinto BBASC Conditional Report] (both Trinity-San Jacinto BBASC Reports are *available at:* http://www.tceq.texas.gov/permitting/water_rights/eflows/trinsanjacgalbaystake.html; Brazos BBASC Report *supra* note 8 at 12, 13 (September 17, 2012); Colorado-Lavaca BBASC Recommendations Report at 31 (August 2011) [hereinafter Colorado-Lavaca BBASC Report], *available at:* http://www.tceq.texas.gov/permitting/water_rights/eflows/colorado-lavaca-bbsc; Guadalupe-San Antonio BBASC Report *supra* note 8 at 73; Nueces BBASC Recommendations Report 66 (September 2012) [hereinafter Nueces BBASC Report], *available at:* http://www.tceq.texas.gov/permitting/water_rights/eflows/nueces-river-and-corpus-christi-and-baffin-bays-stakeholder-committee-and-expert-science-team. *See also* 30 Tex. Admin. Code §§ 298.220(b), 298.2.75(b), 298.325(b), and 298.375(b).
[15] 30 Tex. Admin. Code § 298.1(2)
[16] 30 Tex. Admin. Code §§ 298.220(c), 298.2.75(c), 298.325(c), and 298.375(c).
[17] The Colorado-Lavaca BBASC, Brazos BBASC, Guadalupe-San Antonio BBASC, and Regime Group of the Trinity-San Jacinto BBASC recommended base flow standards that vary depending on hydrologic condition.
[18] "Dry" refers to a hydrologic condition that triggers a specific level of base flow. *See* Colorado-Lavaca BBASC Report at 9.

percentage of water if flows fall below the dry base flow level but remain above the seasonal subsistence flow value.[19] If this occurs, "*the seasonal subsistence flow plus* 50 percent of the difference between the flow and the seasonal subsistence value must be passed, and the balance may be impounded or diverted" (The 50% Rule).[20] The Nueces BBASC proposed a similar rule, but since the committee did not recommend hydrologic conditions as part of its base flow standards, the rule proposed by the Nueces BBASC applies all of the time, as opposed to only during dry conditions.[21]

With some exceptions, the TCEQ adopted the base flow recommendations made by the stakeholder committees. For the Trinity and San Jacinto Rivers and Galveston Bay system and the Sabine and Neches Rivers and Sabine Lake Bay system, the TCEQ adopted a single level of base flows. For the Colorado and Lavaca Rivers and Matagorda and Lavaca Bays system, the adopted standards include three levels of base flows, as proposed by the BBASC. In some instances the TCEQ reduced specific levels of base flows recommended by the stakeholder committees for certain measurement points. Perhaps the most controversial alteration was the TCEQ's decision to remove hydrologic conditions from the base flow standards proposed by the Guadalupe-San Antonio BBASC for the Guadalupe River, which resulted in the adopted standards only including one level of base flow versus the three tiered approach the BBASC recommended.

Pulse Flows

Pulse flows occur after rainfall events when a large amount of water is flowing in a river for a short duration of time.[22] This influx of water has many ecological functions. With the exception of the Conditional members of the Trinity-San Jacinto BBASC and the Sabine-Neches BBASC, all of the stakeholder committees developed restrictions on how much water can be removed from a river when various levels of high pulse flows have been measured. In general, the committees recommended that the TCEQ require permit holders to pass a pulse flow if inflow is greater than a specified peak trigger. These trigger values vary from basin to basin. If after a rainfall event, a peak trigger value is measured at a river gage, a permit holder must pass a specified volume of water for a specified amount of time. Most of the stakeholder committees recommended that permit holders be required to pass a certain number of high flow pulses (often of varying levels) per season and per year. Some committees proposed requirements that a permit holder pass extremely large pulses every few years, but the TCEQ declined to adopt these recommendations out of concern they would result in flooding.[23]

Inflow Recommendations

[19] *See* Guadalupe-San Antonio BBASC Report *supra* note 8 at 74; *See* Brazos BBASC Report *supra* note 8 at 46. To illustrate, in the spring during a dry hydrologic condition, if the protected base flow value is 9.8 cfs and the subsistence value is 6.6 cfs and inflow is 7.5 cfs, under the Guadalupe-BBASC Report requirements, a permit holder would have to pass 7.05 cfs and could divert or impound .45 cfs. The difference between the inflow (7.5 cfs) and the seasonal subsistence value (6.6 cfs) is .9 cfs. Fifty percent of .9 cfs is .45 cfs, which is then added to the subsistence flow value of 6.6 cfs to arrive at 7.05 cfs, the amount of water a permit holder must pass during dry hydrologic conditions under these circumstances. The permit holder could divert or impound the difference between the inflow (7.5 cfs) and what he is required to pass (7.05 cfs), which in this case is .45 cfs.

[20] *Id*.

[21] Nueces BBASC Report at 67.

[22] 30 Tex. Admin. Code § 298.1(8).

[23] TCEQ preamble,

Inflow has several functions in an estuary ecosystem. Inflow dilutes seawater, reducing the salinity of the mixture of fresh and salt water.[24] It provides an influx of nutrients from the land surface of the estuary's watershed, and it provides an influx of suspended sediments originating from the land surface or eroded from stream channels.[25] The approach among stakeholder committees in developing inflow standards differed from committee to committee and from bay to bay. For some bay systems, the stakeholder committees made specific inflow recommendations, while others relied on the instream flow standards they proposed to provide adequate inflow. The inflow standards that the majority of the stakeholder committees proposed specify amounts of water that must flow into a bay or estuary seasonally with recommended attainment frequencies that must be achieved. In general, under the standards proposed by the stakeholder committees and adopted by the TCEQ, the TCEQ will not grant a permit seeking a new appropriation of water if the additional appropriation will result in inflow being reduced below amounts recommended by the stakeholder committees, and the reduction, consequently, results in corresponding attainment frequencies being impossible to achieve.[26]

Environmental Flow Strategy Recommendations

The Water Code directs the stakeholder committees to develop recommendations regarding environmental flow standards, which is discussed in detail above. The Water Code also directs the stakeholder committees to develop "strategies to meet the environmental flow standards."27

The stakeholder committees proposed similar strategies. In general, the strategies submitted by the committees included proposals to dedicate cancelled water rights to environmental flows, using tax incentives to encourage donation of water rights, effluent reuse, conservation strategies, and land stewardship practices. As the Water Code also directs the stakeholder committees to refine strategies as part of a "work plan' after submittal of the recommendations report,28 the strategies proposed by the stakeholder committees are not necessarily exhaustive or fully developed.

Conclusion

The TCEQ has yet to implement any of the environmental flow standards that have currently been adopted. Thus, it remains to be seen whether the standards will, in actuality, protect the ecological environment of rivers and bays. Indeed, the Legislature understood that developing an environmental flow regime and implementing environmental flow standards is an imperfect process and that the process needed to allow for adaptation. The Water Code, therefore, specifically recognizes the importance of "adaptive management," directing each basin and bay area stakeholder committee and expert science team to develop a "work plan" after submitting environmental flow recommendations to the TCEQ.[29]

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[24] Science Advisory Committee: Methodologies for Establishing a Freshwater Inflow Regime for Texas Estuaries, within the Context of the Senate Bill 3 Environmental Flows Process 8 (June 5, 2009), *available at:* http://www.tceq.texas.gov/assets/public/permitting/watersupply/water_rights/eflows/fwi20090605.pdf.
[25] Science Advisory Committee, Methodologies for Establishing a Freshwater Inflow Regime *supra* note 24 at 8.
[26] *See e.g.,* 30 Tex. Admin. Code § 298.380(3)(A)-(C) and (4)(A)-(C).
[27] Tex. Water Code §11.02362(o).
[28] The Water Code recognizes the importance of "adaptive management," directing each basin and bay area stakeholder committee and expert science team to develop a "work plan" after submitting environmental flow recommendations to the TCEQ. Tex. Water Code §11.02362(p).
[29] *Id*.

To date, five stakeholder committees have submitted work plans. In each work plan, the stakeholder committees recommended schedules for reviewing and possibly refining the environmental flow standards and identified top priorities and areas of concern for their respective river basin and bay system. Among the five stakeholder committees that have submitted work plans, there is an overriding consensus that adequate funding is critical to advancing the science on rivers and bay systems and consequently, implementing effective strategies to achieve compliance with environmental flow standards.

Introduction

While Texas is growing, our water is not. Reacting to the pressures being placed on water resources in Texas and recognizing the need to protect the ecological health of rivers, bays and estuaries while balancing increased human needs for water, Senate Bill 3 emerged from the Texas Legislature in 2007 as an attempt to create certainty over how the state deals with allocating water to environmental flows.[30]

Recognizing that each river basin and accompanying bay systems throughout Texas are unique, Senate Bill 3 created a process in the Water Code requiring regional stakeholder groups (referred to as Basin and Bay Area Stakeholder Committees or BBASC's) to develop consensus-based environmental flow standard and strategy recommendations specific to the rivers and bay systems in a particular region.[31] In creating their own recommendations, the stakeholder committees relied on recommendations made by expert science teams appointed for each river basin.[32] Using the "best available science" and focusing solely on environmental flow needs as opposed to other needs, like agriculture and municipal uses, the expert science teams developed environmental flow regimes for the river basins and bays in their study areas.[33]

The stakeholder committees are required under the Water Code to review the expert science team's environmental flow recommendations and "consider them in conjunction with other factors, including the present and future needs for water for other uses related to water supply planning in the pertinent river basin and bay system."[34] Finally, the Texas Commission on Environmental Quality (TCEQ) considers the stakeholder recommendations, in addition to recommendations made by the expert science team and other sources of input,

[30] The legislative findings state, "The legislature finds that to provide certainty in water management and development and to provide adequate protection of the state's streams, rivers, and bays and estuaries, the state must have a process with specific timelines for prompt action to address environmental flow issues in the state's major basin and bay systems, especially those systems in which unappropriated water is still available." Tex. Water Code §11.0235 (d-2).
[31] *See* Tex. Water Code § 11.02362. Stakeholder Committees are created by the Environmental Flows Advisory Group, a nine member committee created under Tex. Water Code §11.0236.
[32] Under Tex. Water Code § 11.02362(c)(2)-(3), the Stakeholder Committees for each river basin must appoint an expert science team that must submit a set of environmental flow recommendations to the Stakeholder Committee.
[33] "Environmental flow analysis" means the application of a scientifically derived process for predicting the response of an ecosystem to changes in instream flows or freshwater inflows. Tex. Water Code § 11.002(15). "Environmental flow regime" is defined under the Water Code 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." Tex. Water Code § 11.002(15).
[34] Tex. Water Code § 11.02362(o).

and subsequently, adopts environmental flow standards "adequate to support a sound ecological environment, to the maximum extent reasonable considering other public interests and other relevant factors."[35]

Senate Bill 3 envisioned a geographical and sequential approach to the development of environmental flow recommendations across the state. The Water Code, therefore, specifies seven river basins and bay systems in Texas and a timeline for which environmental flow recommendations are to be developed for those seven basins.[36] *See* Figure 1, *below*. Originating with the eastern most river basins, the Water Code outlines a fast paced timeline for the science teams, the stakeholder groups and for the TCEQ to follow, ultimately leading to the adoption of rules for each basin and bay system.[37]

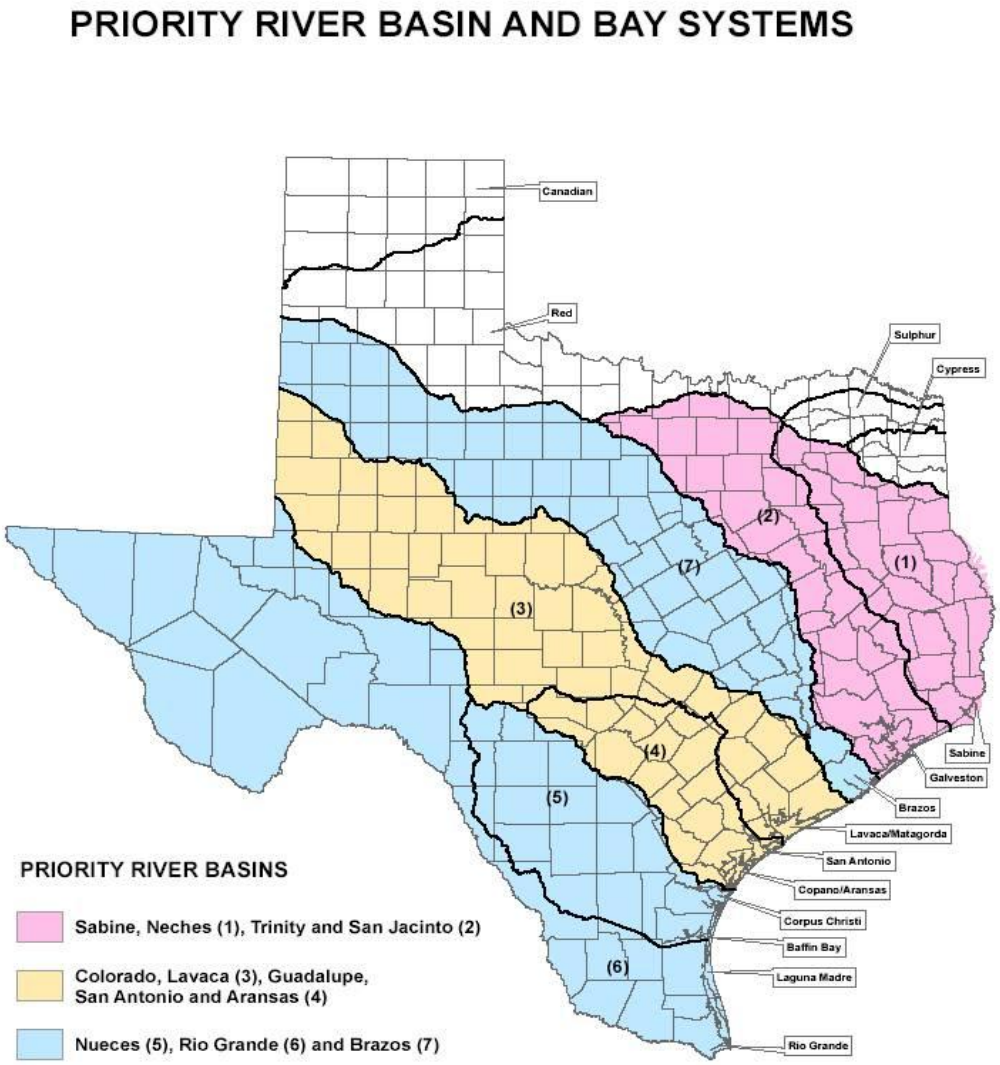

Figure 1. SB3 Map.

[35] Tex. Water Code § 11.1471(a)(1). *See also* Tex. Water Code § 11.1471(b).
[36] Tex. Water Code § 11.02362(b). Even though these are only ones directly addressed in statute, scheme does anticipate including river systems that don't flow to the Gulf in Texas. *See* Tex. Water Code § 11.02362(e).
[37] Tex. Water Code Ann. § 11.02362(c).

Purpose

The purpose of this paper is to provide a resource for policymakers in other states and for members of the public attempting to understand the environmental flow recommendations proposed by the stakeholder committees. The paper summarizes the environmental flow recommendations made by the six stakeholder committees that submitted reports to the TCEQ at the time this paper was completed and compares these to the standards the TCEQ subsequently adopted.[38] It is the authors' hope that this paper provides a basic understanding of the Senate Bill 3 process and the environmental flow standards and strategies that have emerged from it.

Overview of Environmental Flows

The term "environmental flows" describes the flows of water necessary to protect the ecological health of rivers and the bays and estuaries that are the ultimate recipients of these flows. The Water Code directs the TCEQ to adopt environmental flow standards. Essentially, these standards are designed to protect water flowing in a river or into a bay and estuary system by governing when a permit holder is allowed to remove this water. The environmental flow standards that TCEQ adopts must be "adequate to support a sound ecological environment to the maximum extent reasonable considering other public interests and other relevant factors."[39] The Water Code does not define "sound ecological environment," but the Science Advisory Committee clarified that a "sound ecological environment" is one that "sustains the full complement of native species in perpetuity, sustains key habitat features required by these species, retains key features of the natural flow regime required by these species to complete their life cycles, and sustains key ecosystem processes and services, such as elemental cycling and the productivity of important plant and animal populations."[40]

The consensus of the scientific community is that for environmental flow standards to be adequate to support a sound ecological environment in a stream system, they must comprise differing levels of flows that vary throughout the year.[41] These flows include minimum subsistence flows, varying levels of base flows, high flow pulses, and overbank pulses.[42] Similarly, varying magnitudes of inflow into bays and estuaries play, perhaps, the most important role in determining the health of these ecosystems.[43]

Ideally, requirements that govern the amount of water a permit holder may remove from a stream (instream flow requirements) should be structured so that inflow standards (the amount of water flowing into a bay from the source stream) can be realized. The TCEQ evaluates water right permit applications to determine whether a new appropriation of water will impair any of these standards. It is important to note that the environmental flow standards only apply to new water right permits or to amendments to existing permits seeking to increase

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[38] As of the date of this paper, the Rio Grande Stakeholder Committee has not submitted its report.
[39] Tex. Water Code §11.1471(a).
[40] Recommendations of the Science Advisory Committee Presented to the Governor's Environmental Flows Advisory Committee 1 (August 21, 2006), *available at:* http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/deltaflow/docs/exhibits/swrcb/swrcb_sac2006.pdf
[41] Science Advisory Committee, Discussion Paper: Instream Flow Regime, *supra* note 3 at 2-3.
[42] *Id*. at 3.
[43] Science Advisory Committee, Methodologies for Establishing a Freshwater Inflow Regime, *supra* note 24 at 5.

an appropriation of water.[44] In addition, the Water Code directs the stakeholder committees to recommend strategies to the TCEQ that will help achieve compliance with the flow standards.[45]

Background on the Stakeholder Committees for the River Basins and Bay Systems

The river basins and bay systems in Texas are unique, with distinct climates and hydrology, differing rainfall patterns, and varying public use pressures. In general, the structure of the environmental flow standard recommendations that have emerged from the stakeholder committees are similar in many respects, but the standards are specific to the needs of a particular river basin and bay. What is perhaps most interesting, is how the stakeholder committees adapted their recommendations to the process. The first two systems to develop recommendations had no precedent to follow and no expectation of what TCEQ rules based on the recommendations would actually look like. Thus, the recommendations that emerged from the first stakeholder committees were less specific. As the process has continued, other stakeholder committees have had the advantage of learning from the past, and adapted recommendations accordingly. Most of the stakeholder committees developed a singular goal to guide the development of specific standards, and the majority of stakeholder committees recommended a flow regime based on subsistence flows, base flows, and high flow pulses.

Sabine and Neches River Basins and Sabine Lake Bay

In May of 2010, the stakeholder committee for the Sabine and Neches Rivers and Sabine Lake Bay (Sabine-Neches BBASC) submitted its final recommendations report to the TCEQ. Although the expert science team developed an environmental flow regime for the Sabine and Neches Rivers, the stakeholder committee did not recommend environmental flow standards to the TCEQ. The Expert Science Team had developed a flow regime using the Hydrology-Based Environmental Flow Regime, or HEFR[46], which relies on statistical calculations of hydrologic data; however, the BBASC felt that the flow regime proposed by the expert science team merely mimicked historical flows, and that a regime based solely on historical flows might not represent the least amount of water that could be reserved for the environment while simultaneously ensuring a sound ecological system. Thus, they felt it did not meet the Senate Bill 3 mandate to weigh the environmental need for flows with the need for water for other purposes. Consequently, the BBASC did not recommend environmental flow standards to the TCEQ, and instead, submitted general recommendations of further analysis and study of instream flows. [47]

Trinity and San Jacinto River Basins and Galveston Bay

The expert science team for the Trinity and San Jacinto River Basins and Galveston Bay was unable to reach a consensus on an environmental flow regime. Two sets of environmental flow regime recommendations emerged

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[44] Tex. Water Code § 11.147(e-1); 30 Tex. Admin. Code § 298.10(a).
[45] Tex. Water Code §11.02362(o).
[46] For more information on HEFR, *see* Science Advisory Committee, Use of Hydrologic Data in the Development of Instream Flow Recommendations for the Environmental Flows Allocation Process and the Hydrology-Based Environmental Flow Regime (HEFR) Methodology (March 15, 2011) *available at:* http://www.tceq.texas.gov/assets/public/permitting/watersupply/water_rights/eflows/hydrologicmethods06172011.pdf
[47] Sabine-Neches BBASC Recommendations Report 50 (May 2010) [hereinafter Sabine-Neches BBASC Report], *available at* :http://www.tceq.texas.gov/permitting/water_rights/eflows/sabinenechessabinelakebay.html.

from the science team and were presented to the stakeholder committee (Trinity-San Jacinto BBASC). The BBASC could not reach a consensus, and in turn, submitted a recommendations report to the TCEQ in May 2010, with two sets of proposed standards. One set is referred to as the "Science-Based Conditional Phased Approach," (Conditional Recommendation or Conditional Group) and the other is referred to as the "Science-Based Environmental Flow Regime" recommendations (Regime Recommendation or Regime Group).

The members of the stakeholder committee who endorsed the Regime Recommendation utilized the Hydrology-based Environmental Flow Regime or HEFR, to develop a complex, detailed environmental flow regime for locations along the Trinity and San Jacinto Rivers.[48] Much like the Sabine-Neches BBASC, the stakeholder committee members who endorsed the Conditional Recommendation argued that a flow regime based on HEFR might result in a regime that is "more than adequate" to support a sound ecological environment and that "lesser quantities of flow or some lesser frequency of occurrence than were experienced historically may still be adequate to sustain a sound ecological environment."[49] The members in support of the Conditional Recommendation said that a lack of scientific knowledge made it impossible to develop flow recommendations for the majority of the Trinity and San Jacinto Rivers.[50] As a result, the Conditional Recommendation advised the TCEQ to wait until further data is available before developing a complex flow regime and suggested standards for four locations that could be used conditionally, until further supporting science is developed.[51] Both stakeholder groups did agree, however, that the Trinity and San Jacinto River Basins and Galveston Bay are sound ecological environments, and adopted the Science Advisory Committee's definition.

Colorado and Lavaca River Basins and Matagorda and Lavaca Bays

The stakeholder committee for the Colorado and Lavaca Rivers and Matagorda and Lavaca Bays (Colorado-Lavaca BBASC) submitted its final recommendation report in August of 2011. The recommendations represent a consensus of all members of the stakeholder committee. The committee's goal was to "[d]evelop implementable recommendations that provide for a sound ecological environment in the basins, including the rivers, bays and estuaries, balanced with sufficient water for other beneficial uses and which include an adaptive management process that provides for future sustainability."[52]

Guadalupe, San Antonio, Mission, and Aransas River Basins and Mission, Copano, Aransas and San Antonio Bays

The stakeholder committee for the Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas and San Antonio Bays (Guadalupe-San Antonio BBASC) submitted its final recommendation report to the TCEQ in September 2011. The Guadalupe-San Antonio BBASC was unable to reach consensus on every recommendation it submitted to the TCEQ, but for the majority of the proposals, consensus of all members was reached.[53] The committee stated that as it developed recommendations, its purpose was to "balance the environmental flow regime presented by the BBEST with water supply needs across stakeholder groups to

[48] Trinity-San Jacinto BBEST Report at 52.
[49] *Id.* at 17. *See also* Science Advisory Committee, Discussion Paper: Instream Flow Regime, *supra* note 3 at 11.
[50] Trinity-San Jacinto BBASC Conditional Report at 9.
[51] Trinity-San Jacinto BBEST Report at 25.
[52] Colorado-Lavaca BBASC Report at 4.
[53] *See* Guadalupe-San Antonio BBASC Report at iii (specifying the final votes for each recommendation).

reach consensus on recommendations to the TCEQ for future flow requirements that will protect the ecology of the rivers and bays/estuaries."[54]

Nueces River Basin and Nueces and Corpus Christi and Bays

In August of 2012, the Nueces River Basin and Nueces and Corpus Christi Bay Area stakeholder committee (Nueces BBASC) submitted its final recommendation report to the TCEQ. The report represents a consensus of all members of the Nueces BBASC. After extensive review, the stakeholders agreed with the expert science team's determination that as a result of the reduction of freshwater inflow reaching the Nueces Bay and Delta, the Nueces Bay and Delta region are unsound ecological environments. Accordingly, the committee developed a set of environmental flow standards with the goal of returning "the Nueces Bay and Delta to ecological conditions existing prior to the construction of Choke Canyon Reservoir to the extent possible while preserving existing water rights and yield of the reservoir system."[55]

Brazos and San Bernard River Basins and Estuaries

The stakeholder committee for the Brazos and San Bernard River Basins and Estuaries (Brazos BBASC) submitted its environmental flows recommendation report to the TCEQ on September 17, 2012. The majority of the recommendations represent a consensus of the entire stakeholder committee; however, the committee was unable to reach consensus on recommendations for a few locations along the upper Brazos River with respect to pulse flows.[56] The committee worked with a goal of creating "a set of environmental flow recommendations on which future water rights permits are considered that balances all water needs within the basin and that are understandable and are reasonable to implement."[57]

Environmental Flow Standard Recommendations

Hydrologic Conditions

Put simply, hydrologic conditions are a way of defining whether a river basin is experiencing a wet, dry, or average state of rainfall. Hydrologic conditions are useful because they allow environmental flow standards to be tailored to varying and actual weather patterns and corresponding flow conditions. For example, base flow recommendations during wet conditions could be greater than base flow recommendations during dry conditions and fewer high flow pulses might be recommended in average conditions than in wet conditions.[58] According to the Science Advisory Committee, "[i]t must be recognized that flow recommendations which take hydrologic conditions into account begin to reflect an attempt to balance the needs of both water users and the ecosystem."[59]

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[54] Guadalupe-San Antonio BBASC Report at i.
[55] Nueces BBASC Report at 5.
[56] Brazos BBASC Report at 10, 42.
[57] *Id*. at 9.
[58] Science Advisory Committee, Use of Hydrologic Data in the Development of Instream Flow Recommendations for the Environmental Flows Allocation Process and the Hydrology Based Environmental Flow Regime (HEFR) Methodology 6 (March 15, 2011).
[59] Id.

Indeed, the Science Advisory Committee indicates that it might be useful for an environmental flow regime to have separate flows based on whether prevailing conditions are "wet," "average," or "normal."[60] The Science Advisory Committee explains that the "conditions might be based upon independent evaluations of meteorological data, upon operational parameters such as the level of storage in a reservoir, or upon the level of flow itself."[61] The Colorado-Lavaca BBASC explains the purpose of hydrologic conditions very succinctly: "the hydrologic indicator is intended to reasonably reflect climatic conditions and to align flow protections with those conditions."[62]

The Colorado-Lavaca BBASC developed four types of hydrologic conditions, wet, average, dry, and severe, for all locations but those on the Lower Colorado River. The committee's goal was to create a mechanism resulting in: wet hydrologic conditions, with corresponding high base flows engaged 25% of the time; average hydrologic conditions, with corresponding medium base flows engaged 50% of the time; dry hydrologic conditions, with corresponding low base flows engaged 20% of the time; and severe hydrologic conditions, with the corresponding low base flow and subsistence flow engaged 5% of the time.[63] For the Lower Colorado, the committee recommended three hydrologic conditions, average, dry, and severe, with the goal of average conditions being engaged 50% of the time, dry conditions 45% of the time, and severe conditions 5% of the time.[64]

The Colorado-Lavaca BBASC recommended that a hydrologic condition determination be made at the beginning of a season and the determination should control diversions for the remainder of that season. For some locations, the Colorado-Lavaca BBASC recommended using the twelve-month cumulative flow to determine the hydrologic condition; for other locations, it recommended that the TCEQ use reservoir storage or lake elevation as the indicator of hydrologic condition. For example, at the beginning of the summer season at the Colorado River at Bastrop location, if the combined storage of Lake Travis and Lake Buchanan is less than or equal to 1,103,700 acre feet of water, then this indicates a severe hydrologic condition. [65] The base flow values applicable during the summer under severe conditions would then govern diversions for the remainder of the season.

The Guadalupe-San Antonio BBASC recommended three hydrologic conditions to implement base flow requirements: dry, average, or wet. Members of the Trinity-San Jacinto BBASC endorsing the Regime Recommendation recommended low, medium, and high hydrologic conditions to implement base flow.[66] Regardless of the terminology, the intent behind the hydrologic conditions is to establish that "dry, average, and wet conditions will apply 25%, 50%, and 25% of the time."[67] The Guadalupe-San Antonio BBASC recommended that a hydrologic condition for specific locations along the rivers "be determined on the basis of the 12-month cumulative antecedent flow volumes near that location" and that TCEQ rules define hydrologic conditions on the first day of the season. [68]

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[60] Science Advisory Committee, Discussion Paper: Instream Flow Regime, *supra* note 3 at 3.
[61] *Id*.
[62] Colorado-Lavaca BBASC Report at 41.
[63] *Id*.
[64] *Id*.
[65] *Id*. at 44.
[66] Trinity-San Jacinto Regime Report at 9.
[67] Guadalupe-San Antonio BBASC Report at 73.
[68] *Id*.

The Brazos BBASC is the only committee that included hydrologic conditions in its pulse flow standards, and it recommended that TCEQ utilize a different approach in making a hydrologic condition determination.[69] The Brazos BBASC recommended that the TCEQ use the Palmer Hydrological Drought Index (PHDI). The BBASC explains, the "index represents the severity of moisture conditions from extremely dry to extremely wet," and it is "designed to reflect longer term hydrological drought impacts that are usually slow to develop and persist longer than a meteorological drought."[70] The Climatic Data Center (CDC) publishes monthly PHDI values for ten climatic divisions in Texas. The Brazos BBASC recommended that the TCEQ rules use these monthly values to determine the hydrologic condition and that the determination should be updated monthly.[71]

Subsistence Flow

In its rules relating to environment flow, TCEQ defines subsistence flow as "the minimum streamflow needed during critical drought periods to maintain tolerable water quality conditions and to provide minimal aquatic habitat space for the survival and recolonization of aquatic organisms.[72] The Science Advisory Committee explains that subsistence flows maintain water quality criteria and prevent loss of aquatic organisms due to, for example, lethal high temperatures, low dissolved oxygen levels or loss of critical habitat.[73] In addition, several of the stakeholder committees recognized that subsistence flow levels should occur infrequently. The majority of the stakeholder committees, moreover, recognized that subsistence flows in a river should change from season to season as flows in a river vary. Consequently, they developed subsistence flow standards that correspond to these seasonal variations in flow.

The Brazos BBASC, Nueces BBASC, Guadalupe-San Antonio BBASC, and the Colorado-Lavaca BBASC recommended that the TCEQ prohibit permit holders from diverting or impounding water if flows fall below the seasonal subsistence value at a particular location along the river.[74] Depending on the season and the particular gage location, the subsistence flow level varies. For example, during the winter season at the Guadalupe River at Victoria location, the BBASC recommendation would allow a permit holder to divert or impound water until the point that a river gage falls to 160 cubic feet per second (cfs) of water.[75] Once the flow in the river falls to 160 cfs or less during the winter, the recommendations require the permit holder to pass the flow. In the spring, the recommended subsistence flow value changes, however, to 130 cfs,[76] at which point the recommended standard prohibits the permit holder from diverting or impounding water.

The subsistence flow recommendation made by Colorado-Lavaca BBASC was more complex in comparison to the standards endorsed by other stakeholder committees. The standard includes the basic requirement that a permittee may not divert or impound water when flows in the river fall below the seasonal subsistence value. However, the Colorado-Lavaca BBASC created a way to allow permit holders to divert some water during severely dry hydrologic conditions. The recommendation states, "[d]uring severe hydrologic conditions, when flows . . . are above the applicable subsistence flow level but below the applicable dry base flow level, diversion

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[69] Brazos BBASC Report at 45.
[70] *Id*.
[71] *Id*.
[72] 30 Tex. Admin. Code § 298.1(10).
[73] Science Advisory Committee, Discussion Paper: Instream Flow Regime, *supra* note 3 at 3.
[74] Brazos BBASC Report at 12, 13; Colorado-Lavaca BBASC Report at 3; Guadalupe-San Antonio BBASC Report at 73; Nueces BBASC Report at 66.
[75] Guadalupe San Antonio BBASC Report at 93, Table 4.1-17.
[76] *Id*.

or impoundment would be authorized as long as the flow at any applicable flow standard measurement point does not fall below the applicable subsistence flow level". [77]

This was designed to ensure that during extremely dry times, flows between the base flow level and the subsistence flow level are still available for other needs, such as agriculture or municipal use. For example, for the South Concho River at Christoval location, in the summer during a severe hydrologic condition, if the flow of the river measured below 7 cfs (the dry base flow level) but above 2 cfs (the subsistence level), then the permit holder would be allowed to divert or impound water.[78] If, however, the flow fell below the 2 cfs subsistence flow requirement, the permit holder would have to pass the flow.

Finally, the Colorado-Lavaca stakeholder committee recommended that all diversions or impoundments be prohibited during wet, dry, or average hydrologic conditions when flows fall below the base flow level for that particular hydrologic condition. Essentially, this means that the lowest protection level of subsistence flows apply only during the most extreme weather conditions, and that at all other times, the lowest flow level provided for environmental flows is the base flow level. To clarify, at the South Concho River at Christoval location, if it is summer and the hydrological condition for the season is dry, the permittee could divert or impound water as long as the flow in the river does not fall below 7 cfs base-flow level. If it is fall and the hydrological condition is wet and the flow falls below 22 cfs, then the permittee would be required to pass the water.[79] Essentially, when there is more water in the river, the Colorado-Lavaca BBASC recommended a higher threshold to protect flows in the river.

The members of the Trinity-San Jacinto BBASC supporting the Conditional Recommendation proposed subsistence flow standards for the four locations they established as acceptable measurement points on the Trinity and San Jacinto Rivers. The Conditional Recommendation emphasized that the purpose behind establishing a subsistence flow is to maintain historical occurrence and persistence and to prevent development of poor water.[80] The Conditional Recommendation did not provide much implementation guidance to TCEQ beyond emphasizing that the "Conditional Recommendation makes it possible to develop achievable implementation strategies" and "enables a focus on refining the recommendations for low flows and estuary inflows and achieving them."[81]

The Regime Recommendations for the Trinity and San Jacinto Rivers are obviously different than the Conditional Recommendations, but they also differ from the subsistence flow standards that stakeholder committees for other basins developed later in the process. While recommending a general subsistence standard below which flows may not fall, the Regime Recommendations also impose a revised subsistence standard (increased by 50 percent) after diversions have caused flows to continue at or below subsistence levels for a specified continuous duration, on the premise that the subsistence flows are very low flow levels and should not artificially be caused to persist for extended periods of time. [82] For example, at the Trinity River at Dallas gage location, the subsistence flow level in the spring is 15 cfs and the duration is 4 weeks.[83] If diversions have

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[77] Colorado-Lavaca BBASC Report at 32.
[78] *Id*. at 65.
[79] Id.
[80] *See eg*., Trinity-San Jacinto BBEST Report at 29.
[81] Trinity-San Jacinto BBASC Conditional Report at 33.
[82] Trinity-San Jacinto BBASC Regime Group Report at 15-17.
[83] *Id*. at 17.

caused flows to be at or below 15 cfs for a continuous period of longer than four weeks, a permit holder would be required to let flows of 22.5 cfs (50 percent more than 15 cfs) on average pass for two weeks (half the four-week period).

Base Flow

The Science Advisory Committee describes base flows as "representing average or normal flow conditions in the absence of significant precipitation or run off events that provide instream habitat conditions needed to maintain the diversity of habitats and resources that support native habitats and aquatic species."[84] The definition that TCEQ adopted is simplified, defining base flow as "the range of average flow conditions, in the absence of significant rainfall events, that may vary depending on current weather patterns."[85]

The Colorado-Lavaca BBASC incorporated three levels of base flow standards based on hydrologic conditions of dry, average, and wet for most locations in the committee's study area.[86] The Colorado-Lavaca BBASC based its approach on the fact that differing levels of base flows provide for a variety of habitat types. As the report explains, "low base flows often will favor habitats such as riffles and shallow runs, and the species most associated with those types of habitats, and high base flows often will favor deep pools and fast runs, and the species that do best in those habitat types."[87] Consequently, the Colorado-Lavaca BBASC recommended that depending on the controlling hydrologic condition, the threshold to divert or impound water should change.[88] During dry hydrologic conditions, the Colorado-Lavaca BBASC recommended that the TCEQ permit diversions or impoundments when flows at a particular point are above the dry base flow level and below an applicable pulse flow trigger, as long as flows do not fall below the dry base flow level. For example, at the Colorado near Ballinger location, if it is spring and the hydrologic condition is dry, a permit holder could divert or impound water if flows are measured between 3 cfs (the dry base flow level) and 1,300 cfs (assuming this small seasonal pulse flow trigger is applicable at the time). The permittee could not divert in a manner to cause flows to fall below 3 cfs.[89]

During average hydrologic conditions, the Colorado-Lavaca stakeholder committee recommended that permit holders be allowed to divert or impound water only if the flows are between the average base flow level and below any applicable pulse flow trigger point, as long as the flow does not fall below the average base flow level for the particular location being measured. To clarify, for the Colorado near Ballinger location discussed above, in the spring, under average hydrologic conditions, the base flow is 9 cfs. A permit holder could divert or impound water as long as the flow does not dip below 9 cfs, and also is below any applicable pulse flow trigger (compare this to dry hydrologic conditions, where the threshold is only 3 cfs). Similarly, during wet hydrologic conditions, the committee recommended that permit holders be permitted to divert or impound water only if flows are above the applicable wet base flow level and below any applicable pulse flow trigger level, as long as the flow does not fall below the wet base flow level for the particular location being measured.[90]

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[84] Science Advisory Committee, Discussion Paper: Instream Flow Regime *supra* note 3 at 3.
[85] 30 Tex. Admin. Code § 298.1(2)
[86] With the exception of three locations on the lower Colorado, where it recommended two levels of base flows consistent with the BBEST recommendations.
[87] Colorado-Lavaca BBASC Report at 32.
[88] A hydrologic condition would be determined at the beginning of a season and would control diversions for the remainder of that season.
[89] Colorado-Lavaca BBASC Report at 53.
[90] *Id.* at 33.

The Brazos BBASC and the Guadalupe-San Antonio BBASC base flow recommendations are similar to each other but differ from those proposed by the Colorado-Lavaca BBASC. In general, the main difference is that the Brazos and Guadalupe-San Antonio BBASCs allow permit holders to divert or impound water even when flows fall below the dry base flow level, whereas, the Colorado-Lavaca BBASC prohibits diversions that would reduce flows to less than the dry base flow level. Specifically, when the flow in the river is less than the seasonal base value but greater than the seasonal subsistence value, "*the seasonal subsistence flow plus* 50 percent of the difference between inflow and the seasonal subsistence value must be passed, and the balance may be impounded or diverted" subject to senior water rights (The 50% Rule).[91]

Like the Colorado-Lavaca BBASC, the Brazos and Guadalupe-San Antonio BBASCs recommended that under average and wet hydrologic conditions, the TCEQ prohibit permit holders from diverting or impounding water when inflow is less than the seasonal base value for the specific location being measured. For example, in the summer at the Guadalupe River at Cuero location, the wet base value is 800 cfs.[92] If the hydrologic condition for the summer season at this location is wet and the river gage measures less than 800 cfs, the permit holder would be required to pass water and would be unable to divert or impound water until flows increased.

The base flow recommendations proposed by the Nueces BBASC did not include hydrologic conditions, as other BBASCs recommended. As a result, each measurement point in the Nueces BBASC's study area only has one base flow value, as compared to differing values for dry conditions, average conditions, and wet conditions. The Nueces BBASC recommended a 50% Rule allowing permit holders to divert a certain percentage of water when flows fall below the base flow value but remain above subsistence flow.[93] The difference between this rule and the 50% Rules proposed by the Guadalupe-San Antonio and Brazos BBASCs is that because it is not dependent on hydrologic conditions, it applies at all times rather than only during dry hydrologic conditions.[94] This means that whenever flows fall below the base flow level but remain above subsistence flow, a permit holder may divert water in accordance with the 50% Rule. The result might be that more water is available for diversion under the Nueces BBASC's recommendations than under the Guadalupe-San Antonio and Brazos BBASC's proposed standards because under average and wet hydrologic conditions, if flows fall below the base

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[91] Guadalupe-San Antonio BBASC Report at 74. To illustrate, in the spring during a dry hydrologic condition, if the protected base flow value is 9.8 cfs and the subsistence value is 6.6 cfs and inflow is 7.5 cfs, under the Guadalupe-San Antonio BBASC requirements, a permit holder would have to pass 7.05 cfs and could divert or impound .45 cfs. The difference between the inflow (7.5 cfs) and the seasonal subsistence value (6.6 cfs) is .9 cfs. Fifty percent of .9 cfs is .45 cfs, which is then added to the subsistence flow value of 6.6 cfs to arrive at 7.05 cfs, the amount of water a permit holder must pass during dry hydrologic conditions under these circumstances. The permit holder could divert or impound the difference between the inflow (7.5 cfs) and what he is required to pass (7.05 cfs), which in this case is .45 cfs. The Brazos BBASC recommended a similar requirement in its report at page 46-47.

[92] *Id.* at 91, Table 4.1-15.

[93] *See* Nueces BBASC Report at 67. Under the Nueces BBASC's 50% Rule, if inflow is less than the seasonal base value and greater than the seasonal subsistence value, then the seasonal subsistence flow plus 50 percent of the difference between inflow and the seasonal subsistence value must be passed, and the balance may be impounded or diverted to the extent available, subject to senior water rights.

[94] *Id*.

flow level, the Guadalupe-San Antonio and Brazos BBASCs prohibit permit holders from diverting or impounding water.

Finally, similar to the Colorado-Lavaca BBASC, the Guadalupe-San Antonio BBASC and the Nueces BBASC recommended that if inflow is greater than the seasonal base value but less than the lowest applicable pulse peak value, a permit holder must pass the seasonal base value, but may divert or impound the balance, subject to senior water rights. For example, in the winter, under the regime proposed by the Guadalupe-San Antonio BBASC, the lowest pulse peak value at the San Antonio River near Elmendorf location is 830 cfs and the dry base flow is 115 cfs.[95] If a river gage measures 500 cfs of water, then a permit holder would be required to pass 115 cfs, but could divert or impound up to 385 cfs, depending on what the permit allows (the difference between the 500 cfs flow and the 115 cfs seasonal base value). The Brazos has a similar concept of allowing diversion between base flow and pulse flow, but goes into detail to describe when a qualifying high flow pulse event is initiated.[96]

The members of the Trinity-San Jacinto BBASC who endorsed the Conditional Recommendation proposed base flow standards for the four locations submitted to the TCEQ as measurement points. Unlike the majority of the stakeholder committees, the Conditional Recommendation did not recommend adopting separate base flow standards for dry, average, or wet conditions, noting "there is no data relating the concept [of hydrological conditions] to actual ecological functions and specific flows in the Trinity basin."[97] As a result, the proposal included one level of base flow (similar to the Nueces). In contrast, the Trinity-San Jacinto Regime Recommendation included standards protecting three levels of ecological base flow (dry, average, and wet) during each season for locations along the Trinity and San Jacinto Rivers and in addition, developed recommended base flow attainment frequencies for each location.[98]

Pulse Flows

Pulse flows occur after rainfall events when a large amount of water is flowing in a river for a short duration of time.[99] The Science Advisory Committee describes pulse flows "as short duration, high magnitude, in-channel high flow pulses that occur during or immediately after rainfall events and provide spawning cues and transport of eggs and larvae of fishes and aquatic invertebrates, as well as helping to maintain important physical habitat features and connectivity along a stream channel."[100] The stakeholder committees in all river basins, with the exception of the Sabine-Neches BBASC, developed recommendations for maintaining such pulse flows, with restrictions on how much water can be removed from a river when a high pulse has been measured.
The Colorado-Lavaca BBASC, for all but the three gages on the Lower Colorado River, divided its recommendations of pulse flows into two groups: (1) those with a recurrence interval of one-year or less (seasonal pulses and annual pulses) that would be implemented through permit conditions; and (2) larger pulses occurring less frequently than once a year, and which would be evaluated and implemented, if required, through

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[95] Guadalupe-San Antonio BBASC Report at 101, Table 4.1-23.
[96] The Brazos BBASC Report does not specifically explain the recommendation allowing diversions between pulse flow and base flow, but it is addressed in the BBEST Report. *See* Brazos BBEST Report at 6.1.
[97] Trinity BBEST Report, Conditional Recommendation at 28.
[98] Regime Group BBASC Report 9-10. The concept of attainment is reflected in other BBASC recommendations by virtue of how they define dry, average and wet hydrologic conditions.
[99] Tex. Admin. Code § 298.1(8).
[100] Science Advisory Committee, Discussion Paper: Instream Flow Regime *supra* note 3 at 3.

a modeling analysis, with permit conditions imposed only if a pulse flow standard is likely to be impaired.[101] In addition, as a site-specific study recommending a different pulse flow structure had been previously conducted on the Colorado River below Longhorn Dam, the Colorado-Lavaca BBASC recommended pulse flow standards that are different for locations on the Colorado below Longhorn Dam.[102]

For seasonal and annual pulses, permit conditions would require a permittee to maintain a specific flow of water at a specific location for a number of days (duration) and for a certain number of times a season or annually.[103] The amount of water that triggers requirements varies from location to location as do the actual requirements of how much water to pass and for how long. The requirements are designed to protect the high pulse of water and allow it to flow. All of the stakeholder committees for the different river basins utilized this basic structure for protecting pulse flows.
For all locations in the Colorado and Lavaca River basins and coastal basins (other than on the Colorado River below Longhorn Dam), the BBASC proposed small seasonal pulses (two per season) and large seasonal pulses (one per season) as well as an annual pulse, all with increasingly large trigger levels. Pulse-flow recommendations are not based on hydrologic conditions, but do vary seasonally for the small and large seasonal pulses. To illustrate how the Colorado-Lavaca BBASC recommended the TCEQ implement the pulse flow requirements in a new permit or in an amendment to an existing one, it is helpful to look at an example. During the fall season, if the river gage at the Pedernales River near Johnson City location measures 160 cfs or greater of water (the pulse trigger level for this location) the permit requirements for a small seasonal pulse are triggered. The permit holder then is required to pass 620 acre-feet of water or pass flows for six days, whichever occurs first.[104] This requirement must be met twice in a season if flows are sufficient.[105] This means that if, at another point during the fall, the river gage measures 160 cfs, the permit holder must honor the same pulse requirements rather than diverting or impounding water. The permit holder may continue to divert water during the pulse flow provided that the flow does not fall below the trigger level and all of the requirements to pass the flow have been satisfied.

Below Longhorn Dam, the requirements are slightly different. First, pulse flows are measured in terms of magnitude, a daily average flow of water measured over a certain number of days, as opposed to an instantaneous volume. Second, the stakeholder committee created an exemption for smaller appropriations of water. The recommendations state that pulse flow magnitudes only apply to permit holders who are seeking to divert at a rate of 500 cfs or greater or impound more than 2,500 acre-feet of water.[106] The BBASC, however,

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[101] Colorado-Lavaca BBASC Report at 33. There are some exceptions to this general rule. The division into automatic permit conditions for the smaller pulse flows, and those imposed only after modeling for pulse flows recurring less frequently than annually "resulted primarily from a concern about the complexity of tracking implementation of pulse flow requirements across multiple years, particularly for entities with smaller permits."
[102] The instream flow study performed on the Lower Colorado River is *available at:* http://www.twdb.state.tx.us/wrpi/rwp/3rdRound/2011_RWP/RegionK/Files/Reference_Docs/WMS_Impacts/BIO_LSWP_IFguidelines_FINAL.pdf
[103] Colorado-Lavaca BBASC Report at 34.
[104] For example, (1) if flows meet the 620 acre-feet requirement in three days, the permit holder would be able to resume diversion or storage; (2) if flows have not met the 620 acre-feet requirement but six days have passed, the permit holder would be able to resume diversion or storage.
[105] Colorado-Lavaca BBASC Report at 77.
[106] *Id*. at 34. [106] The instream flow study performed on the Lower Colorado River is *available at:* http://www.twdb.state.tx.us/wrpi/rwp/3rdRound/2011_RWP/RegionK/Files/Reference_Docs/WMS_Impacts/BIO_LSWP_IFguidelines_FINAL.pdf
[106] Colorado-Lavaca BBASC Report at 34.

recommended that the TCEQ make the threshold to qualify for this exemption harder to obtain once TCEQ has appropriated a cumulative amount of water upstream of the location where a permit holder is seeking to appropriate additional water.[107]

In addition, the Colorado-Lavaca BBASC did not differentiate between small and large seasonal pulses on the lower Colorado River, as was done for other locations in the basin. Below Longhorn Dam, there is only the requirement to pass two pulses per season, as opposed to two small seasonal pulses, one large seasonal pulse, and an annual pulse. To illustrate, at the Colorado River near Wharton location (below Longhorn Dam), a permit holder would be required to pass a daily magnitude of 3,000 cfs of water over four days, two times each season.[108]

For all locations in the study area, the BBASC clarified that if, as a result of decreased rainfall, a pulse flow trigger or magnitude does not occur naturally, a permit holder is not required to stop diverting or impounding water and is not required to release water to artificially produce a pulse.[109] Finally, the Colorado-Lavaca BBASC explained that a permit holder who satisfies the requirements of a larger pulse flow event will have also satisfied the requirements for a smaller pulse event during the same season. As the report states, "if an annual pulse flow event occurs within the spring season, that event is also considered to satisfy both the one-per-season and one of the two-per-season pulse flow events for the spring season at the same measurement point."[110]

For extremely large pulse flows (Pulses Larger than Annual Pulse), the Colorado-Lavaca BBASC recommended a two-step approach. It is important to note that "Pulses Larger than Annual Pulses" are smaller than overbank pulses, which are discussed below. First, the BBASC created an exemption for small appropriations unlikely to impair a larger pulse of water. If a permit holder is diverting less than 10% of the trigger level (for all but the gage locations in the Lower Colorado) or impounding less than 5% of the volume of water for that pulse, pulse flow requirements do not apply.

Next, the Colorado-Lavaca BBASC recommended that when the TCEQ receives an application seeking authorization to divert or impound water and the application is not exempt, the TCEQ should analyze whether the additional appropriation of water would impair the pulse flow. Under this analysis, if the appropriation, in combination with other permits subject to the standards, reduces the frequency of attainment of a pulse by 10% or more or reduces the average volume of the protected pulse by 10% or more, then the pulse is considered impaired. If the TCEQ determines that the pulse will be impaired under these standards by a new appropriation,

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[106] For example, (1) if flows meet the 620 acre-feet requirement in three days, the permit holder would be able to resume diversion or storage; (2) if flows have not met the 620 acre-feet requirement but six days have passed, the permit holder would be able to resume diversion or storage.
[106] Colorado-Lavaca BBASC Report at 77.
[106] *Id*. at 34.
[106] *See* Colorado-Lavaca BBASC Report at 35. The Stakeholder Committee recommended that once a cumulative amount of water is appropriated upstream of a measurement point, pulse flow magnitudes apply to
[107] *See* Colorado-Lavaca BBASC Report at 35. The Stakeholder Committee recommended that once a cumulative amount of water is appropriated upstream of a measurement point, pulse flow magnitudes apply to applications seeking authorization to divert at a rate of 250 cfs or greater or impound in a new-on channel reservoir wit
h a capacity of 1,250 acre-feet or more.
[108] *Id*. at 96, 34.
[109] *Id*. at 34. Nor are permit holders required to release water lawfully stored to meet other levels of flow requirements.
[110] *Id*. at 35.

then it may develop permit conditions to protect the flow of water. If, on the other hand, TCEQ determines that the new appropriation will not impair the flow of the large pulse, then the permit holder is free to divert or impound the permitted amount of water, subject only to permit conditions protecting smaller pulses and base and subsistence flows.

Once a cumulative amount of water has been appropriated subject to the standards, the committee recommended that the TCEQ use a more narrow interpretation of when an appropriation will impair attainment of a protected pulse.[111] The committee recommended that under these circumstances, the TCEQ raise the baseline determination for impairment and consider an application that seeks to divert at a rate greater than 5% of the smallest trigger level or store more than 3% of the volume of the pulse in an on-channel reservoir as impairing the protected pulse.[112] The idea is that once water right holders are removing a certain amount of water from the river, conditions on when additional water may or may not be removed will apply to more permits.

Below Longhorn Dam, the regulatory scheme for pulses larger than annual pulse flows is similar in some respects. For all locations on the Colorado below Longhorn Dam, the BBASC created requirements designed to protect a large pulse of water once every eighteen months and once every two years.[113] Like the pulse flow requirements elsewhere along the Colorado and Lavaca Rivers, the pulse flows requirements below Longhorn Dam only apply to permit holders seeking to divert or impound more than a certain amount of water and apply to a larger set of applicants once the TCEQ has appropriated a cumulative amount of water.[114] The one-per-eighteen month requirements only apply to applications seeking to divert at a rate of 800 cfs or greater, or seeking to impound 2,500 acre-feet or more.[115] If the application does not meet the exemption, the BBASC recommended that TCEQ evaluate whether a new appropriation would impair the protected pulse flow and issue permit conditions accordingly.

The one-per-two year pulse flow requirements for all locations below Longhorn Dam apply to all applications seeking to divert at a rate of 2,700 cfs or greater or impound in a new on-channel reservoir with a capacity of 2,500 acre feet or more.[116] The Colorado-Lavaca BBASC recommended applications subject to the one-per-two-year pulse requirement incorporate a permit provision that if a river gage measures 27,000 cfs of water and this flow of water has not been passed in the last 24 months, a permit holder's diversions during the first 48 hours after the event must not reduce the flow at that point below 27,000 cfs.[117]

The Guadalupe-San Antonio BBASC, the Brazos BBASC, and the Nueces BBASC proposed an exemption for new permit holders seeking to divert or impound an amount of water unlikely to impact a high pulse flow. As explained by the Guadalupe-San Antonio and Nueces BBASC's, the committee members attempted to balance "water supply and environmental considerations by developing a concept to exempt smaller diverters from high

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[111] *See* Colorado BBASC Report at 36. The cumulative impacts provision applies "once permits subject to the standards have been issued upstream of the measurement location that collectively authorize diversions at a cumulative diversion rate equal or greater than 25% of the trigger level for the pulse or impound in on-channel reservoirs with a cumulative volume equal or greater than 15% of the volume of the pulse."
[112] *Id.* at 36.
[113] *Id*.
[114] *Id*. at 36-37.
[115] *Id*. 36.
[116] *Id*. at 37
[117] *Id*.

pulse requirements based on a ratio of their diversion rate to the pulse peak."[118] The Guadalupe-San Antonio, Nueces, and Brazos BBASCs established a ratio of 20 percent for the TCEQ to utilize when determining whether an applicant is exempt from the pulse flow requirements. If an applicant's maximum diversion rate is less than 20 percent of the specified peak flow for a particular location, then the permit is exempt from the pulse flow requirements.[119]

If the "Pulse Exemption Rule" described above does not apply, both the Guadalupe-San Antonio and Nueces BBASCs recommended that the TCEQ require permit holders to pass a pulse flow if inflow is greater than a specified peak trigger (Qp) and less than the next greatest specified peak trigger.[120] A permit holder must pass a specified volume of water for a specified amount of time, whichever occurs first, and may divert or impound the remainder. For example, at the Guadalupe River at Victoria site, during the summer, the peak trigger for a small seasonal pulse is 1,040 cfs and the peak trigger for a large seasonal pulse is 2,060 cfs.[121] If the river gage at this location measures an amount of water between these two peak trigger values, then a permit holder must pass flows up to 1,040 cfs until either the recommended volume (8,570 acre feet of water) or duration (eleven days) has passed for the small pulse at this location.

For most locations in its study area, the Guadalupe-San Antonio BBASC recommended that the TCEQ adopt standards requiring permit holders to pass a small seasonal high pulse flow twice in each season and a larger seasonal high pulse flow once in each season. Additionally, for some locations the Guadalupe-San Antonio BBASC recommended standards requiring a permit holder to pass even higher pulse flows in varying patterns from three times in only one season, to once a year, once every two years, and once every five years.[122] The Nueces BBASC proposed protecting small and large seasonal pulses sometimes as frequently as four times per season (but not always for all seasons, and often at a lower per season amount), and significantly larger pulses varying from once a year, once every two years, and/or once every five years. [123]

If a permit holder has passed the required amount of high pulses in a season, and inflow is greater than the seasonal base value for the current hydrologic condition, the Guadalupe-San Antonio BBASC and the Nueces BBASC recommended that the TCEQ require a permit holder to pass the seasonal base value of water and allow him or her to divert or impound the balance up to permit limits.[124]

The Brazos BBASC is the only stakeholder committee that included hydrologic conditions in its pulse flow recommendations. The committee proposed pulse flow requirements that differ depending on the season and the applicable hydrologic condition. For example, if it is winter and a dry hydrologic condition exists, the pulse flow trigger would be smaller than if a wet hydrologic condition exits. In other words, the permit holder would not have to pass as much water if a pulse flow trigger occurred during a dry hydrologic condition. The requirements that are triggered once a pulse flow event occurs are similar to the standards that other stakeholder committees proposed – after a trigger event, a water right holder must pass a particular volume of water for a

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[118] Guadalupe- San Antonio BBASC Report at 123; Nueces BBASC Report page 94. The Brazos BBASC explained this exception was based on "the likelihood that the available pumping capacity" for small users "would not be able to extract enough water to adversely impact the overall pulse event." Brazos BBASC Report at 42.
[119] *See* Guadalupe-San Antonio BBASC Report at 123, 124; Nueces BBASC Report at 94, Brazos BBASC Report at 42.
[120] Guadalupe-San Antonio BBASC Report at 74, Section 4.1.1.4; Nueces BBASC Report at 67, Section 4.1.1.3.
[121] *Id*. at 93.
[122] See Guadalupe-San Antonio BBASC Report at 77, 79, 81, and 85.
[123] Nueces BBASC Report at 73, 80, 84, 85, 86, 87, and 88.
[124] Brazos BBASC Report at 67; Guadalupe-San Antonio BBASC Report at 74-75.

particular duration of time, whichever occurs first.[125] In general, the Brazos BBASC proposed standards protecting high pulse flows anywhere from one to three times per season depending on the hydrological condition.[126]

The increasing sophistication of the BBASC groups in dealing with the complexities of pulse flows is demonstrated by comparing the later-adopted Colorado-Lavaca, Guadalupe-San Antonio, Brazos and Nueces BBASC approaches to pulse flows with the concerns and recommendations of one of the first BBASCs – the Trinity-San Jacinto. The Conditional members of the Trinity-San Jacinto BBASC were the only group that recommended against establishing high pulse flow standards. As the Conditional recommendation report states, "[w]hile the "Conditional Recommendation" recognizes the importance of high-flow pulses, it also recognizes the paucity of data and subsequent inability of current science to correlate specific pulse volumes with ecological health."[127]

The Regime Group of the Trinity-San Jacinto BBASC proposed that the TCEQ adopt standards requiring a permit holder to pass one high pulse, and two low pulses in the winter, two high pulses and two low pulses in the spring, and two low pulses in the summer and fall.[128] The Regime Group departed from the Regime BBESET recommendations, however, and did not recommend establishing requirements for a permit holder to pass a particular volume of water or to pass water for a particular duration of time. The Group noted that due to analytical difficulty in characterizing volume and duration, it would be difficult for the TCEQ to address these requirements in permits.[129]

Overbank Flows

Overbank flows are infrequent, high magnitude flow events that produce water levels that exceed channel banks and result in water entering the flood plain to maintain riparian habitat.[130]

With the exception of the Guadalupe-San Antonio BBASC, none of the stakeholder committees developed recommendations for overbank flows. These committees noted that although overbank flows provide important ecological functions for rivers, permit conditions are unnecessary to protect overbank flows, as overbank flows will likely continue to occur naturally. In addition, the stakeholder committees were concerned about the possibility of overbank flows causing property damage and liability as a result of flooding.[131]

The Guadalupe-San Antonio BBASC, however, recommended requirements protecting overbank flows for most of its gages. The overbank flow standards operate in a manner similar to that described in the above section on high pulse flows. The difference between the high pulse flow requirements and the overbank flow requirements

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[125] Brazos BBASC Report at 47. Section 3.5.5.
[126] *See* Brazos BBASC Report, Appendix B at 56-75. The Brazos BBASC reached consensus on pulse flows for all but three gages.
[127] Trinity-San Jacinto BBASC Conditional Report at 32. The Trinity-San Jacinto expert science team members issuing the conditional BBEST report did, however, propose conditional high pulse flow standards for a few locations once the science to support these standards exists. *See* Trinity-San Jacinto BBEST Report at 32.
[128] Trinity-San Jacinto Regime Group BBASC Report at 7.
[129] Trinity- San Jacinto Regime Group BBASC Report at 6.
[130] Science Advisory Committee, Discussion Paper: Instream Flow Regime *supra* note 3 at 3.
[131] Colorado-Lavaca BBASC Report at 38; Brazos BBASC Report at 9; Nueces BBASC Report at 94; Trinity-San Jacinto Conditional BBASC Report at 32; Trinity-San Jacinto Regime Report at 4.

are the peak trigger levels. The overbank flow requirements are triggered by a much larger pulse flow, and thus, the peak trigger levels are higher.

Inflow Standards

Inflow has several functions in an estuary ecosystem. Inflow dilutes seawater, reducing the salinity of the mixture of fresh and salt water.[132] It provides an influx of nutrients from the land surface of the estuary's watershed, and it provides an influx of suspended sediments originating from the land surface or eroded from stream channels.[133] In addition to the amount of inflow, the "frequency, timing and duration" of inflow play significant roles in the effects of salinity and nutrient and sediment transport.[134] As guidance from the Science Advisory Committee explains, "biological resources in estuaries are influenced by the *effects* of inflow, notably on salinity, nutrients and sediments, not inflow *per se*."[135]

The approach among stakeholder committees in developing inflow standards differed. Some of the stakeholder committees made specific inflow recommendations, while others relied on the instream flow standards they proposed to provide adequate inflow.

The expert science team for Matagorda and Lavaca Bays did not make a specific inflow recommendation for East Matagorda Bay, as there are no gaged inflows into the bay. The science team concluded that localized rainfall and runoff would continue to provide inflows to the system and that the focus should be on increasing inflows rather than prohibiting future diversions. As a result, the Colorado-Lavaca BBASC adopted the following statement instead of a numerical inflow recommendation: "[s]trategies to maintain and increase freshwater inflows should be pursued to support a sound ecological environment within East Matagorda Bay."[136]

The inflow standards for both Matagorda Bay and Lavaca Bay reflect the idea that a freshwater inflow regime consisting of a range of inflow conditions is essential for maintaining a sound ecological environment. Consequently, the standards for both bays are built on varying levels of inflow quantities, from a minimum threshold designed to provide refuge conditions for all species and habitats, to larger pulses of inflows that support, for example, oyster reef health, benthic condition, low estuarine marsh, and shellfish and forage fish habitat.[137] These ranges of inflow into the bays must occur a certain percentage of time in order to maintain a sound ecological environment.

For both bays, the Colorado-Lavaca BBASC proposed a dual set of inflow standards. One set is to be used for the purposes of permitting, and is designed to not preclude the possibility for some additional permitting to allow the capture of limited amounts of water during periods that inflows comply with the inflow regime levels recommended for protection by the BBEST. The other set, proposed by the expert science team, reflects inflow values needed to maintain a sound ecological environment in both Matagorda and Lavaca Bay. The second set of standards serve as targets that should be achieved, if possible, through environmental flow strategies. The

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[132] Science Advisory Committee, Methodologies for Establishing a Freshwater Inflow Regime *supra* note 24 at 5.
[133] Id.
[134] *Id*. at 6.
[135] *Id.* at 8.
[136] Colorado-Lavaca BBASC Report at 117.
[137] Colorado-Lavaca BBEST Report at 2-223.

stakeholder committee agreed that the inflow standards should balance the goal of protecting a sound ecological environment with the goal of recognizing potential future needs for water.[138]

In general, under the Colorado-Lavaca BBASC's proposed inflow standards for Matagorda Bay, the TCEQ will not grant a new permit or an amendment to an existing permit if the new appropriation of water will reduce flows into the bay below the Long-Term Annual Quantity For Permitting, the Annual Frequency For Permitting, or the Monthly Threshold.[139] For the purposes of permit review, the Lavaca Bay inflow standards are similar as well. The BBASC recommended that the TCEQ not grant a new permit or an amendment to an existing permit if the new appropriation of water will decrease flow into the bay to the point where it is impossible to comply with any of the Frequency For Permitting values for the five inflow regimes listed in the standard.

The Guadalupe-San Antonio BBASC developed a set of freshwater inflow criteria utilizing a similar approach the Colorado-Lavaca BBASC used for Matagorda and Lavaca Bays. The Guadalupe-San Antonio BBASC proposed one set of inflow standards based on the TCEQ's model of the full use of existing water rights, which the TCEQ would use when determining whether or not to authorize a new appropriation of water. The Guadalupe-San Antonio BBASC proposed a second set of standards that provide attainment goals to maintain a sound ecological environment based on the BBEST recommendations. The BBASC recommended that the second set of standards be used as the "basis for pursuit of strategies to address identified shortcomings" in meeting these numbers.[140] Both standards proposed by the Guadalupe-San Antonio BBASC include specific freshwater inflow levels for two seasons and rely on instream flow protections for the remaining two seasons.[141] Under the BBASC's recommendations, an authorization in a new permit or in an amended permit to increase the amount of water stored or diverted may not make compliance with the attainment frequencies worse than the permitting standards.[142]

Additionally, the Guadalupe-San Antonio BBASC recommended that for new appropriations of water greater than 200 acre-feet a year, the TCEQ require that either ten percent of a new project's firm yield or ten percent of an authorized annual diversion, whichever is less, be dedicated to the environment to support attempts to move toward the standards necessary to maintain a sound ecological environment.[143] The committee explained that a permit holder may satisfy the ten percent dedication requirement by undertaking measures to provide an amount of water "equivalent in benefit" to the ten percent dedication through commitments and/or agreements not necessarily associated with the project and emphasized that the ten percent dedication requirement was recommended in lieu of a three tier base flow structure during the fall and winter for the Guadalupe River at Gonzales, Cuero, and Victoria locations.[144] Finally, the recommendation states that the inflow standards only apply to permits seeking to divert an amount of water equal to or greater than 1,000 acre feet a year or store 10,000 acre feet of water or more in a year.[145]

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[138] Colorado-Lavaca BBASC Report at 119, 125.
[139] *Id*. at 121.
[140] Guadalupe- San Antonio BBASC Report at 121.
[141] Myron Hess, National Wildlife Federation, *An Update on Senate Bill 3 Implementation* at 7.
[142] Guadalupe-San Antonio BBASC Report at 121.
[143] *Id*.
[144] *Id*. at 121, 125.
[145] *Id*. at 121, Section 2.e.

For the Brazos River Estuary and San Bernard River Estuary, the Brazos BBASC did not adopt specific inflow standards. The BBASC explained that the expert science team based its recommendation on the assumption that inflow into the estuary would equate to the expert science team's environmental flow recommendations for the Brazos River at Richmond gage. The BBASC recommendation for the Richmond gage, however, did not include many of the high flow pulses that were included in the expert science team's regime recommendation. The Brazos BBASC indicated it did not have the opportunity to fully vet and analyze what potential impacts to the estuary may result from BBASC modifications of the environmental flow regime at Richmond, specifically, not adopting high flow pulses, annual pulses, and one level of seasonal pulse. However, the Brazos BBASC noted that unless an on-channel reservoir is developed on the main stem of the Lower Brazos or several on-channel reservoirs are developed on main tributaries to the Lower Brazos, it expects high flow pulses will likely continue to maintain the health of the estuaries of both the Brazos and San Bernard Rivers even though not specifically prescribed by the BBASC.[146] The Brazos BBASC "recommended that a long-term study be commissioned to monitor salinity, nutrient transport, and sediment transport and deposition and associated estuarine health in order to detect any negative effects as upstream projects are implemented over the next few decades."

The recommendations made by the Nueces BBASC are significant because, as discussed earlier, the expert science team determined and the BBASC agreed that the Nueces Bay and Delta are not sound ecological environments. The expert science team described the Nueces Delta as a "reverse estuary where low salinity water enters the delta from the bay as opposed to fresh water entering the delta from a river source."[147] The determination that the Nueces Bay and Delta represent an unsound ecological environment presented a challenge, as the stakeholder committee was faced with developing an estuary inflow regime that improves the ecological conditions of the Nueces Bay and Delta, rather than merely maintaining them. Of course, it is important to recognize that other BBASC groups were faced with a similar challenge of comparing conditions with the full exercise of exiting water rights against the recommendations made by the expert science team needed to maintain a sound ecological environment.

The Nueces BBASC recommended annual and seasonal freshwater inflow volumes and corresponding attainment frequencies for subsistence, base, and high flow conditions. The attainment frequencies in the recommendation correspond to the volumes of bay inflow associated with operating the existing Corpus Christi water supply system. The BBASC noted, however, that if all existing water rights were utilized, it would be impossible to comply with the proposed attainment frequencies.[148] The BBASC explained that a new appropriation would likely violate the attainment frequencies, which would make it very difficult for the TCEQ to authorize new appropriations of water in the lower basin of the Nueces River. For this reason, the BBASC proposed that for new appropriations of water in excess of 500 acre feet per year, the Nueces Estuary Advisory Council (NEAC) be given the opportunity to review and provide recommendations to the TCEQ. According to the stakeholder committee, "[t]his review allows for the possibility that NEAC could choose to recommend approval of an application violating specified attainment frequencies, but providing significant benefits to the bay and estuary through operations, permit conditions, or adaptive management."[149]

The Nueces expert science team and the stakeholder committee determined that Corpus Christi Bay, Oso Bay, Baffin Bay, and the Upper Laguna Madre are sound ecological environments and did not make specific inflow

[146] Brazos BBASC Report at 43.
[147] Nueces BBEST Report at 2-18.
[148] Nueces BBASC Report at 46.
[149] *Id*. 47.

recommendations for these bays.[150] Of significance to the expert science team was the fact that, according to salinity data, freshwater inflows do not impact the salinity levels of these bays.[151]

The members of the Trinity-San Jacinto BBASC endorsing the Conditional Recommendation and the Regime Recommendation each proposed a set of inflow standards for Galveston Bay. For the Trinity and San Jacinto Rivers, the Regime Recommendation proposed two tiers of inflow criteria covering low to medium inflow conditions for four separate seasons. The Regime Recommendation based the inflow criteria on the impact salinity levels have on certain indicator species in Galveston Bay. In addition, the Regime Recommendation proposed a separate Drought Inflow Criteria for the Bay.[152]

In contrast, the Conditional Recommendation criticized the Regime Recommendation's approach of focusing primarily on salinity levels to develop inflow standards, arguing that the approach "has many limitations that unfortunately do not allow for the identification of freshwater inflow requirements that can be shown to be necessary to support a sound ecological environment."[153] The Conditional Recommendation maintained that other factors, besides bay inflows, affect bay health. Viewing there to be a lack of scientific data, the members chose to propose simplified inflow standards, consisting of four different annual inflow levels based on quantities of water needed to flow into Galveston Bay a certain percentage of future years.[154]

Environmental Flow Strategy Recommendations

The Water Code directs the stakeholder committees to "develop recommendations regarding environmental flow standards," which is discussed in detail above. In addition, the Water Code directs the stakeholder committees to develop "*strategies to meet the environmental flow standards."*[155] Similar strategies were proposed by all of the stakeholder committees, with the exception of the Sabine-Neches BBASC, who as discussed previously, did not recommend specific environmental flow standards or strategies. In general, the strategies submitted by the other stakeholder committees included proposals to dedicate cancelled water rights to environmental flows, using tax incentives to encourage donation of water rights, effluent reuse, conservation strategies, and land stewardship practices. As the Water Code also directs the stakeholder committees to refine strategies as part of a "work plan' after submittal of the recommendations report,[156] the strategies proposed by the stakeholder committees are not necessarily exhaustive or fully developed.

Both factions of the Trinity-San Jacinto BBASC recognized the difficulty in creating strategies when the recommended attainment frequencies are higher than a WAM Run 3 scenario where all water right permits use their maximum authorized amounts of water. The members endorsing the Conditional Recommendation argued this was a fatal flaw in the Regime Recommendation and claimed that any strategy to pursue the Regime Recommendation would result in a "serious reduction in existing water rights."[157] The Regime Group argued,

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[150] Nueces BBEST Report at 1-7 – 1-9, Section 1.3.2.
[151] *Id*. at 4-7.
[152] *See* Inflow recommendations in Trinity-San Jacinto BBASC Regime Report at 19 - 26.
[153] Trinity-San Jacinto BBASC Conditional Report at18.
[154] *Id*. at 16.
[155] Tex. Water Code §11.02362(o).
[156] The Water Code recognizes the importance of "adaptive management," directing each basin and bay area stakeholder committee and expert science team to develop a "work plan" after submitting environmental flow recommendations to the TCEQ. Tex. Water Code § 11.02362(p).
[157] Trinity-San Jacinto BBASC Conditional Report at 32.

"reliance on a reasonable level of return flows…is a viable strategy for meeting environmental flow standards."[158]

The Brazos BBASC understood that the environmental flow strategies "should work in concert with a regime that balances ecological needs and human uses."[159] According to the BBASC, "these strategies could be used by water planners, state or federal agencies, legislators, or permit holders to pursue protection goals established by the BBASC." [160] With this in mind, the BBASC created a list of strategies it recommended "be viewed as a set of voluntary or incentive-based measures that could be used to achieve environmental flow standards within the Brazos basin."[161] To help achieve compliance with environmental flow standards, the Brazos BBASC recommended multiple strategies. Among other things, the BBASC suggested forming a group of reservoir owners to periodically review ways and means, such as scheduling releases to better mimic natural flow patterns, to improve reservoir operations to enhance both environmental floes and water supply.[162]

As there is very little unappropriated water in the Colorado River to which new permits would apply, the Colorado-Lavaca BBASC recognized that voluntary strategies might be the only way to meet the environmental flow standards for the basin.[163] The Colorado-Lavaca BBASC proposed several regulatory strategies that could be implemented to meet environmental flow standards. One unique strategy proposed by the BBASC is the idea that local governments could require developers to coordinate with local entities and perform pre-development studies to determine that sufficient water is available for proposed projects.[164]

The Nueces BBASC, among other things, recommended the construction of water control structures and landform modifications to help maximize the benefits of freshwater inflows and to help ensure longer retention of desired salinity levels.[165] Finally, a few of the strategies the Guadalupe-San Antonio BBASC recommended included a dry year option, where agricultural water rights holders could be compensated for not diverting water during dry years, in addition to the construction of storage facilities designed to capture water during higher flows that would be used exclusively for environmental flows during drier times.[166]

TCEQ Standards

The Water Code requires the TCEQ to "adopt appropriate environmental flow standards for each river basin and bay system in this state that are adequate to support a sound ecological environment, to the maximum extent reasonable considering other public interests and other relevant factors." [167] In adopting environmental flow standards, the TCEQ must consider recommendations developed by the applicable basin and bay area stakeholders committee, the environmental flow regime recommended by the applicable expert science team, comments submitted by the advisory group to the commission, specific characteristics of the river basin and bay system, economic factors, the human and other competing water needs in the river basin and bay system, all

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[158] Trinity-San Jacinto BBASC Regime Report at 27.
[159] Brazos BBASC Report at 48.
[160] *Id.*
[161] *Id*.
[162] *Id*. at 48-51.
[163] Colorado-Lavaca BBASC Report at 130.
[164] *Id*.
[165] Nueces BBASC Report at 100.
[166] Guadalupe-San Antonio BBASC Report at 131.
[167] Tex. Water Code §11.1471(a).

reasonably available scientific information, including any scientific information provided by the science advisory committee, and any other appropriate information.[168]

Currently, the TCEQ has adopted rules for four systems, the Trinity-San Jacinto River Basins and Galveston Bay, the Sabine and Neches Rivers and Sabine Lake Bay, the Colorado and Lavaca Rivers and Matagorda and Lavaca Bay, and the Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas and San Antonio Bays. The Nueces BBASC and the Brazos BBASC submitted their recommendations in August and September of 2012. The Rio Grande, Rio Grande Estuary and the Lower Laguna Madre BBASC had until December 1, 2012, to submit its final recommendation report, but it missed this deadline. The TCEQ has extended the rulemaking for these last three river basins from September 2013 to February 2014.

The adopted standards only apply to permits seeking a new appropriation of water or to an amendment to an existing water right that increases the amount of water authorized to be stored, taken, or diverted.[169] The TCEQ adopted many of the recommendations proposed by the stakeholder committees, but it also made many alternations. The TCEQ adjusted specific flow standards for various measurement points from basin to basin, did not adopt an overbank flow standards for any of the basins, and removed or reduced many of the high pulse flow standards recommended by stakeholder committees. Furthermore, if a stakeholder committee, like the stakeholder committee for the Sabine-Neches BBASC, failed to recommend specific environmental flow standards, the TCEQ developed its own.

In addition, the Water Code directs the TCEQ to establish an amount of unappropriated water for each basin, if available, to be set aside to satisfy the environmental flow standards to the maximum extent reasonable when considering human water needs. Once the TCEQ adopts environmental flow standards, the TCEQ's objective will be to protect the standards, along with the interests of senior water right holders, as it considers whether to permit new appropriations of water or to amend existing permits that seek to increase an appropriation. The TCEQ may use the set-aside or use its existing authority to place special conditions in permits to protect the environmental flow standards.

Trinity and San Jacinto River Basins and Galveston Bay. As discussed above, the expert science team and stakeholder committee for the Trinity and San Jacinto River Basins and Galveston Bay failed to reach a consensus and submitted two sets of recommendations to the TCEQ. The TCEQ considered both sets of recommendations and adopted standards based on recommendations proposed by both groups. The TCEQ adopted standards for four locations on the Trinity River and two locations along the San Jacinto River. According to the TCEQ, the majority of the members of the stakeholder committee recommended these measurement points.[170] The TCEQ adopted a basic subsistence flow standard prohibiting a water right holder from storing or diverting water unless the flow at a measurement point is above the subsistence flow standard for that point.[171] The TCEQ did not adopt the Regime Group's approach of prohibiting diversions from causing flows to continue at or below subsistence levels for a particular *duration* of time. In most cases, the TCEQ increased the subsistence flow values at the measurement points to alleviate concern from commenters regarding low flow levels.[172] Regarding base flow, the TCEQ adopted the Conditional Committee's

[168] *Id*. at (b)(3)-(10).
[169] 30 Tex. Admin. Code § 298.10.
[170] 36 Tex. Reg 2914. May 6, 2011.
[171] 30 Tex. Admin. Code § 298.220(b).
[172] 36 Tex. Reg. 2914. May 6, 2011.

recommendation against incorporating hydrologic conditions in the flow regime. As a result, the base flow standards for the Trinity-San Jacinto system are based on one level of protection. Finally, under the TCEQ's rules, a water right holder must pass two pulses per season if a high flow pulse trigger is measured and may not store or divert water until the applicable volume has passed or the applicable duration time has passed. This rule departs from the Regime Group's proposed standard requiring water right holders to pass three pulses in the winter and four pulses in the spring.

Without a consensus recommendation, the TCEQ developed its own inflow standards for Galveston Bay. According to the TCEQ, "the adopted bay and estuary inflow standards for Galveston Bay are based on the recommendations of the majority of stakeholders and comments received on the proposed rule and include seasonal values and frequencies based on a balancing of human and other competing needs for water."[173] The rule provides for three levels of inflow requirements for both the Trinity and San Jacinto Rivers for each season, in addition to Annual Inflow Quantity requirements and annual target frequencies. The rule states, "[a] water right application in the Trinity or San Jacinto river basins, which increases the amount of water authorized to be stored, taken or diverted…shall not reduce the long-term frequency on either a seasonal or annual basis at which the volumes of freshwater inflows to Galveston Bay…occur."[174] The TCEQ reduced the adopted inflow standards from those originally proposed by the expert science team and entirely eliminated a standard for the Trinity River in the fall season.[175]

Sabine and Neches River Basins and Sabine Lake Bay. Despite the fact that the Sabine-Neches BBASC did not submit specific environmental flow recommendations to the TCEQ, the TCEQ adopted environmental flow standards for the basin.[176] All of the standards adopted by the TCEQ were based on scientific information from the expert science team, and in this case, the TCEQ, as opposed to the stakeholder committee, considered the human needs for water use when it adopted standards.[177]

The TCEQ adopted ten environmental flow standards using measurement points recommended by the expert science team. For the subsistence flow standard, the TCEQ utilized the same implementation approach as it did for other basins, that a permit holder is prohibited from diverting or storing water unless the flow is above the seasonal subsistence level.[178]

The base flow standard the TCEQ adopted is simple, as it does not rely on hydrologic conditions in determining base flow values. If flows are above the seasonal base flow level (which corresponds to the dry base flow level recommended by the expert science team) and below the applicable high flow pulse trigger level, a water right holder may store or divert water in accordance with his permit.[179] As a result of public concern over the possibility of low flows, the TCEQ increased the base flow values recommended by the expert science team by ten percent.[180]

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[173] Id.
[174] 30 Tex. Admin. Code § 298.225(a).
[175] 30 Tex. Admin. Code § 298.225(a).
[176] *See* Tex. Admin. Code § 298.275.
[177] 36 Tex Reg 2917, May 6, 2011.
[178] Tex. Admin Code § 298.275 (b).
[179] Tex. Admin. Code § 298.275(c).
[180] 36 Tex Reg 2917, May 6, 2011.

Under the TCEQ standards, a permit holder must pass two high flow pulses in the spring and fall seasons and one high flow pulse during the summer and winter seasons if a high flow pulse is measured. The standards prohibit the water right holder from diverting or impounding water until either the applicable volume amount or the duration time has passed.[181]

Like the expert science team, the TCEQ did not adopt inflow standards for Sabine Lake Bay. The TCEQ explained that pulse flow requirements in permits for new appropriations and of water and naturally occurring flood events should provide sufficient freshwater inflows to Sabine Lake Bay, but that further analysis and studies may need to be performed to ensure that this is actually the case.[182]

Colorado and Lavaca River Basins and Matagorda and Lavaca Bays. As it did for all the systems, the TCEQ adopted a uniform subsistence flow standard for the Colorado and Lavaca River Basins prohibiting water right holders from diverting or storing water unless flows are above the applicable seasonal subsistence flow value.[183] The subsistence flow rule for the Colorado and Lavaca Basin is slightly different, however, as it incorporates the BBASC's recommendation for including a standard only allowing diversions down to the subsistence flow during severe hydrologic conditions when flows are above the applicable subsistence level and below the applicable dry base flow level.

The TCEQ simplified the language in the BBASC's base flow requirement, but the result is the same. When flow is above the applicable base flow standard, but below any applicable high flow pulse level, a water right holder may store or divert water as long as the flow does not fall below the base flow standard for that hydrologic condition.[184]

Under the rules, pulse flow requirements are divided into standards applicable to (1) points on the Colorado River below Lake Travis and (2) to points on the Colorado River above Lake Travis, tributaries of the Colorado River, the Lavaca River Basin, and the Colorado-Lavaca and Lavaca-Guadalupe Coastal Basins.[185] This is a departure from the BBASC's division of measurement points between locations below Longhorn Dam and all other locations on the Colorado and Lavaca Rivers. Under the TCEQ's rules, below Lake Travis, permit holders must pass two pulses per season, one pulse per eighteen months, and one pulse per two years. For all other locations, a permit holder must pass one or two pulses per season and one pulse per year. In a few instances, the TCEQ did reduce the trigger level for the annual pulse, but most of the specific standards for measurement points are the same as recommended by the BBASC.

One major difference between the BBASC's proposed pulse flow standards and the rules that the TCEQ adopted is that the TCEQ did not include the requirement that water right holders pass pulse flows larger than the annual pulses (one per two years and one per five years) for points on the Colorado River above Lake Travis, tributaries of the Colorado River, the Lavaca River Basin, and the Colorado-Lavaca and Lavaca-Guadalupe Coastal Basins. The TCEQ explained that although these larger pulse flows were not intended to be overbank flows, the stakeholder committee considered them to be bankfull events. The TCEQ was unwilling to assume the risk of these pulse flows causing flooding in low lying areas, and consequently, omitted the one per

[181] Tex. Admin. Code § 298.275(d)(1).
[182] 36 Tex. Reg. 2918, May 6, 2011.
[183] *See* Tex. Admin. Code § 298.325(b).
[184] 30 Tex. Admin. Code § 298.325(c)
[185] *Id*. at 298.325(d).

two years and one per five years pulses from the standards for all locations other than on the Colorado River below Lake Travis.[186]

Another departure in the adopted rules from the BBASC's recommendations is the omission of the cumulative impacts provision that applied to pulse flow standards for all measurement points, both on the Colorado River below Lake Travis and the on the Colorado River above Lake Travis, tributaries of the Colorado River, the Lavaca River Basin, and the Colorado-Lavaca and Lavaca-Guadalupe Coastal Basins. The TCEQ defended its decision to remove the cumulative impact provisions from the rules arguing that because the cumulative impacts provisions change the application of standards in future permitting, they result in a more complicated rule.[187] Furthermore, the TCEQ argued that the cumulative impacts provisions were unnecessary, as the adaptive management process envisioned by Senate Bill 3 would provide avenues in the future to adjust standards if necessary.[188]

Under the TCEQ's adopted inflow standards for Matagorda and Lavaca Bays, a water right application that increases the amount of appropriated water is prohibited from impairing the inflow regime.[189] As part of the permit review process, the TCEQ determines whether the new application will impair the inflow regime. Under the rules for Matagorda Bay, an application would impair the inflow regime if the additional appropriation of water decreases the annual average freshwater inflow at the most downstream point on the Colorado River below 60% of the long-term annual strategy quantity, or decreases the modeled annual frequency of any inflow regime (the frequency at which specific levels of freshwater inflows occur in the commission's water availability models[190]), or results in the monthly inflow quantity to Matagorda Bay falling below 15,000 acre-feet per month. For Lavaca Bay, an application is considered to have impaired an inflow regime if "when considered in combination with any prior authorizations," it "would decrease the modeled annual frequency of any inflow regime level."[191] For both Matagorda Bay and Lavaca Bay, the TCEQ adopted the specific quantities and frequencies of inflow the Stakeholder Committee recommended,[192] with the exception of the "modeled annual frequency." The TCEQ did not include specific frequencies for the modeled annual frequency, because the frequencies fluctuate as new permits are added to the water availability model. Instead, according to the TCEQ, the adopted rule prohibits a new permit from decreasing the modeled annual frequency "below the baseline values in the WAM in effect at the time the first application for a water right permit or amendment…is considered."[193] Finally, to the extent that strategies are implemented through a water right permit or amendment to help meet the freshwater inflow standards, the rules prohibit a new water right application from reducing the long-term annual strategy quantity, the modeled annual frequency, or the monthly threshold inflow for any inflow regime for Matagorda or Lavaca Bays.[194] In other words, the point of the strategies is to see improvement in the ecological health of the bays. The rules, therefore, protect this improvement by prohibiting future permits from making conditions worse.

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[186] 37 Tex. Reg 6633, August 24, 2012.
[187] Texas Commission on Environmental Quality Page 121 Chapter 298 - Environmental Flow Standards for Surface Water Rule Project No. 2011-059-298-OW, Response to Comments on 30 TAC 298.355.
[188] *Id*.
[189] 30 Tex. Admin. Code § 298.330.
[190] 30 Tex. Admin. Code § 298.305(12).
[191] 30 Tex Admin. Code § 298. 330.
[192] Id.
[193] 37 Tex. Reg 6633, August 24, 2012.
[194] 30 Tex. Admin. Code § 298.330(c) & (d).

For East Matagorda Bay, the TCEQ adopted the stakeholder committee's recommendation that specific inflow standards were unnecessary, finding, "the sound ecological environment of East Matagorda Bay can be maintained by avoiding further reduction of freshwater inflows, to the extent those reductions can be avoided, and that strategies to provide additional freshwater inflows to East Matagorda Bay should be pursued."[195]

Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas and San Antonio Bays. The TCEQ adopted the Guadalupe-San Antonio BBASC's subsistence flow recommendation that a water right holder may not store or divert water unless the flow at the measurement point is above the applicable subsistence flow level. In addition, the TCEQ adopted the committee's "50% Percent Rule" but included it under the subsistence flow section of the rules. Regarding base flow, the TCEQ departed from the recommendations made by the stakeholder committee. As discussed above, the stakeholder committee recommended three tiers of base flows for all rivers (wet, average, and dry); however, for the Guadalupe River, the TCEQ only adopted one tier, utilizing the wet base flow standard proposed by the stakeholders.[196] The TCEQ defended its decision to adopt only one level of base flow, arguing, "based on balancing human and other competing needs for water it does not adopt multiple levels of base flow for measurement points on the Guadalupe River."

The TCEQ adopted the BBASC's recommendation to exempt water right holders from the pulse flow standards if they are seeking to divert at a rate of less than 20 percent of the pulse trigger level.[197] The actual standard that the TCEQ adopted is the same as what the committee proposed: a water right holder shall not divert or store water except during times when streamflow at the applicable measurement point exceeds the applicable high flow pulse trigger level and until either the applicable volume amount has passed the measurement point or the applicable duration time has passed since the high flow pulse trigger occurred. Under the rules, water right holders are required to pass one, two, or three seasonal pulses depending on the location, but the TCEQ did not adopt the BBASC's proposed annual pulse flow standards or overbank standards.[198]

For both the San Antonio Bay system (the Guadalupe Estuary) and the Mission and Aransas Bays (Mission-Aransas Estuary), the TCEQ relaxed the frequencies significantly from the levels recommended by the stakeholders. The rules provide for permitting frequencies to either be increased or decreased by no more than a certain percentage.[199] For the San Antonio Bay system, the standards are divided into requirements for the spring and for the summer. There are eight different levels or combinations of inflow requirements for the spring season and ten different levels or combinations of inflow requirements for the summer season with varying inflow quantities and frequencies that a new permit may not impair.[200] For the Mission and Aransas Bays, the TCEQ adopted the stakeholder committee's recommendation for one inflow regime in the summer season.

In general, a new appropriation of water may not decrease the modeled permitting frequency (the frequency at which specific volumes of freshwater inflow occur in the TCEQ's water availability models[201]) for any inflow

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[195] *Id*. at § 298.310(d).
[196] *Id*. at § 298.375(c).
[197] *Id*. at § 298.385.
[198] *Id*. at § 298.375(d)(1) & (2).
[199] 30 Tex. Admin. Code § 298.380(a)(3).
[200] *See* Figure 30 TAC § 298.380(a)(3).
[201] 30 Tex. Admin. Code § 298.355(5)

regime by certain percentages specified in the rules.[202] If a modeled permitting frequency is reduced by the percentages specified in the rules, the TCEQ considers the inflow regime to be impaired. Like the inflow standards for the other bay systems, under the TCEQ's inflow rules for the San Antonio Bay System and the Mission and Aransas Bays, a water right application is prohibited from impairing any inflow regime. The TCEQ evaluates whether a new water right will impair an inflow regime as part of the water availability determination for a new water right or amendment.[203]

Conclusion

As of the date of this paper, the TCEQ has yet to implement any of the environmental flow standards that have been adopted. Thus, it remains to be seen whether the standards will, in actuality, protect the ecology of the rivers and bays. Indeed, the Legislature understood that developing an environmental flow regime and implementing environmental flow standards is an imperfect process and that the process needed to allow for adaptation. The Water Code, therefore, specifically recognizes the importance of "adaptive management," directing each basin and bay area stakeholder committee and expert science team to develop a "work plan" after submitting environmental flow recommendations to the TCEQ.[204] Under the Water Code, the work plan must "(1) establish a periodic review of the basin and bay environmental flow analyses and environmental flow regime recommendations, environmental flow standards, and strategies, to occur at least once every 10 years; (2) prescribe specific monitoring, studies, and activities; and (3) establish a schedule for continuing the validation or refinement of the basin and bay environmental flow analyses and environmental flow regime recommendations, the environmental flow standards adopted by the commission, and the strategies to achieve those standards."[205]

To date, five stakeholder committees, with the exception of the Brazos BBASC and the Rio Grande BBASC, have submitted work plans.[206] In each work plan, the stakeholder committees recommended schedules for reviewing and possibly refining the environmental flow standards and identified top priorities and areas of concern for their respective river basin and bay system. These priorities are specific to each group, but in general, the groups recommended further analysis and study of a variety of issues where data is currently negligent. These priorities include further study regarding the connection between physical habitat and flow, the relationship between bay salinity and indicator species, and the relationship between groundwater withdrawals and flows in a river.

Finally, among the five stakeholder committees who have submitted work plans, there is an overriding consensus that adequate funding is critical to advancing the science on river and bay systems and consequently, implementing effective strategies to achieve compliance with environmental flow standards. During the 83rd legislative session, conservation groups pushed the Legislature to appropriate funds dedicated to environmental flow projects. The Legislature appropriated two million dollars, $750,000 of which has been reserved for projects in the Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San

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[202] See 30 Tex. Admin. Code § 298.380(3)(A)-(C) and (4)(A)-(C).
[203] 30 Tex. Admin. Code § 398.3309(a)
[204] Tex. Water Code § 11.02362(p).
[205] Id.
[206] Work Plans for each BBASC are *available at:* http://www.tceq.texas.gov/permitting/water_rights/eflows/resources.html.

Antonio Bays Basin and Bay Area, with the remaining funds to be distributed to other basins as determined by the Science Advisory Committee and approved by the Environmental Flows Advisory Group.[207] While the two million dollar appropriation is helpful and needed, it is significantly less than the funding amounts the stakeholder committees estimated are needed to implement their work plans.[208] The funding may enable some of the basins to implement smaller projects recommended in their work plans, but two million dollars is a drop in the bucket. It seems, therefore, that at least for now, funding for environmental flow projects in Texas, much like water, is limited.

[207] S.B. 1, Article IX, Section 18.03, 83rd Leg. Reg. Sess. (Tex. 2013).

[208] For example, the Colorado-Lavaca BBASC estimated that the projected costs to address the projects in its work plan are two to four million dollars. *See* Colorado-Lavaca BBASC Work Plan, Transmittal Letter to the TCEQ (June 26, 2012) *available at*: http://www.tceq.texas.gov/permitting/water_rights/eflows/colorado-lavaca-bbsc. The Guadalupe-San Antonio BBASC estimated that to implement its tier one priority project (an instream flow study for the lower Guadalupe River), the cost would be between one to two million. *See* Guadalupe-San Antonio BBASC Work Plan at 11 (May 25, 2012) *available at*: http://www.tceq.texas.gov/permitting/water_rights/eflows/guadalupe-sanantonio-bbsc

Comparison of BBASC Recommendations with TCEQ Rules

*The Rio Grande BBASC has not submitted a recommendations report; therefore, the column is marked N/A.
**TCEQ rulemaking for the Nueces, Brazos, and Rio Grande BBASCs is not scheduled to occur until February 2014; therefore, the column is marked N/A.

	Sabine Neches	Trinity San Jacinto	Guadalupe	San Antonio	Colorado	Lavaca	Nueces	Brazos	Rio Grande
SUBSISTENCE FLOWS									
BBASC	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	N/A
TCEQ	Yes	Yes	Yes	Yes	Yes	Yes	N/A	N/A	N/A
BASE FLOWS									
BBASC	No	Conditional: 1 tier; Regime: 3 tiers	3 tiers; 50% Rule	3 tiers; 50% Rule	3 tiers above Longhorn Dam; 2 tiers below	3 tiers	3 tiers; 50% Rule	3 tiers; 50% Rule	N/A
TCEQ	1 tier	1 tier	1 tier; 50% Rule	3 tiers; 50% Rule	3 tiers above Lake Travis; 2 tiers below	3 tiers	N/A	N/A	N/A
HIGH PULSE FLOWS									
BBASC	No	Conditional: No high flow pulses Regime: 1 high pulse, and two low pulses in Winter, 2 high pulses and 2 low pulses in the Spring, and 2 low pulses in the Summer and Fall	2 small pulses per season; 1 large pulse per season; 1 annual; 1 per 2 years; 1 per 5 years Pulse Exemption: Diversion rate less than 20% of the pulse peak	2 small pulses per season; 1 large pulse per season; 1 annual; 1 per 2 years; 1 per 5 years Pulse Exemption: Diversion rate less than 20% of the pulse peak	Below Longhorn Dam: Seasonal: 2 pulses per season; 1 per 18-month pulse, 1 per 2 year pulses.	2 small seasonal, 1 large seasonal; 1 annual; 1 per 2 years, 1 per 5 years	Small and large seasonal pulses 1 to 4 times per season, 1 per year, 1 per 2 years, 1 per 5 years Pulse Exemption: Diversion rate less than 20% of the pulse peak	1 to 3 seasonal pulses depending on the hydrologic condition and the season Pulse Exemption: Diversion rate less than 20% of the pulse peak	N/A
TCEQ	1 pulse per season in Summer and Winter; 2 pulses per season in Spring and Fall Pulse Exemption: Diversion amount less than 10,000 acft/yr	2 pulses per season Pulse Exemption: Diversion amount less than 10,000 acft/yr	2 small pulses per season; 1 large pulse per season Pulse Exemption: Diversion rate less than 20% of the pulse peak	1 or 2 small pulses per season; 2 or 3 large pulses per time period Pulse Exemption: Diversion rate less than 20% of the pulse peak	Below Lake Travis: 2 pulses per season, 1 pulse per 18 months, 1 pulse per 2 years Pulse Exemption: Diversion rate less than 500 cfs or impoundment less than 2,500 acft below Lake Travis	2 small seasonal; 1 large seasonal; 1 per year. Pulse Exemption: None	N/A	N/A	N/A
BBASC Decision by Consensus									
	Consensus on recommendations	No. BBASC submitted two separate reports by sub-groups plus some consensus policy recommendations	Consensus on majority of flow recommendations, with the exception of those related to 10% dedication rule. *See* Guadalupe-San Antonio BBASC Report, page iii for a tabulation of final vote.	Consensus on all recommendations for gages on San Antonio River	Consensus on all recommendations	Consensus on all recommendations	Consensus on all recommendations	Consensus on flow recommendations for all 20 gages, with the exception of pulse flows for 3 gages	N/A