## Technical Memorandum

**Date:** November 19, 2010

**To:** Sabine and Neches Rivers and Sabine Lake Bay Basin and Bay Area Stakeholder Committee (BBASC)

**From:** Sabine and Neches Rivers and Sabine Lake Bay Basin and Bay Expert Science Team (BBEST) BBASC Flow Regime Review Subcommittee (BBEST Subcommittee)
Jack Tatum, Co-Chair, SRATX; Scott Hall, Co- Chair, LNVA

**Subject:** Evaluation of TCEQ proposed and Sabine-Neches BBASC proposed environmental flow standards and set-asides for the Sabine and Neches River Basins

At the request of the BBASC, the BBEST Subcommittee conducted a review of the Texas Commission on Environmental Quality (TCEQ)'s proposed environmental flow standards for the Sabine and Neches River Basins and the potential impact these standards would have on the available future water supplies in the basins. The TCEQ conducted a similar analysis for these future projects; however, the TCEQ's analysis was limited to one set of simplified assumptions. The Sabine-Neches BBASC directed the BBEST Subcommittee to conduct a broader analysis as a part of this evaluation and to evaluate several additional projects and conditions in order to provide to the Sabine-Neches BBASC a more thorough evaluation of the impacts. Additionally, since the TCEQ's proposed standards were determined based on the BBEST "recommended" regime that the BBASC determined could not result in an appropriate balance between environmental needs and the need for water for other purposes, the BBASC requested that the BBEST Subcommittee examine an alternative flow regime that does not include hydrologic weather conditions or as many high flow pulses. The set of environmental flow standards proposed by Sabine-Neches BBASC for evaluation are outlined in the table below and further detailed in Tables 1 and 2 on page 11.

RECOMMENDED SABINE-NECHES BBASC FLOW REGIME

| **Flow Component** | **Recommendation** |
|---|---|
| *Subsistence Flows* | Seasonal subsistence flow |
| *Base Flows* | Seasonal base flow |
| *High Flow Pulses* | • 1 spring high flow pulse |
| | • 1 fall high flow pulse |
| *Overbank Flows* | Not recommended (no change to current TCEQ proposed standards) |

As requested by the Sabine-Neches BBASC, the following technical memorandum provides relevant observations and the modeled impacts to future available supplies within the Sabine and Neches River Basins that can be expected from the environmental flow standards proposed by TCEQ and to the standards proposed by the BBASC.

## ***TCEQ Evaluation of Proposed Standards and Rules for the Sabine and Neches Basins***

For the Sabine and Neches River Basins, TCEQ evaluated the potential impact of its proposed standards on two projects: a pending application to increase the annual diversion amount from Toledo Bend Reservoir located on the Sabine River, and a proposed run-of-the-river diversion from the Neches River near Alto, TX into an off-channel reservoir. These two projects were evaluated by TCEQ under the following alternatives: 1) no environmental flow requirements, 2) environmental flow requirements using the Lyons method, and 3) environmental flow requirements using the TCEQ proposed rules and standards.

### Sabine River Basin

In the TCEQ's analysis for the Toledo Bend Reservoir application for additional diversions, the existing State of Texas authorized diversion amount is *senior* to the proposed environmental flow standards while the increase in authorized annual diversion amount is *junior* to the proposed environmental flow standards. **Additionally, under the TCEQ's evaluation, the storage right for Toledo Bend Reservoir is considered to be *senior* to the environmental flow standards under all assumed conditions.** Because the storage right is senior to the environmental flow standards, the impact of the proposed standards (or the current default standards) on the proposed increase for diversions is negligible, as shown in the table below. Previous analysis was provided to the BBASC in April, which was based on a "worst-case" assumption that there was a proposed amendment that resulted in the entire reservoir being fully subjected to the SNBBEST flow regime. That previous analysis indicated that the yield of Toledo Bend Reservoir would be reduced by ~30%.[1] The TCEQ's analysis of impacts, primarily because the TCEQ allowed the entire storage right of Toledo Bend Reservoir to be senior to the proposed flow regime, predicted very little impact on the yield of Toledo Bend Reservoir. Although the SNBBEST subcommittee agrees with TCEQ that the storage right should be considered senior to the environmental flow standards, the proposed rules do not specify this nor do they speak to many other issues regarding application of the standards that could have a dramatic effect on the degree to which the proposed standards affect available water supply. Also, the strategy selected by TCEQ for balancing the environmental need for water with the need for water for other purposes, being virtually exempt from the proposed environmental standards, appears to be a poor choice. As shown in our analysis for other projects, the impact on water supply projects that are fully subject to the proposed standards is similar to that found in the analysis done in April.

[1] That report also indicated that if the entire Toledo Bend Reservoir was subjected to the SNBBEST flow regime and the loss in yield were totally allocated to the Texas portion of the reservoir, the water supply yield of the reservoir would be decreased by more than 60%.

Toledo Bend Reservoir New Permit Application

| Environmental flow scenario | Annual Yield (acre feet) | Impact (afy) |
|---|---|---|
| None | 1,859,400 | baseline |
| Lyons default standards | 1,859,400 | none |
| TCEQ proposed standards | 1,859,300 | -100 |

It is not clear to what extent a future Interbasin Transfer (IBT) amendment to Toledo Bend Reservoir (as planned for in the SB 1 Texas state water planning process) will be protected from substantial impact from TCEQ's proposed environmental flow standards as a result of the senior storage right. The proposed rules do not specify how the environmental flow standards are to be applied to an amendment to increase the annual appropriation from a reservoir with a senior storage right. Further complicating the evaluation of any future amendments to Toledo Bend Reservoir are the issues of: 1) the joint ownership with Sabine River Authority, State of Louisiana, and use of the reservoir by the State of Louisiana under the Sabine River Compact, and 2) the use of the reservoir for hydropower generation and the subsequent regulations imposed by the Federal Energy Regulatory Commission (FERC).[2] Neither of these issues are explicitly addressed in the rules or in the analysis of the impacts of those rules. The TCEQ's analysis of impacts does consider both the Texas and Louisiana portions of the reservoir and assumes full use of the hydropower pool authorized under the Texas water rights. Various alternative scenarios related to these issues were analyzed by this subcommittee and are presented below.

**Neches River Basin**

The TCEQ also evaluated the potential impact of one proposed project which would require additional diversions on the Neches River near Alto, TX. This project is generally included in the Region C Regional Water Plan (RWP) as a future "scalping and storage" project to replace the Fastrill Reservoir project proposed in a previous RWP; however, the plan as proposed within Region C is quite different than the project evaluated by TCEQ. The new project, as outlined by TCEQ, proposes a 540,000 afy diversion from available run-of-river flows which would not be 100% reliable. The summary of results for the TCEQ analysis is shown below.

Neches River Scalping Project

| Environmental Flow Scenario | % reliability by period | % reliability by volume |
|---|---|---|
| None | 33.6% | 53.1% |
| Lyons Default | 30.0% | 42.0% |
| Proposed by TCEQ | 27.5% | 40.5% |

This table indicates that both the Lyons and TCEQ proposed standards have limited impact on the reliability of the water right relative to its reliability without any environmental flow requirements. However, since the project objective would be to develop a water supply yield using the storage capacity from an off-channel reservoir, a more appropriate factor to be evaluated is the "water volume available for storage" using a practical maximum diversion amount. Therefore, as a part of this analysis, the entire period of

[2] The Toledo Bend Project hydropower license expires in 2013, and the Project is currently in a relicensing process.

record for the model was evaluated using: 1) an assumed unlimited diversion rate and, 2) a pumping rate limited to a maximum 1 million gallons per minute. The resulting long-term average of the annual water available for diversion shown below provides a better indication of the potential yield of this proposed scalping project under these assumed conditions.

Neches River Scalping Project- Revised

| | Streamflow available for diversion (afy) | |
|---|---|---|
| Environmental Flow Scenario | with infinite infrastructure | with diversion rate limited |
| None | 607,555 | 504,516 |
| Lyons Default | 525,944 | 428,855 |
| Proposed by TCEQ | 511,422 | 412,762 |

Assuming a reasonable maximum diversion rate and applying the proposed TCEQ environmental flow standards results in a loss of over 18% of the potential diversion, while the Lyons method reduces potential project diversion and corresponding yield by 15%.

**Other Issues Identified with the TCEQ Standards**

Weather conditions

As a result of using the default HEFR method, the Sabine Neches BBEST provided flow regime recommendations based on variable weather condition as defined in the HEFR criteria (dry, wet, and average) based on the arbitrary 25% and 75% probability distribution of cumulative water supply storage in major reservoirs located upstream. Several unexpected and unintended consequences that occur as a result of this recommendation have since been recognized by the Sabine-Neches BBASC. These are as follows:

- The actual implementation of the flow regime recommendations within permit conditions for new projects will be significantly complicated and will require additional data analysis and effort for the permit holder or project operator to determine the actual operational diversion, storage, and subsequent pass-through requirements for each designated season. The resulting overall level of complexity is not warranted and it creates too many opportunities for errors in the implementation of the environmental flow standards.
- Prior to full utilization of all authorized permits, the predominate climatic condition which will be established based on the proposed rules for reservoir storage content is that of “wet” or occasional “average” conditions, no matter what actual climatic condition exists. While the project yield will not necessarily be negatively impacted by this interim condition, there will occasionally be pass-through flows called for within dry pre-drought conditions which will reduce the average water level of the impacted project inappropriately even though the designated dry condition may not be reached by the reservoir levels.

In order to address the problems presented by the use of weather conditions within the standards, the Sabine-Neches BBASC requested that the impact evaluation of base flows be done without hydrologic conditions. Furthermore, in the Sabine and Neches Basins, the Sabine-Neches BBASC flow regime proposal,

in addition to the seasonal subsistence and seasonal base flows, includes a single spring pulse and a single fall pulse.

Bon Wier Measuring Site

The Bon Wier historic hydrologic dataset presented some problems for the BBEST analysis developed during the recommendations phase of the SB3 program. As stated in the Sabine-Neches BBEST Environmental Flows Recommendations Report (page 123), in the HEFR analyses for Sabine-Neches BBEST, the Bon Wier gage appeared to have discrepancies and counter-intuitive statistical flow records when compared to the downstream Ruliff gage (see Section 6.2.1.6, page 127). In most cases, it is expected that the downstream gage would have higher values for the flow regime than the upstream gage due to the larger flows generally created by the larger drainage area. However, the HEFR flow regime values for the Bon Wier gage site are almost always significantly higher than the comparable flow regimes for the Ruliff gage site located approximately 59 river miles downstream. The reason for this discrepancy may stem from various factors including a change in the HEFR criteria adopted for the Bon Wier and Ruliff gages, but it is unclear based on available information if threshold parameters should be changed and how this would translate into actual environmental flow needs for this reach of the river. Because of this uncertainty, it is recommended for consideration that the BBASC may want to exclude the Bon Wier gage as a measuring point at this time and designate that the Ruliff gage be used exclusively to represent the environmental flow standards for the lower Sabine River.

Subsistence Flow Targets in a Monthly Model

The proposed environmental flow criteria are expressed as daily average (in cfs) target flow amounts which potentially must be passed-through without diversion or storage in accordance with the state's priority water rights system. For new or amended projects, flows below the base flow and above subsistence targets may be stored or diverted when appropriately permitted. However, current water availability models use a monthly time step to evaluate operations and the resulting predicted allowable diversions and storage. Under the TCEQ methodology for predicting the amount of flow in a given month that may be available for diversion or storage, there is a potential for the amount to be significantly over-estimated based upon the actual daily average flow amounts (cfs).[3] If the subsistence target is instead omitted from the model evaluation and the flows less than the base flow are not included in the diversion estimates, the predicted diversions will be somewhat under-estimated. In the evaluation of the alternative standards for the Neches River Basin, the subsistence flow targets were not included in order to provide a more conservative estimate of the potential firm yield of future projects.

## ***Evaluation of Potential Impacts for Other Future Projects***

[3] For example, using the SNBBASC recommended regime for spring at Ruliff, the base flow is 1,208 CFS and the subsistence flow is 436 CFS. If the daily flow values for a single month were comprised of one day of exactly the subsistence flow and 29 days of exactly the base flow, the model would calculate that 71,311 af could be diverted, when in the real world, no diversions would be allowed that month.

From review of the TCEQ's analyses of the probable impact of its proposed environmental flow standards on water available for use for purposes other than environmental flows, it was obvious that the two projects that TCEQ evaluated had unique attributes that minimizes the effect of the TCEQ proposed environmental flow standards. In order to provide the Sabine-Neches BBASC with additional relevant information, the impacts of the TCEQ's proposed environmental flow standards were analyzed for other proposed water supply projects within the Neches and Sabine River basins. Using the same general methodology used by TCEQ, the BBEST Subcommittee modeled the potential impacts of the proposed standards for four additional projects using appropriate modeling assumptions for those projects, as further outlined below. The projects evaluated were: 1) an amendment for an existing mid-basin reservoir (Toledo Bend Reservoir) on the Sabine River, 2) a future reservoir (Big Sandy Reservoir) located on a small tributary in the upper Sabine River Basin, 3) a future reservoir (Mineola Reservoir) located on the main stem of the upper Sabine River, and 4) a mid-basin reservoir (Rockland Reservoir) located on the Neches River. Each project has unique issues and constraints and, as a group, provides an excellent range of conditions for evaluating the likely impact of TCEQ's and the BBASC's proposed standards on the amount water available for human use.[4]

***Toledo Bend Reservoir Interbasin Transfer***

The current approved RWP for Region C includes significant projects which require IBT amendments for Toledo Bend Reservoir to meet future long-term needs. Although these needs are not designated to occur for many years into the future, there are necessary activities which must begin in the near future in order to allow these projects to move forward. The TCEQ's draft rules currently do not address how future IBT amendments might be handled for existing projects such as Toledo Bend Reservoir; therefore, this evaluation considered two options: 1) the proposed diversions which require IBT amendments were considered to be junior to the environmental flow standards but the existing reservoir storage would remain senior, and 2) both the proposed diversions and storage to support those diversions were considered junior to the environmental flow standards. In both options, similar to the TCEQ methodology, the Louisiana diversions and storage were held senior and no FERC criteria[5] were included. The impact of the proposed TCEQ standards is relatively small under the senior storage assumption, but serious under the junior storage assumption. In order to provide comparable results, the amount of senior diversion and storage for Texas was "set" at 150,000 afy for this modeling scenario and the resulting available diversion amount (combined junior and senior) is provided below for each of the two options evaluated. No hydropower was assumed to be generated by releasing water from the authorized hydropower storage pool for either of these options.

[4] The BBEST Subcommittee again points out that the proposed rules do not, with any detail, specify how TCEQ's proposed flow regime will be applied to water rights on a real-time basis. The actual effect on a project when it is constructed could vary widely from what is simulated because the assumptions can make a great deal of difference on the final results of the simulation.

[5] Currently 144 cfs continuous minimum release at the spillway which equals approximately 104,000 afy.

Toledo Bend IBT (with 150,000 afy remaining senior)

| Environmental Flow Scenario | Total Project Yield (afy) | Impact (afy) | Texas Share of Yield (afy) | % reduction from baseline |
|---|---|---|---|---|
| None | 1,911,100 | baseline | 955,550 | - |
| Lyons - storage senior | 1,895,150 | - 15,950 | 939,600 | 1.7 % |
| Lyons - storage junior | 1,597,050 | -314,050 | 641,500 | 32.9 % |
| TCEQ Standards-storage senior | 1,892,150 | - 18,950 | 936,600 | 2.0 % |
| TCEQ Standards-storage junior | 1,720,250 | -190,850 | 764,700 | 20.0 % |
| BBASC Standards-storage senior | 1,910,950 | -150 | 955,400 | - |
| BBASC Standards-storage junior | 1,885,550 | -25,550 | 930,000 | 2.7 % |

***Big Sandy Reservoir***

A relatively small reservoir on Big Sandy Creek has been identified in previous studies as a potential future source of water for the upper Sabine River Basin area. Although the Big Sandy Reservoir project is not recommended for inclusion within any current RWP, it was selected as a typical upper basin tributary project which can be used for evaluating the impact of proposed environmental flow standards. Other similar reservoir projects in this region are currently being evaluated and may be recommended in the future. One complication for evaluating this project is related to the subordination provision in the Toledo Bend Reservoir water rights. For this analysis, Big Sandy Reservoir was evaluated under two different assumptions: 1) the new reservoir would be considered junior in priority for both diversion and storage to the environmental flow standards and to Toledo Bend Reservoir, and 2) the new reservoir would be junior in priority to the environmental flow standards but senior to Toledo Bend Reservoir. The results for this analysis are shown below. In April, the BBASC was provided with a preliminary analysis of the expected impact of the SNBBEST recommended standards for a slightly different version of Big Sandy Reservoir which assumed that this reservoir would be senior to Toledo Bend Reservoir. That previous analysis indicated an approximate loss of yield from the baseline "no standards condition" of ~47 %.

Big Sandy Reservoir-junior to Toledo Bend

| Environmental Flow Scenario | Total Project Yield (afy) | Impact (afy) | % reduction from baseline |
|---|---|---|---|
| None | 7,740 | baseline | - |
| Lyons Standards | 7,740 | - | - |
| TCEQ Proposed Standards | 7,180 | -260 | 3.4 % |
| BBASC Standards | 7,740 | - | - |

Big Sandy Reservoir-senior to Toledo Bend

| Environmental Flow Scenario | Total Project Yield (afy) | Impact (afy) | % reduction from baseline |
|---|---|---|---|
| None | 44,090 | baseline | - |
| Lyons Standards | 23,380 | -20,710 | 47.0 % |
| TCEQ Proposed Standards | 31,900 | -12,190 | 27.7 % |
| BBASC Standards | 33,950 | -10,140 | 23.0 % |

***Mineola Reservoir***

A large upper basin reservoir has been previously proposed on the Sabine River immediately downstream of Lake Tawakoni with a dam located near FM 17. This reservoir is not currently included within any RWP, but could also meet significant future needs of the upper basin and this region of the state for additional water supplies. Like Big Sandy Reservoir, this project provides an additional opportunity to evaluate the long-term impact of the proposed environmental flow standards for this and other similar main-stem projects which have been identified for the upper basin. Mineola Reservoir was also evaluated assuming that it would be junior to the proposed environmental flow standards but would be either junior or senior to Toledo Bend Reservoir.[6] The results of this analysis are shown below. In April, the BBASC was provided with a preliminary analysis of the expected impact of the SNBBEST recommended standards assuming senior priority to Toledo Bend Reservoir which indicated an approximate loss of yield from the baseline "no standards condition" of ~25 %.

Mineola Reservoir-junior to Toledo Bend

| Environmental Flow Scenario | Total Project Yield (afy) | Impact (afy) | % reduction from baseline |
|---|---|---|---|
| None | 92,880 | baseline | - |
| Lyons Standards | 59,190 | -33,690 | 36.3 % |
| TCEQ Proposed Standards | 78,550 | -14,330 | 15.4 % |
| BBASC Standards | 89,980 | -2,900 | 3.1 % |

Mineola Reservoir-senior to Toledo Bend

| Environmental Flow Scenario | Total Project Yield (afy) | Impact (afy) | % reduction from baseline |
|---|---|---|---|
| None | 174,230 | baseline | - |
| Lyons Standards | 90,840 | -83,390 | 47.9 % |
| TCEQ Proposed Standards | 159,040 | -15,190 | 8.7 % |
| BBASC Standards | 165,750 | -8,480 | 4.9 % |

[6] it should be noted that in the cases where the proposed reservoir is senior to Toledo Bend Reservoir, the increase in the yield of the proposed reservoir is offset by a loss of yield from Toledo Bend Reservoir.

***Rockland Reservoir***

Since the Neches off-channel reservoir project near Alto does not readily lend itself to evaluation and yield analysis, the BBEST Subcommittee evaluated another theoretical mid-basin Neches River project, Rockland Reservoir, which has been proposed to meet long-term future needs within the region. The project was modeled based on physical data from the original US Army Corps of Engineers project report. For the purpose of this evaluation Rockland was considered to primarily be a water supply project and hydro-power was not included in the evaluation. A primary modeling assumption included making the Rockland Reservoir a new site, junior to existing water rights. The impoundment "baseline" was then evaluated to maximize its yield without environmental flow requirements and without diminishing the present yield of any other existing water right in the basin. The "baseline" yield of this project was determined to be 826,590 acre feet/year. Environmental flow standards were incrementally applied in this evaluation using the Rockland USGS Gage as the only measurement point. Results of the impact to yield for the various conditions are displayed below. Similar to the off-channel project near Alto, the impacts of the TCEQ environmental flow standards appear to be fairly limited when evaluating the "reliability" of achieving the baseline and can be easily overlooked. When subjected to the TCEQ proposed standards, the table shows a loss of achieving the desired flow only about 10% of the time or a loss of achieving the desired annual volume of flow of about 10% less by volume. However, the actual firm or 100% reliable yield of the project is reduced substantially, with over 225,000 afy of reduced yield or approximately 27% less than the baseline. As shown in the table, any of the environmental flow standards which are imposed of this large mid-basin project, including the BBASC suggested standards, become detrimental to the project yield and the problems are exacerbated when multiple pulses per season, especially large pulses, are prescribed, such as in the TCEQ standards.

Rockland Reservoir

| | Reliability of baseline 826,590 afy | | Total Project | % reduction |
|---|---|---|---|---|
| Environmental Flow Scenario | % by period | % by volume | Yield (afy) | from baseline |
| None | 100 % | 100 % | 826,590 | 0% |
| Lyons | 89.2 % | 90.0 % | 509,709 | 38.3% |
| TCEQ Proposed Standards | 88.6 % | 90.6 % | 598,408 | 27.6% |
| BBASC Standards | 95.0 % | 96.0 % | 657,828 | 20.4% |

**Summary and Conclusions**

TCEQ Analysis of Impact- The TCEQ selected one project for each of the Sabine and Neches River Basins to evaluate the potential impacts of the proposed environmental flow standards. The selected Sabine project was essentially defined as being exempt from the standards and thus was only negligibly affected. The Neches project lost over 18% of its potential yield under the modeled assumptions. The Subcommittee also identified several issues with the TCEQ proposed standards which were the result of following the default methodology provided by the SAC and which caused unexpected problems, including: 1) the use of weather conditions to establish flow targets within the proposed flow regime used to set the standards, 2)

using the Bon Wier gage data in the Sabine River Basin which produced questionable results, and 3) over-estimating yield of new projects through use of monthly WAM models.

Impact on Other Future Projects- Based on the above analyses it is readily apparent that the effect of TCEQ's proposed standards on future projects can vary widely. For example, it appears that projects in the upper reaches of a river basin are affected less by TCEQ's proposed standards than projects proposed for lower in the basin. There is also a wide variation in the predicted impacts of TCEQ's proposed standards based on the modeling assumptions selected. As a result, the impact of TCEQ's proposed flow regime on projects can range from negligible to excessive. This presents a substantial problem for the SNBBASC in addressing its charge to weigh proposed environmental flow regimes with man's need for water in that the impact of the regime on future projects is only a crude estimate. There are several layers of uncertainty. The computational tools (WAMs) use to conduct these analyses are still evolving. The priority system of Texas water rights process necessitates a highly complex operational river management system. For example, there are water rights with multiple water use categories and variable patterns of use. There can also be multiple priority dates for storage within a single reservoir storage pool, complex subordination agreements, interstate compacts for shared waters, seasonal hydropower operations. On top of this, TCEQ is proposing multi-tiered environmental flow regimes which must be woven into the required operational rules governing diversions and storage of the State's waters with little if any guidance how these proposed standards are to be met on a real time basis. The TCEQ's fundamental tools for analyzing water rights, the Water Availability Models (WAMs), were not initially developed to handle this complex set of factors and have only recently been modified to allow evaluation of these environmental flow regimes.[7] As has occurred throughout this SB3 process, the initial basins which have led this SB3 process, including the Sabine and Neches, are once again required to develop untested procedures and formulate new tools within a highly compressed time-frame. To date, there has not been sufficient time to adequately review and test these models for their appropriateness or precision. As a consequence, the absolute values for the project yields and computed impacts are, in many cases, subject to further change and evolution for purely mechanical reasons, irrespective of the final interpretation of policies and procedures.

Observation- In an ideal situation, elements of this program should be better defined and clarified to reduce the uncertainty of the information regarding the impact of TECQ's proposed standards on future water supply projects. Unfortunately, as in the other phases of the SB 3 process, the timeliness of the answer seems to be the focus rather than the correctness of the answer.

One simplified approach to visually demonstrate and compare the potential impacts of the proposed TCEQ standards with the BBASC standards is provided in Figures 1 and 2, below. Historical flow hydrographs for the last five years are shown for two locations within the Sabine and Neches River basins, the Beckville and Rockland gages, with the required respective pass-through flows at each location also shown in the graphs for the two proposed standards. These graphs illustrate the amount of flow above the respective environmental flow standards which would be available for diversion or storage during this 5-year period for a potential new project in each area and the resulting reductions in total volume of diversion for those flows is noted within each graph.

[7] These modified WAMs have only been available to the public for a few weeks.

| Season | Flow Status | Table 1 Sabine River and Tributaries<br>BBASC Recommended E-flow (cfs) by location, season, and flow status<br>**BSBS**<br>Big Sandy Creek near Big Sandy, TX | **SRGW**<br>Sabine River near Gladewater, TX | **SRBE**<br>Sabine River near Beckville, TX | **SRBW***<br>Sabine River near Bon Wier, TX | **n/a****<br>Big Cow Creek near Newton, TX | **SRRL**<br>Sabine River near Ruliff, TX |
|---|---|---|---|---|---|---|---|
| Winter | Subsistence | 20 cfs | 45 cfs | 66 cfs | 479 cfs | 28 cfs | 949 cfs |
| Jan-Feb-Mar | Base | 66 cfs | 277 cfs | 438 cfs | 1,460 cfs | 56 cfs | 1,520 cfs |
| | Pulse | None Required | None Required | None Required | None Required | None Required | None Required |
| Spring | Subsistence | 9 cfs | 22 cfs | 28 cfs | 279 cfs | 20 cfs | 436 cfs |
| Apr-May-Jun | Base | 30 cfs | 119 cfs | 232 cfs | 857 cfs | 38 cfs | 1,208 cfs |
| | Pulse 1 per season | Trigger: 313 cfs<br>Duration: 13 days<br>Volume: 5,062 ac-ft | Trigger: 1,580 cfs<br>Duration: 16 days<br>Volume: 51,150 ac-ft | Trigger: 2,160 cfs<br>Duration: 15 days<br>Volume: 72,092 ac-ft | Trigger: 6,700 cfs<br>Duration: 12 days<br>Volume: 151,163 ac-ft | Trigger: 350 cfs<br>Duration: 7 days<br>Volume: 2,545 ac-ft | Trigger: 3,250 cfs<br>Duration: 8 days<br>Volume: 42,883 ac-ft |
| Summer | Subsistence | 8 cfs | 14 cfs | 22 cfs | 241 cfs | 20 cfs | 396 cfs |
| Jul-Aug-Sep | Base | 14 cfs | 34 cfs | 51 cfs | 478 cfs | 28 cfs | 670 cfs |
| | Pulse | None Required | None Required | None Required | None Required | None Required | None Required |
| Fall | Subsistence | 8 cfs | 17 cfs | 22 cfs | 241 cfs | 20 cfs | 396 cfs |
| Oct-Nov-Dec | Base | 20 cfs | 49 cfs | 75 cfs | 478 cfs | 36 cfs | 735 cfs |
| | Pulse 1 per season | Trigger: 130 cfs<br>Duration: 9 days<br>Volume: 2,189 ac-ft | Trigger: 380 cfs<br>Duration: 11 days<br>Volume: 1,098 ac-ft | Trigger: 628 cfs<br>Duration: 9 days<br>Volume: 7,245 ac-ft | Trigger: 2,590 cfs<br>Duration: 7 days<br>Volume: 40,957 ac-ft | Trigger: 322 cfs<br>Duration: 7 days<br>Volume: 2,232 ac-ft | Trigger: 2,020 cfs<br>Duration: 5 days<br>Volume: 17,662 ac-ft |

*Due to uncertainties related to HEFR flow regime values at Bon Wier, it is recommended for consideration by the BBASC that the Bon Wier gage not be used as a measuring point at this time.

**No control point is established within the WAM for this gage.

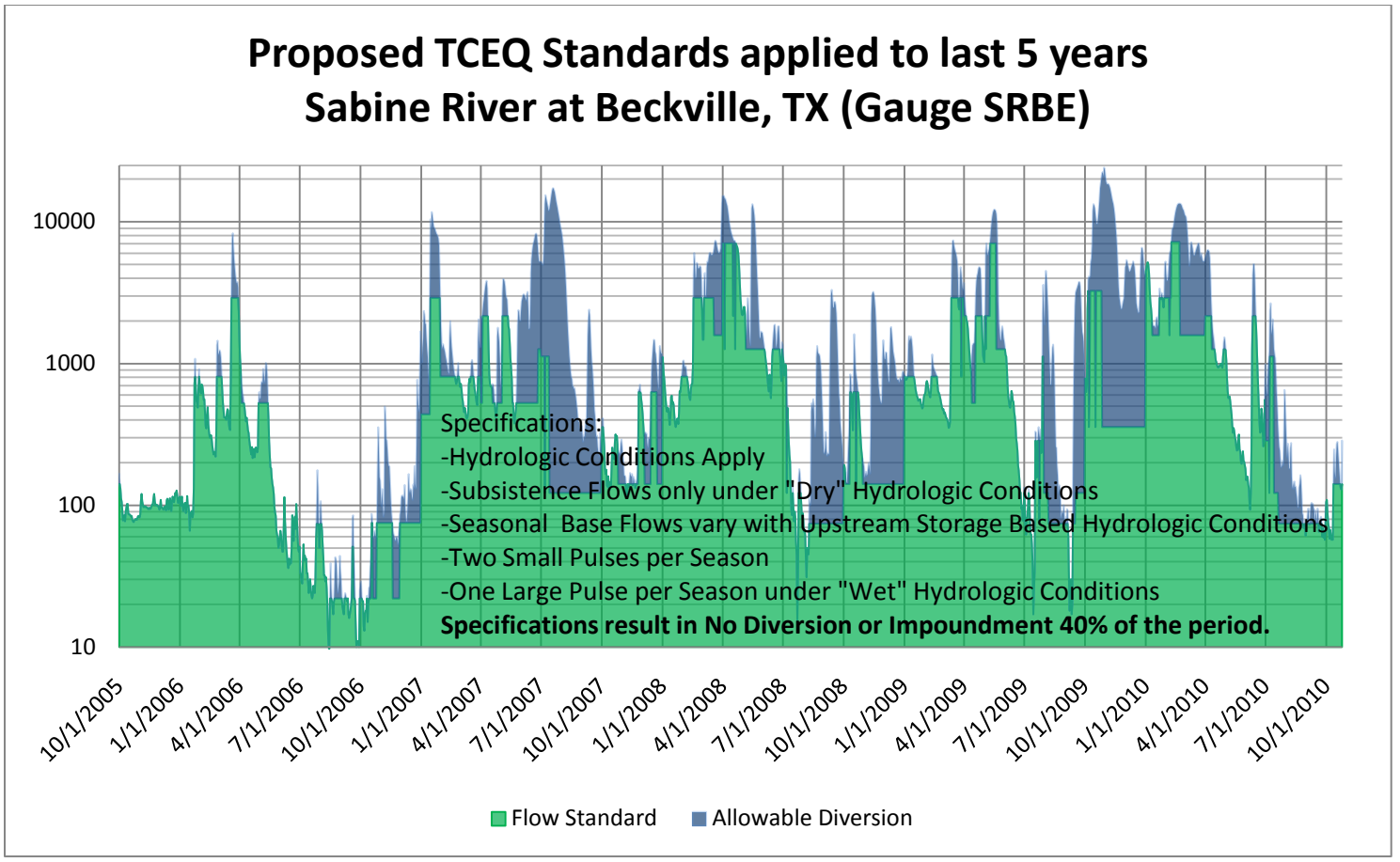
All designated flow rates shown in this table represent average daily values in units of cubic feet per second.

| Season | Flow Status | Table 2 Neches River and Tributaries<br>BBASC Recommended E-flow (cfs) by location, season, and flow status<br>**NENE**<br>Neches River near Neches, TX | **NERO**<br>Neches River near Rockland | **ANAL**<br>Angelina River near Alto, TX | **NEEV**<br>Neches River near Evadale, TX | **VIKO**<br>Village Creek near Kountze, TX |
|---|---|---|---|---|---|---|
| Winter | Subsistence | 51 cfs | 67 cfs | 55 cfs | 228 cfs | 83 cfs |
| Jan-Feb-Mar | Base | 178 cfs | 548 cfs | 252 cfs | 1,750 cfs | 240 cfs |
| | Pulse | None Required | None Required | None Required | None Required | None Required |
| Spring | Subsistence | 21 cfs | 29 cfs | 18 cfs | 266 cfs | 49 cfs |
| Apr-May-Jun | Base | 87 cfs | 382 cfs | 82 cfs | 1,640 cfs | 106 cfs |
| | Pulse 1 per season | Trigger: 820 cfs<br>Duration: 12 days<br>Volume: 20,405 ac-ft | Trigger: 1,720 cfs<br>Duration: 12 days<br>Volume: 39,935 ac-ft | Trigger: 1,100 cfs<br>Duration: 14 days<br>Volume: 24,117 ac-ft | Trigger: 3,830 cfs<br>Duration: 12 days<br>Volume: 68,784 ac-ft | Trigger: 1,380 cfs<br>Duration: 13 days<br>Volume: 23,093 ac-ft |
| Summer | Subsistence | 12 cfs | 21 cfs | 11 cfs | 288 cfs | 41 cfs |
| Jul-Aug-Sep | Base | 42 cfs | 61 cfs | 36 cfs | 527 cfs | 70 cfs |
| | Pulse | None Required | None Required | None Required | None Required | None Required |
| Fall | Subsistence | 13 cfs | 21 cfs | 16 cfs | 228 cfs | 41 cfs |
| Oct-Nov-Dec | Base | 73 cfs | 82 cfs | 47 cfs | 465 cfs | 89 cfs |
| | Pulse 1 per season | Trigger: 345 cfs<br>Duration: 8 days<br>Volume: 5,391 ac-ft | Trigger: 515 cfs<br>Duration: 8 days<br>Volume: 8,172 ac-ft* | Trigger: 588 cfs<br>Duration: 12 days<br>Volume: 12,038 ac-ft | Trigger: 1,570 cfs<br>Duration: 7 days<br>Volume: 17,815 ac-ft | Trigger: 712 cfs<br>Duration: 9 days<br>Volume: 11,426 ac-ft |

* 8,172 ac-ft is calculated based on trigger flow rate and duration as TCEQ/BBEST published number of 649 ac-ft is obvious error.

All designated flow rates shown in this table represent average daily values in units of cubic feet per second.

Figure 1


Proposed TCEQ Standards applied to last 5 years
Sabine River at Beckville, TX (Gauge SRBE)
10000
1000
100
10
Specifications:
-Hydrologic Conditions Apply
-Subsistence Flows only under "Dry" Hydrologic Conditions
-Seasonal Base Flows vary with Upstream Storage Based Hydrologic Conditions
-Two Small Pulses per Season
-One Large Pulse per Season under "Wet" Hydrologic Conditions
Specifications result in No Diversion or Impoundment 40% of the period.
10/1/2005
1/1/2006
4/1/2006
7/1/2006
10/1/2006
1/1/2007
4/1/2007
7/1/2007
10/1/2007
1/1/2008
4/1/2008
7/1/2008
10/1/2008
1/1/2009
4/1/2009
7/1/2009
10/1/2009
1/1/2010
4/1/2010
7/1/2010
10/1/2010
Flow Standard
Allowable Diversion

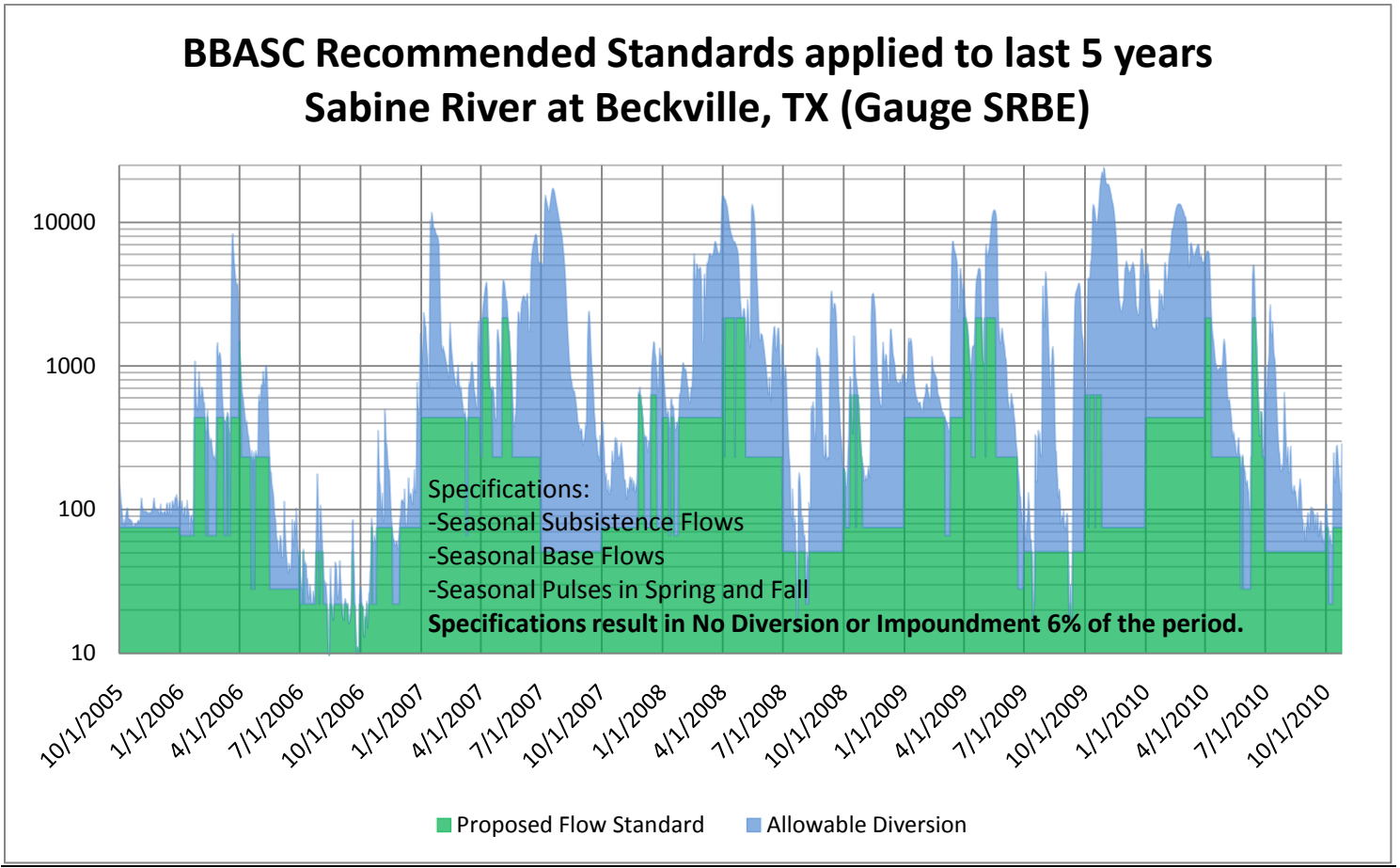
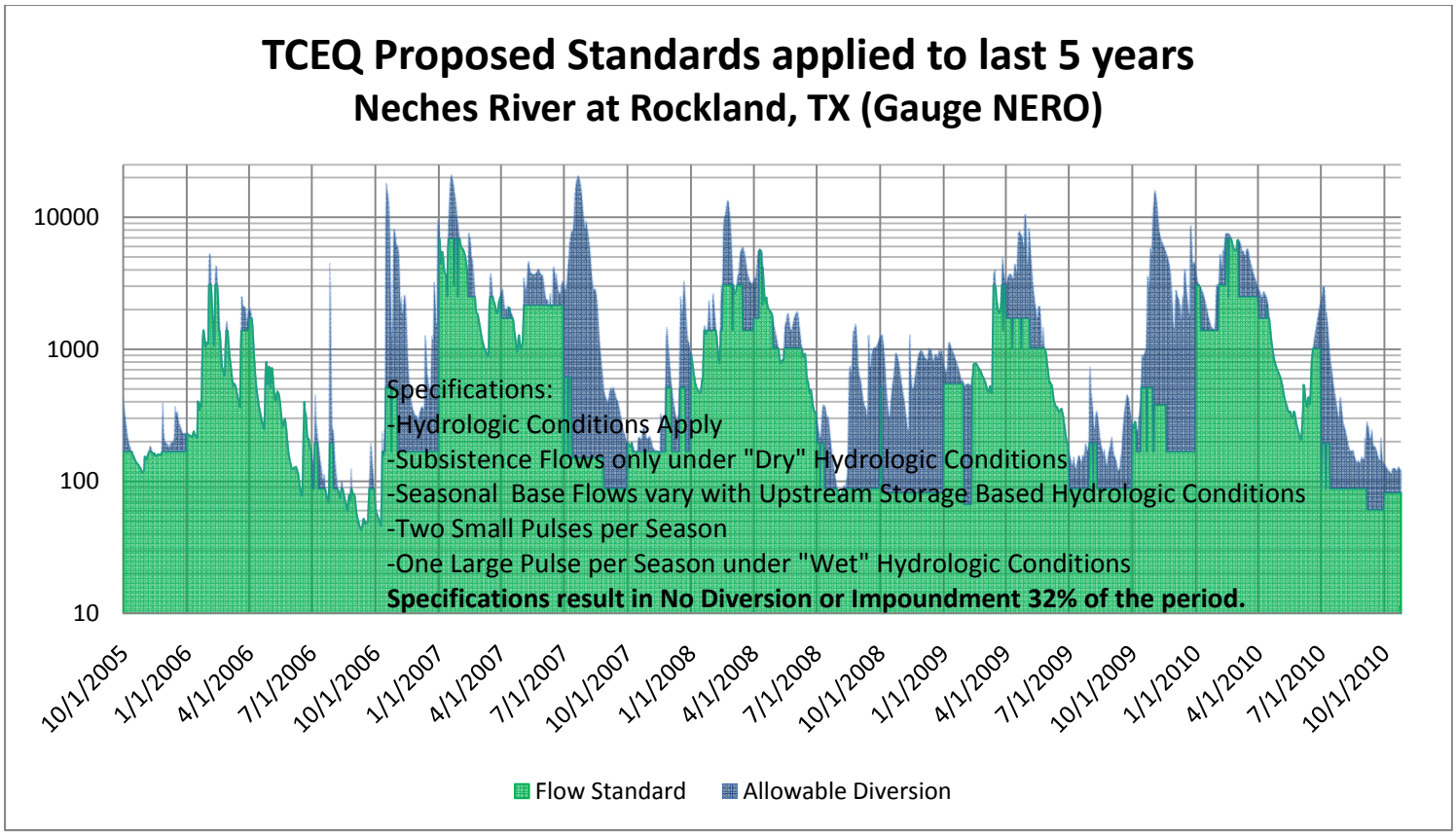
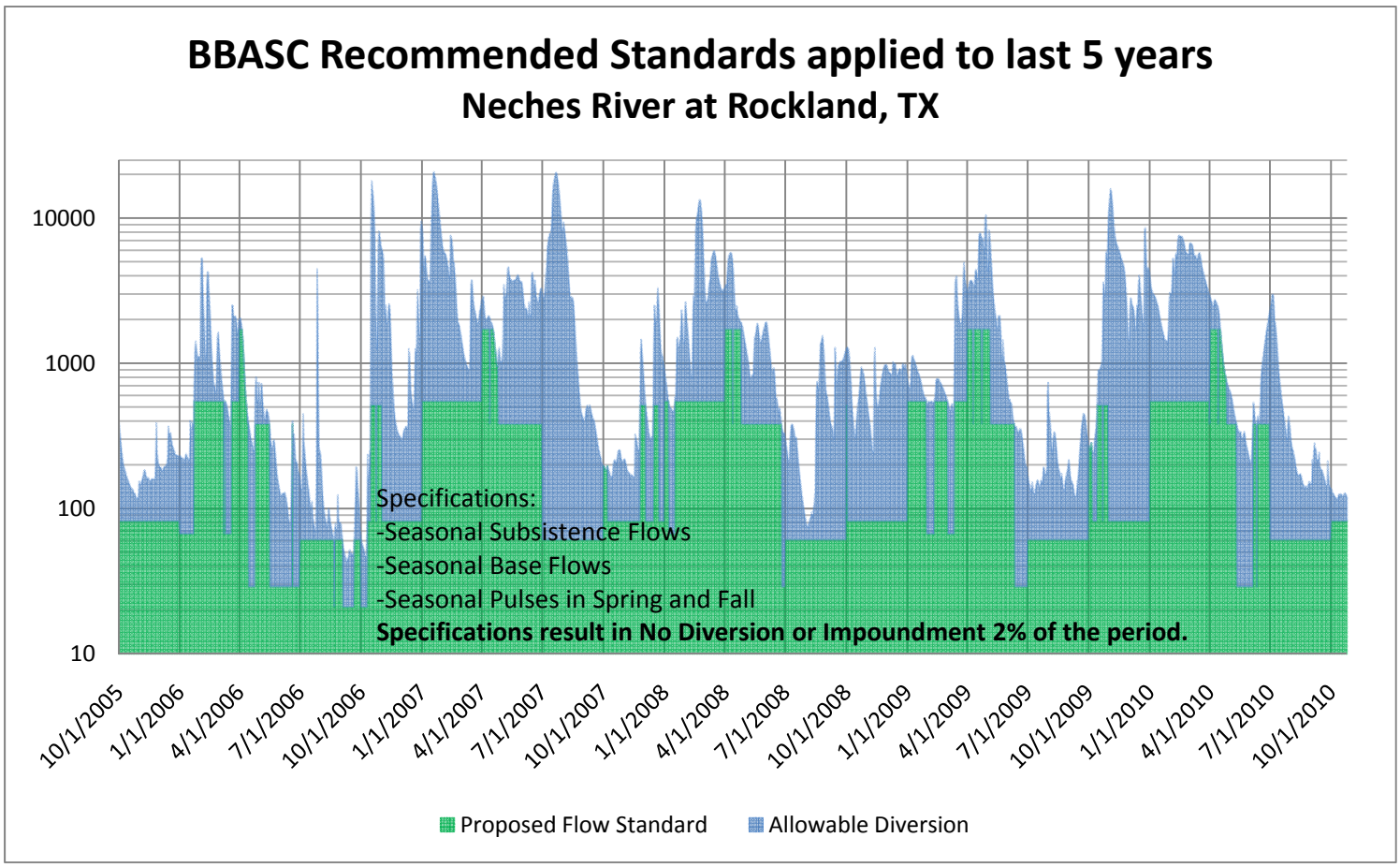

BBASC Recommended Standards applied to last 5 years
Sabine River at Beckville, TX (Gauge SRBE)
10000
1000
100
10
Specifications:
-Seasonal Subsistence Flows
-Seasonal Base Flows
-Seasonal Pulses in Spring and Fall
Specifications result in No Diversion or Impoundment 6% of the period.
10/1/2005
1/1/2006
4/1/2006
7/1/2006
10/1/2006
1/1/2007
4/1/2007
7/1/2007
10/1/2007
1/1/2008
4/1/2008
7/1/2008
10/1/2008
1/1/2009
4/1/2009
7/1/2009
10/1/2009
1/1/2010
4/1/2010
7/1/2010
10/1/2010
Proposed Flow Standard
Allowable Diversion

Figure 2


TCEQ Proposed Standards applied to last 5 years
Neches River at Rockland, TX (Gauge NERO)
10000
1000
100
10
Specifications:
-Hydrologic Conditions Apply
-Subsistence Flows only under "Dry" Hydrologic Conditions
-Seasonal Base Flows vary with Upstream Storage Based Hydrologic Conditions
-Two Small Pulses per Season
-One Large Pulse per Season under "Wet" Hydrologic Conditions
Specifications result in No Diversion or Impoundment 32% of the period.
10/1/2005
1/1/2006
4/1/2006
7/1/2006
10/1/2006
1/1/2007
4/1/2007
7/1/2007
10/1/2007
1/1/2008
4/1/2008
7/1/2008
10/1/2008
1/1/2009
4/1/2009
7/1/2009
10/1/2009
1/1/2010
4/1/2010
7/1/2010
10/1/2010
Flow Standard
Allowable Diversion


BBASC Recommended Standards applied to last 5 years
Neches River at Rockland, TX
10000
1000
100
10
Specifications:
-Seasonal Subsistence Flows
-Seasonal Base Flows
-Seasonal Pulses in Spring and Fall
Specifications result in No Diversion or Impoundment 2% of the period.
10/1/2005
1/1/2006
4/1/2006
7/1/2006
10/1/2006
1/1/2007
4/1/2007
7/1/2007
10/1/2007
1/1/2008
4/1/2008
7/1/2008
10/1/2008
1/1/2009
4/1/2009
7/1/2009
10/1/2009
1/1/2010
4/1/2010
7/1/2010
10/1/2010
Proposed Flow Standard
Allowable Diversion