RESPONSE TO TRINITY-SAN JACINTO BBASC INQUIRY

1. **It was noted that not all recommendations discussed and/or listed in the Draft Work Plan document were included in Table 4. Were these omissions intended? Why was each item omitted?**

   The study of methods for evaluating interrelationships between environmental flow regimes and proposed water supply projects was inadvertently omitted from the summary table, and as noted in the Draft Work Plan should be included as a near term work plan objective.

   Other work elements explicitly identified in the text were considered to be represented by the items enumerated within Table 4.

2. **BBEST input is needed with respect to the sequencing and dependency of the items included in the recommended "First Five Year Cycle Priorities" and items listed in Table 4 but not recommended in the first cycle.**

   Please refer to the full schedule presented as Figure 1 (Attachment A). The entities and agencies identified herein are merely those that may have the capability to perform and/or fund a specific effort. The identification of a specific entity does not represent an assignment of work, nor does it represent that such work performed by a different entity (such as academic or private) would be unacceptable. The identified time periods are an order-of-magnitude estimate of the time necessary to perform and report the work, and do not include an estimate of the time necessary to locate funding or secure a contract.

3. **Is there a critical work item not included in the recommended priority list that needs to be done in the first 5 years?**

   BBEST #7: May be necessary, depending upon availability and utility of aerial imagery.

   7.. Surveys of long reaches covering TCEQ-adopted flow sites.

   BBEST #16-19, #22-23: These items are performed as components of BBASC #6.

   16. Identification of typical riffle-run sequences, conduct low flow subsistence monitoring, biological surveys.
   17. Synoptic survey of selected rivers under baseflow conditions
   18. Coordinated surveys during high flow pulses.
   19. Basin-wide baseline surveys of (state listed species) mussels and related studies.
   22. Gather water quality data and sediment characteristic data within the segments related to Gages TR near Oakwood (Note: within SB 2 segment for TR), TR at Romayor, EFSJR near Cleveland, and WFSJR near Conroe.
   23. Gather Trinity River channel physical data for segments related to Gages TR near Oakwood (Note: within SB 2 segment for TR), TR at Romayor, EFSJR near Cleveland, and WFSJR near Conroe.

BBEST #32: The determination of the validity of indicators is necessary for the establishment of subsequent studies and monitoring.

32. Test the conclusion that these indicators (either the three immobile species or an expanded list) are appropriate for representing the ecological health of Galveston Bay.

BBEST #33: Quantification of the capability of salinity zones specific to certain organisms to represent the ecological soundness of the remaining makeup of the estuarine system would inform subsequent analyses and studies, e.g. does maintenance of the salinity niche of Vallisneria indeed relate to the ecological viability of other organisms found within the Galveston Bay system?

33. Recognizing that estuarine species have broad tolerances for salinity ranges, if a set of indicators responsive to salinity cannot be identified "as representing a healthy Galveston Bay ecosystem in its entirety" this should be explicitly stated and some attempt to quantify the relative benefit of preferred salinity zones to overall estuarine health might be attempted.

BBEST #35: Should it be determined that the existing organisms considered by the TSJ BBEST are not sufficient, it will be necessary to consider additional species.

35. Consider the addition of new species which were previously not recognized during the BBEST process.

BBEST #38: Presently, a simple average is used to delineate the proportion of flows required from the Trinity and the San Jacinto River basins. It is unknown if this is sufficient. The inter-play between freshwater inflows from these systems in the estuary underlies the foundation of subsequent analysis of salinity flux in the system, nutrient, or sediment delivery.

38. Analyze geographic factors related to flows and salinity zone areas.

BBEST #44: The TSJ BBASC identified within BBASC #11) the need for the BBEST to both design and promote studies to obtain the data necessary for statistical modeling of nutrients and sediments to inflow, as well as the need for the BBEST to develop recommendations for projects monitoring nutrient and sediments. However, between those two tasks an effort would be necessary to collect nutrient data such that informed recommendations of monitoring needs could be developed.

44. Nutrient concentration water sampling at frequencies shorter than two weeks.

4. Based on the work effort being identified by each of the recommended 13 work items, please provide an estimate of the cost to complete all elements of each work item.

Table 1. Estimated Budget

BBEST NO.	BBASC NO.	Cost	Who	Category	Description
1	3	50,000	SB 2/CRP	Instream-Hydro	3-Tier study area development
3	4	260,000	TWDB/RWPG/BBEST/USGS	Instream-Hydro	Flow regime component characterization
*	5	150,000	RWPG/BBEST/BBASC	Instream-Hydro	Evaluate interrelationships between environmental flow regimes and proposed water supply projects
8	3	80,000	CRP/TWDB	Instream-Hydro	Imagery analyses
9	3	30,000	CRP/TPWD/BBEST/BBASC	Instream-Hydro	Prioritization of intensive study sites
10	6	160,000-1,800,000 (20,000/2day visit/site, 2-15 sites)	TCEQ/CRP/TPWD/TWDB	Instream-Hydro	Intensive site-specific studies of high priority sites
14	7	125,000	BBASC/BBEST/CRP	Instream-Eco	Analyses and establishment of baseline ecological conditions
15	8	125,000	BBEST/BBASC/TPWD	Instream-Eco	Identification of Indicator Metrics & Species
21	1	100,000	TWDB/TPWD/CRP	General	Coordinate data gathering and special studies with work plan being developed for Senate Bill 2.
24	9	75,000	CRP	Instream-WQ	Analyze data and develop findings and conclusions regarding the relationship between water quality data and the proposed flow regimes.
37	10	15,000	BBEST/TWDB	Estuary-Salinity	Analyze frequencies of occurrence of proposed freshwater inflows
39	10	60,000	BBEST/TWDB	Estuary-Salinity	Expand current analysis to evaluate broader range encompassing a full flow regime, or propose alternative or complementary approach to address other components of freshwater inflow regime
43	11	30,000	BBEST/TWDB/CRP	Estuary-Nut/Sed	BBEST design and promote studies to obtain the data necessary for statistical modeling
45	11	100,000	BBEST/TWDB	Estuary-Nut/Sed	BBEST develop recommendations for monitoring projects.
50	12	300,000	BBEST/TWDB/TPWD	Estuary-Eco	Process for identifying environmental flow regime for the estuary (could include: reevaluation of the process for determining the relationships between salinity and *Vallisneria, Rangia* reproduction, and/or oyster parasitism
54	2	90,000	BBEST/TWDB/TCEQ/TPWD/BBASC	General	Determine how best to evaluate changes from a "sound ecological environment"
61	13	200,000	TPWD	Estuary-Benth/Oys	Initiate quantitative data collection for Atlantic rangia
62	13	100,000	TPWD	Estuary-Benth/Oys	Initiate or expand monitoring programs designed to assess reproduction of Rangia and parasite and predator impacts on oysters.

Total	2,020,000 - 3,660,000

Below is the total estimated cost if the additionally recommended tasks identified in response to Question 3 are included:

Total w/additional tasks	2,990,000 - 4,630,000

5. For each of the 13 recommended work items, please prepare a very brief scope of work necessary to accomplish the work item. This could include a brief outline of the steps and activities required.

1. Coordinate data gathering and special studies with work plan being developed for Senate Bill 2.
    a. Ongoing monitoring and coordination by the TWDB.
    b. Semi-annual meetings of the BBEST and BBASC in which TWDB will report on ongoing efforts, supplemented by information from TCEQ and TPWD staff.
2. Determine how best to evaluate changes from a "sound ecological environment".
    a. BBEST development of a proposed framework of:
        i. baseline indicator parameters,
        ii. baseline values of these indicators,
        iii. acceptable range of variations corresponding to a “sound ecological” condition.
        iv. Differentiate variation cause by flow from variation caused by other factors.
    b. A broad analysis and integration of information derived through other initially identified tasks.
    c. A series of four meetings of the BBEST to review these efforts, resulting in the BBEST establishing a scientific description of the baseline conditions corresponding to a “sound ecological environment” and acceptable ranges of variation from the baseline indicator conditions.
3. Study area development
    a. 3-Tier study area development.
        i. Tier 1 – Perform a high-level evaluation based primarily on basin geology, valley shape, and Texas ecoregions, resulting in the designation of large-scale study segments for both the Trinity and San Jacinto rivers.
            1. Further divide these segments into study reaches based on major hydrological and geomorphological features and conditions.
        ii. Tier 2 – More detailed evaluation focusing on specific parameters relative to the hydrology, biology, physical processes, and water quality supported within those Reaches.
            1. Perform a least one “long reach” reconnaissance survey, should be conducted at each flow level.
        iii. Tier 3 – Determine locations for the performance of a detailed examination in shorter stretches of the rivers representative of the reach in general, of practical size for the resources available.
    b. Imagery analyses
        i. Review and acquisition of available imagery information.
        ii. Analysis of aerial and satellite imagery.

c. Prioritization of intensive study sites
    i. Perform literature review of surveys, maps, and related information to determine original conditions and changes that have occurred.
    ii. Prioritize sites by utilizing literature review, imagery analysis and "long reach" survey data.

4. Flow regime component characterization.
    a. Phase 1:
        i. Perform hydrologic analyses evaluating natural/spatial/temporal variability, gains/losses.
        ii. Locate, compile, and if necessary input information on channel and flow datasets for all gages in each basin.
    b. Phase 2:
        i. Analyze data and develop findings and conclusions regarding the relationship between data collected from intensive studies and flow regimes.
5. Evaluate interrelationships between environmental flow regimes and proposed water supply projects.
    a. Evaluate to what degree a prescribed instream flow scenario (environmental flow regime or standard) is satisfied based on some current or future infrastructure/water rights assumptions, and
    b. Analyze impacts of a proposed environmental flow regime on a specific water supply project(s)
    c. Perform analyses investigating issues regarding:
        i. Use of daily versus monthly flows in the analysis of environmental flow regimes with respect to both compliance with recommended frequency guidelines and impacts on proposed water supply projects;
        ii. Appropriate means for effectively representing and satisfying frequency guidelines associated with the different base-flow components of an environmental flow regime;
        iii. Procedures for defining and implementing different hydrologic conditions as an approach for satisfying frequency guidelines associated with the different base-flow components of an environmental flow regime; and
        iv. Varying methods for defining high-flow pulse and overbank flow events for purposes of both analyzing environmental flow regimes with the WAM or other tools and implementing environmental flow regimes in the real world.
        v. Sufficiency of the assumption that the historical distribution and timing of various flow components are representative of future conditions.
    d. Review and assess the capabilities of existing environmental flow impact assessment tools and methodologies (such as WAM, or the Flow Regime Analysis Tool, dubbed FRAT).
6. Intensive site-specific studies of high priority sites
    a. Objective is to detail the flows at which key ecological functions change.

b. Perform detailed sampling, preferentially starting with a number of sites representative of the initial six locations for which standards have been promulgated.
    i. Two days per trip per site
    ii. Minimum of a trip per season
    iii. Characterize specific habitat types relevant to aquatic organisms present in areas.
    iv. Identify breakpoints or sharp changes in habitat availability related to flow variation
c. Focus on development of two-dimensional hydraulic and habitat models relating usable area with flow, capable of evaluating changes in microhabitat across a range of flow rates from about the 10^{th}-percentile to median flows.
    i. biological data collection to characterize relevant habitat,
    ii. physical data collection to characterize the river channel,
    iii. data processing to integrate points into a cohesive map of the river system,
    iv. hydraulic model development, calibration and validation,
    v. habitat model development, including the integration of habitat utilization data,
    vi. analysis of habitat model results and, finally,
    vii. evaluation of results leading to development of flow guidelines.
d. Identification of typical riffle-run sequences, low flow subsistence monitoring, biological surveys.
e. Synoptic survey of selected rivers under baseflow conditions.
f. Coordinated surveys during high flow pulses.
g. Basin-wide baseline surveys of (state listed species) mussels and related studies.

7. Analyses and establishment of baseline ecological conditions.
    a. Using selected indicator organisms, define the flow regime, water quality, sediment budget, and habitat conditions that would support these communities.
    b. Identify "alert" conditions that would indicate possible exceedances of the normal range of baseline conditions.
8. Identification of indicator metrics and species.
    a. Perform analysis using available information applicable to the Trinity and San Jacinto rivers on fish community, macrophyte community, mussel community, and riparian community to select indicator metrics (e.g. species, guilds, traits).
9. Analyze data and develop findings and conclusions regarding the relationship between water quality data and the proposed flow regimes
    a. Apply available calibrated and verified water quality models (i.e., QUAL-TX, etc.) to assess dissolved oxygen conditions at adopted flow regimes that can be examined with existing models.
    b. Adapt models to selected stream segments to address extremely low flow conditions that are less than flows for which calibrated models can be used. The

adaptation of these models should be based on physical characterization of stream segments (i.e., cross sections, profiles, flow velocities, etc.)

c. Confirm, using existing data and new data collected as described above; compliance with stream standards and/or other criteria to protect ecological conditions.
d. Perform an initial analysis using empirical approaches to determine impact of flow-related conditions, (i.e., higher nutrient load) on downstream reservoirs.
e. Perform analyses to assess the probable introduction of constituents (i.e., nutrients, toxics) into the water column from sediment material.
f. Perform analyses to assess the variability of water quality conditions (dissolved oxygen, temperature, conductivity, nitrogen, phosphorus, and other selected parameters) during moderate to high flow events and between moderate to high flow events. Assess whether the nature and frequency of the variability of water quality conditions have changed from historical conditions and the potential impact on ecological conditions.
g. Perform analyses to assess the probability of moderate to high flow events, reducing oxygen and causing fish kills like those occurring in the mid-1980's.
h. Develop long-term action plan to gather data and perform analyses of water quality conditions for river segments associated with other proposed gages.

10. Analyze frequencies of occurrence of proposed freshwater inflows.
    a. Perform an analysis to clarify historical flow frequencies related to the period of record used in the various BBEST analyses.
    b. Evaluate broader range encompassing a full flow regime.
        i. Expand the current analysis to evaluate a broader range encompassing a full flow regime, or
11. BBEST design and promote studies to obtain the data necessary for statistical modeling of nutrient loadings to Galveston Bay.
    a. Develop a statistical model of flow and nutrient loadings based on available data or support a sampling program to provide the necessary data.
    b. BBEST develop recommendations for monitoring projects.
        i. Using a statistical model of flow and nutrient loadings, the BBEST should develop recommendations for monitoring projects.
12. Process for identifying environmental flow regime for the estuary
    a. Reevaluation of the relationship between salinity and Vallisneria, Rangia reproduction, and/or oyster parasitism or development of other biological indicators.
    b. Communicate needs for analysis, data collection, and research needs to organizations that may be able to do the recommended work and/or provide funding to others to do the work.
    c. Identify data collection, analysis and research needed to develop strategies to meet standards set by TCEQ.

d. Identify data collection, analysis and research needed to validate whether freshwater inflow standards set by TCEQ are protecting sound ecological function.
e. Develop research concepts that outline future recommended analysis, data collection, and processes for evaluating freshwater inflow regimes and to determine the freshwater inflow recommendations.
f. Meet at least annually to provide and to receive updates on progress in analysis, data collection, and research related to better understanding of the relationship between environmental flows and a sound ecological environment in the Galveston Bay system. Upon hearing and considering the updates, BBEST should revise recommendations as necessary.
g. Compare available information to performance of indicators and values 4 years after implementation of the work plan. The purpose should be to conduct a preliminary evaluation whether estuarine health has been or is being affected by changes in freshwater inflow. At this time, the BBEST should identify a long-term schedule for work plan review.
h. Short term objectives should be set for the characterization of indicator baselines and to determine how best to detect changes from a "sound ecological environment."

13. Initiate quantitative data collection for Atlantic Rangia
    a. Studies of the reproductive condition of Rangia, the abundance of larvae and the level of river inflow in the area of the bay with high Rangia abundance should be conducted.

    b. Studies are underway in Galveston Bay to obtain data on the reproductive condition of Rangia, the abundance of Rangia larvae and the river flow levels at the time of sampling. BBEST should stay informed of this and other studies of Rangia reproduction to determine whether suitable data is being collected to fill this data gap.
    c. Initiate efforts to determine whether the current oyster decline is caused by ecological conditions related to freshwater inflow.
        i. Validation of predation and parasitism frequencies will be challenging for eastern oysters. The existing Galveston Bay fishery independent data demonstrate a significant declining trend for oysters in Trinity Bay, Upper and Lower Galveston Bay, and East Bay. The cause(s) of these declining trends is (are) unknown. Oysters in West Bay and Christmas Bay have not declined. BBEST should consider the relationship between this trend and the use of oyster parasitism and predation as an indicator. If appropriate, studies should be recommended to determine the stability and suitability of the indicators.

6. **Please prepare a timeline for all 13 recommended work items in the five-year period of time, indicating which items will carry over to later cycles for completion.**

   See Figure 2 below.

Figure 2. TSJ BBASC Recommended Item Schedule

BBEST NO.	BBASC NO.	Cost	Who	Category	Description	Near Term
1	3	50,000	SB 2/CRP	Instream-Hydro	3-Tier study area development	x
3	4	260,000	TWDB/RWPG/ BBEST/USGS	Instream-Hydro	Flow regime component characterization	x
*	5	150,000	RWPG/BBEST/ BBASC	Instream-Hydro	Evaluate interrelationships between environmental flow regimes and proposed water supply projects	x
8	3	80,000	CRP/TWDB	Instream-Hydro	Imagery analyses	x
9	3	30,000	CRP/TPWD/ BBEST/BBASC	Instream-Hydro	Prioritization of intensive study sites	x
10	6	160,000-1,800,000 (20,000/2day visit/site, 2-15 sites)	TCEQ/CRP/ TPWD/TWDB	Instream-Hydro	Intensive site-specific studies of high priority sites	x
14	7	125,000	BBASC/BBEST/ CRP	Instream-Eco	Analyses and establishment of baseline ecological conditions	x
15	8	125,000	BBEST/BBASC/ TPWD	Instream-Eco	Identification of Indicator Metrics & Species	x
21	1	100,000	TWDB/TPWD/ CRP	General	Coordinate data gathering and special studies with work plan being developed for Senate Bill 2.	x
24	9	75,000	CRP	Instream-WQ	Analyze data and develop findings and conclusions regarding the relationship between water quality data and the proposed flow regimes.	x
37	10	15,000	BBEST/TWDB	Estuary-Salinity	Analyze frequencies of occurrence of proposed freshwater inflows	x
39	10	60,000	BBEST/TWDB	Estuary-Salinity	Expand current analysis to evaluate broader range encompassing a full flow regime, or propose alternative or complementary approach to address other components of freshwater inflow regime	x
43	11	30,000	BBEST/TWDB/ CRP	Estuary-Nut/Sed	BBEST design and promote studies to obtain the data necessary for statistical modeling	x
45	11	100,000	BBEST/TWDB	Estuary-Nut/Sed	BBEST develop recommendations for monitoring projects.	x
50	12	300,000	BBEST/TWDB/ TPWD	Estuary-Eco	Process for identifying environmental flow regime for the estuary (could include: reevaluation of the process for determining the relationships between salinity and *Vallisneria*, *Rangia* reproduction, and/or oyster parasitism	x
54	2	90,000	BBEST/TWDB/ TCEQ/TPWD/ BBASC	General	Determine how best to evaluate changes from a "sound ecological environment"	x
61	13	200,000	TPWD	Estuary-Benth/Oy	Initiate quantitative data collection for Atlantic rangia	x
62	13	100,000	TPWD	Estuary-Benth/Oy	Initiate or expand monitoring programs designed to assess reproduction of Rangia and parasite and predator impacts on oysters.	x