

**Exhibit A of Task Order 2**  
**2005 Statement of Work:**  
**Colorado River flow Relationships to Aquatic Habitat**  
**And State Threatened Species: blue sucker**  
**Vendor: Bio-West, Inc.**

**Date: April 1, 2005**

Colorado River - Aquatic Habitat and Water Quality  
Committee Chairs: Tom Arsuffi; Larry Hauck  
Members: Khaled Bali, Thom Hardy, Warren Pulich, Doug Slack, Terry Whitledge  
Draft Comments

## **1. Overview**

Page 1, Study Objective, 2nd bullet. This objective does not read in a meaningful manner, was a word such as "determine" omitted - ...blue sucker to "determine" the degree that...

**Response:** Looks like it. We will add "determine" back in.

### **Task 3 – Intensive Site – Physical Data Collection** **Subtask 3.10 – Hydrodynamic Model Calibration**

Page 8, Task 3, Subtask 3.10 - Hydrodynamic Model Calibration: In the first sentence or two the standard process of calibrating a model followed by its subsequent verification is explained. It appears from further description that the focus of this subtask must only be collecting data for calibration. By absence of any discussions of actual verification of the model in this subtask (or subtask 7.20), SRP wonders whether there is truly a verification planned. Further elaboration on this important aspect of model development should be incorporated in the SOW. It appears that Subtask 7.20 - Hydrodynamic Model actually envisions a calibration process without a verification process. Again, such may be appropriate for the process of model developed envisioned for this project, but present wording is confusing.

**Response:** The project team agrees that the terms calibration, verification, and validation can be very confusing. To clarify the project team will change the referenced section by replacing the word "verification" with "validation". Calibration will be defined as the process by which you fine tune certain parameters (i.e. roughness and viscosity) to maximize measures (i.e. velocity and depth) of model performance. Validation is the comparison of known data versus the calibrated model results. Each time the project team is out collecting the stage-discharge data to develop our rating curves (each intensive site at 3 flows), we will collect approximately 50 additional depth/velocity point measurements. Elevation contour maps and a random point generator will be used to produce the quasi-random set of calibration/validation point locations. The project team will use half of this velocity and depth data to calibrate the roughness and viscosity

parameters in River2D and the other half to validate the model results and report uncertainty. It was an oversight not to include the validation data collection activities in section 7.20. These activities and procedures will be detailed in Task Order 3 for 2006.

The term verification is used to determine whether the modeling code is mathematically sound. River 2D has been used extensively in instream studies and our canvas of experts has lead us to conclude that it has been verified. We will continuously evaluate the applicability of the model to the special situations that we may encounter in this study and make appropriate adjustments if necessary.

3) Within the same Subtask 3.10, collection of velocity data to "validate" the model is mentioned. What does the word "validate" mean in this usage - is it part of calibration or verification?

**Response:** Please see previous response.

### **Subtask 3.30 – Sediment Transport**

Page 10, Task 3, Subtask 3.3 - This section of the task order describes sediment transport divided into two categories: bed load and suspended load and how sediment transport will be modeled to evaluate how alternative flow regimes may affect riparian and aquatic habitat. Field data collected to develop bed load rating surveys will include surveyed channel cross sections, water surface slope, and streambed particle size distributions within each of the intensive sites. The task order describes the data collection approaches to bed load sampling as:

#### *“Bed load Sampling*

*Bed load will be sampled at all intensive sites. Bed load will be sampled during low, moderate, and high flows using a modified Helley Smith type bed load sampler. To sample bed load, the sampler will be lowered into the flow by hand or cable/winch and held firmly to the streambed. This will be done at different locations incrementally across the channel. Total sample time will be dependent on the material moved but will be approximately 20 minutes.*

#### *Bed load Sieving*

*Each field-collected bed load sample will be dried and sorted into the following size categories using standardized sieves. After sieving each size category will be individually weighed using a digital scale accurate to 1 gram. When practical, organic matter present in the sample will be removed before weighing. The organic material will also be individually weighed. Additionally, before sorting, digital photographs will be taken of each sample using a penny for scale. These photographs will be used to compare sample characteristics for the different intensive sites and collection dates.”*

SRP has included a section from a USGS techniques webpage

<http://water.usgs.gov/osw/techniques/sedtech21/ryan.html>

concerning bed load sampling considerations and limitations using a Helley Smith type bed load sampler that need consideration by the project team.

There are several recognized limitations to bed load data collected by portable samplers, such as the Helley-Smith. Their main weakness is that the confidence in measurements can be relatively low, at least in comparison to other sampling methods, such as instream traps. The reason for low confidence in estimates of transport is that the spatial and temporal variability may not be adequately assessed by these samplers and methods. There are several different "philosophies" on how the samplers should be used to obtain the most reliable measurements for mean transport. For instance, there is little consensus on the correct number of verticals needed or the number of times an individual vertical should be measured. Additional weaknesses result from difficulties in designing a suitable device for measuring bed load for a wide range of conditions. This is problematic because introducing any device to the stream alters local flow hydraulics, which, in turn, may affect local transport patterns. There is some indication that slight differences in sampler design can produce significant differences in bed load collection rates (e.g., Ryan, in progress). Also, there is a limit to the size of material that may be sampled with a relatively small nozzle (3 x 3" in our case) so estimates of flow competence based solely on data from portable samplers are suspect. Finally, sampling efforts using portable samplers are highly labor intensive and, therefore, can be quite expensive.

Relative to the USGS concern that sediment transport determinations are labor intensive, SRP determined from the task order that bed load sampling will occur at 10 sites x 3 flow regimes x 20 locations (note the project team did not specify the number of locations but instead reported a 20 minute total sample time distributed across the channel, the 20 locations SRP used in this calculation is based on USGS recommendations for using a Helley-Smith sampler) across channel/site = 600 sediment samples. From the SOW task order (see above), each sample will be sieved into 6 sediment categories plus an organic and each then dried and weighed. This represents 7 sediment categories x 600 sediment samples = 4200 separate samples and weightings- a lot of work.

Also on the USGS techniques webpage are recommended procedures and guidelines for using the Helley-Smith sampler and those guidelines are copied below.

<http://water.usgs.gov/admin/memo/QW/qw79.17.html>

Until further guidelines are issued the Helley-Smith sampler with a 76.2 mm opening should not be considered for use in

a) streams in which the median diameter of the bed material is

smaller than about 1.0 mm. (Exception: If the median diameter is smaller than 1.0 mm but the content of material finer than about 0.25 mm is no greater than 10-15 percent, the sampler may still be used.

b) streams in which the median diameter of the bed material is larger than about 8 mm. (Exception: If the median diameter is larger than 8 mm but the content of material larger than 32 mm is no greater than about 10 percent, the sampler may still be used.)

c) streams in which the quantity of fine material, particularly organic material, is great enough to clog the sampler bag.

d) streams in which large particles or irregular bed configurations are likely to interfere with a good fit of the sampler to the streambed. Dune bed forms having a length: height ratio of less than about 20 may fall in this category.

Sampling technique--Emmett's field-calibration studies indicated that the technique used in the collection of samples with the Helley-Smith sampler may be as significant as the actual efficiency of the sampler. Therefore, upon receipt of this memorandum and until further notice, the following sampling technique should be used. This technique used with the standard 76.2 x 76.2 mm Helley-Smith sampler and for material in the size range specified above, will be considered a provisional method of the Geological Survey for measurement of bed load discharge. Measurements made using this method should be documented and referred to as having been collected by the provisional USGS method (for bed load sampling using the standard Helley-Smith sampler).

#### Provisional method

1. Samples will be collected at a minimum of 20 equally-spaced sampling stations in the cross section.

Variations--For wide cross sections, sampling stations should not be spaced greater than 15 meters (50 ft) apart. For narrow cross sections, sampling stations need not be closer than about 0.5 meters apart.

2. The sampling duration will be the same at each sampling station (for each sample in the cross section). The sampling duration will depend upon the rate of filling of the bag, and probably will vary from 30 to 60 seconds. If more than 60 seconds is required to collect an appreciable quantity of material, the transport rate generally is insignificant.

The correct procedure would be to collect a sample at a high-velocity location in the cross section to see whether there is bed load moving and to select a sampling duration that will

assure that the bag does not fill to more than about 40 percent at any sampling station (Druffel, 1976).

3. One sample will be collected at each sampling station starting from one bank and proceeding across to the other bank. Each sample will be placed in a separate bag and labeled. Return to the beginning sampling station and repeat the sampling, collecting a second sample at each of the same stations sampled during the first pass across the river. Each sample will be placed in a separate bag and labeled.

4. Depending upon the objective of the sampling program, (1) each sample will be analyzed individually, or (2) a composite of the two samples collected at each sampling station will be analyzed. It is recommended that analyses always include a determination of particle-size distribution in each sample or composite.

5. Results will be reported in terms of mass per unit time per unit width, such as pounds per second per foot (of width) or kilograms per second per meter. The unit bed load discharge reported will be a width weighted average for the cross section.

6. If possible, the bed should be sampled to determine the size distribution of the bed material, and suspended-sediment samples should be collected so that total sediment discharge can be calculated (Hubbell, 1964, pp 7-19). Note that this is not a simple calculation.

SRP recommends the Project Team use the provisional method of USGS for sediment transport determinations. The Project Team should also conduct preliminary sediment sampling to determine if the sediment particle size distribution of the Colorado River falls into one of the 4 categories (a-d above) where USGS deems a Helley-Smith sampler inappropriate. The Project Team should consider if instream traps may be more suitable.

**Response:** The focus of the sediment transport analysis has shifted since the original statement of work document was written. Following the geomorphic assessment (conducted in February 2005) of the river from Longhorn Dam to Bay City, it became apparent that extensive field-sampling of bedload adjacent to all intensive fisheries study sites would not be feasible or appropriate. Therefore, extensive use of Helley-Smith type samplers is no longer proposed for this study.

The revised sediment transport evaluation effort will initially focus on completing the geomorphic assessment to appropriately divide the study area into distinct geomorphic reaches. Between Austin and Bay City, the Colorado River transitions through different geologic regions and the influence of Longhorn Dam becomes less pronounced. Therefore, it will be important to evaluate flow- sediment transport relationships independently within each reach. The geomorphic assessment effort includes the completed field reconnaissance component as well as an "office" component which will entail reviewing/analyzing available geomorphic literature and data (historical USGS

gage station measurements, existing LCRA HEC-RAS model, topographic/geologic data, geomorphic studies on the Colorado River or similar nearby rivers, aerial photography, etc.).

Within each geomorphic reach, bedload transport rating curves will be developed in order to relate discharge to bedload sediment transport rates. It is anticipated that the bedload relationships will be developed either at existing USGS gage transects or at existing HEC-RAS modeling transects where stage-discharge relationships have already been established. We anticipate that the rating curves will be developed using a bedload transport equation (e.g., Einstein, Meyer-Peter and Muller, etc.). Field data collection efforts will focus on gathering information for model (transport equation) inputs and calibration purposes.

Once bedload rating curves are established for each analysis site, effective discharge will be calculated for the existing and proposed flow regimes. The transport relationships will also be used in conjunction with discharge versus bar/floodplain inundation relationships (determined from the LCRA HEC-RAS model) to evaluate potential effects of flow regime changes on in-channel features such as sand and gravel bars, floodplain sediment deposition, etc.

Page 10, Suspended Load: The SOW appropriately distinguishes between single-point sampling and cross-sectionally flow-weighted sampling for TSS and the potential bias of using the former data without correction. Since no data collection effort appears to be associated with this project aspect, it would be helpful to add a sentence or change wording in an existing sentence to bring assurance that there are indeed sufficient existing cross-sectional, flow-weighted TSS data to determine the bias in any single-point sampling data.

**Response:** The results from the suspended load modeling effort being conducted by the LSWP Water Quality team will be incorporated into this study's assessment. This modeling effort was a new scope addition to the LSWP Water Quality team this spring and thus was unknown during the drafting of the original Scope. It is BIO-WEST's understanding that the Water Quality Team will be collecting samples (grab samples taken at several water column depths; analyzed for turbidity, TSS, and SSC) at two locations on the river to help determine sediment loads to Matagorda Bay. These data will be used as appropriate to help develop suspended sediment rating curves (discharge versus suspended sediment transport rate). Additionally, BIO-WEST will use the compiled set of existing sediment concentration/TSS data developed by the LSWP Water Quality team to supplement field data.

However, because the proposed grab sampling will not be cross-sectionally integrated, and will only occur at two locations, BIO-WEST anticipates that there may be a need to perform additional field sampling (to be conducted in 2006) of suspended sediment (cross-sectionally/ depth integrated samples collected within each defined geomorphic reach). BIO-WEST also anticipates a potential need to analyze the size distribution of suspended sediment samples and how it relates to discharge.

Once suspended sediment rating curves are developed, they will be used in conjunction with the bedload rating curves to evaluate the potential effects of proposed flow regime changes on effective discharge, floodplain deposition processes, and other relevant processes.

#### **Task 4 – Intensive Site – Biological Data Collection**

Page 11, Subtask 4.10 – Fish Collection to supplement fish habitat guild development; The addition of a backwater/tributary/side channel functional habitat for fish guild development is a good idea and will provide a more complete understanding between fish community and flow conditions.

**Response:** No response necessary

Page 12, Subtask 4.20, Description of Work and Key Assumptions: The description of work indicates that all ten intensive sites will be sampled for biological aspects during low-flow conditions. That seems appropriate given the logistical complications of biological sampling at high flows. But if such be the case, why is a key assumption made regarding being able to collect moderate- and high-flow biological data?

**Response:** The fish guild collection effort (4.1) discussed above and biological validation effort (4.2) are two separate efforts. The assumption of moderate to high-flow biological data is so that we have biological data from the three different flows in order to better validate the habitat model results.

#### **Task 5 – Blue sucker Life History Assessment**

Page 12 and subsequent pages under Task 5 - Blue Sucker Life History Assessment: Under subtask 5.10, the mention is made of spawning surveys to occur in the spring of three years (2005-2007). It is not clear in subsequent studies whether there is a mistake in study duration or whether the spawning surveys are the only monitoring efforts that go into 2007. As examples, a) Subtask 5.10, last paragraph mentions habitat characterization over the course of the study (2005 and 2006) - so not through 2007?; b) subtask 5.20 also mentions larval/juvenile sampling only in 2005 and 2006; and c) subtask 5.30 has as the 2nd key assumption a 2 1/2 year time period of study which is the same as that for subtask 5.10, which again goes through 2007.

**Response:** Spawning activities and telemetry will continue into the spring of 2007. However, all habitat characterization and habitat modeling will be conducted prior to the end of 2006. Springtime conditions on the Colorado River can be so variable, the likelihood of observing spawning activities was deemed low and thus, multiple years were proposed to make sure we observed a spawning event. Note: We have already identified one spawning location in 2005. The habitat characterization field work needs to be completed in 2006 so that the habitat model can be run. The second reason for extending the spawning and telemetry work into 2007 is to obtain a validation data set for the habitat model results relative to spawning.

Page 13, Subtask 5.10, paragraph at top of page. For the spawning surveys it is mentioned that as many as 10 visits will occur per site. Is this up to 10 visits per year or total over project duration? Under key assumptions mention is made that additional tagging may be necessary if survival rates (from tagging are low?). Yet, under key assumptions (page 15, subtask 5.3) if mortality or tag shedding of blue suckers is greater than 50%, then re-tagging is not proposed. The 2 contrasting statements need reconciled.

**Response:** The up to 10 visits reflects over the course of the study. However, several other biological collection efforts are taking place over similar time periods in which the project team will be evaluating spawning conditions. I will remove the assumption that additional tagging may be necessary. After 6 months of the study we have found 28 out of 30 fish and the fish seem to be healthy (alive and accompanied by other untagged blue suckers).

Page 14, Subtask 5.20 – Larval/Juvenile Sampling and Habitat Assessment: The Project Team will conduct larval and juvenile sampling in areas downstream of the five likely spawning areas as well as up to five additional sites that might be determined to be located below spawning areas during previous biological sampling efforts and these sites will be sampled from April to June (one time per month) in both 2005 and 2006 and subsequently in August and November of each year to track year class development and recruitment success. They will use a combination of seining, light traps, and dip netting associated with lights for larval sampling. Backpack electrofishing with block nets and hoop nets will likely be employed as an additional collection method for juveniles. The SOW notes the primary focus of this evaluation is to document the existence of larval/juvenile blue suckers in the lower Colorado River and define the associated habitat requirements. SRP understanding is that in a number of studies of blue suckers in streams of several states that collection of larval/juvenile blue suckers is infrequent. What contingencies are planned by the project team if during initial sampling efforts larval/juvenile blue suckers are not encountered? The ability to capture ecologically meaningful numbers of larval/juvenile blue suckers should be listed as a key assumption.

**Response:** If no larval or juvenile fish are collected in 2005, the data collection effort in 2006 will be expanded in time, location, and technique in an attempt to locate these lifestages. We agree with the assumption proposed by the SRP and will add to our list.

Page 15, Subtask 5.30 – Migration Assessment: Under key assumptions for this SOW the Project Team writes, *“It is likely that some of the fish will die and others will shed their tags, but the majority of the fish should remain for subsequent tracking. If mortality or tag shedding of greater than 50% of the individuals occur, then this method will be deemed unsuitable for collection of this type of data. Therefore, re-tagging is not proposed under these circumstances. However, in the event that telemetry is deemed unsuitable, the contingency plan will be to document the situation and use the remaining funding associated with subsequent telemetry tasks for physical observations of fish movement and spawning via conventional sampling techniques.”* This is a confusing key

assumption in that decision statements and alternatives appear arbitrary. For example, what is critical about the 50% loss of tagged fish relative to study objectives? A 50% loss means there are still 15-tagged fish. How many tagged fish are required to meet the study objectives and what are the criteria by which this number is reached?

**Response:** There should have been a time period placed in the assumption. If 50% of the fish shed their tags or died within the first 3 months of tagging, then we would have lost confidence in the ability of this species to maintain tags or survive with tags. However, six months into the study we still are locating 28 of 30 tagged fish. The more important parameter at this point is not the number of fish but the health of the fish. We anticipate losing fish over the next two years to mortality, shedding, fishing, etc., however, if the remaining tagged fish still appear healthy (alive and congregating with other untagged blue suckers) we will continue this study component. If the fish are not congregating with other blue suckers and rapid mortality/shedding starts to occur, then we will shift to more conventional sampling techniques. Our experience so far is that this will not be the case.

## **Task 6 – Aquatic Resource Characterization**

Page 15, Subtask 6.10 – Species of Concern Evaluation: This subtask describes a second component of the aquatic resource evaluation to look at potential impacts to not only the state-listed blue sucker, but also those species of concern that may be listed before the permit process is complete. It is unclear what is meant by species of concern, especially in the context where the product will be an evaluation of a wide group of species (guild) as opposed to individual species and/or life stages? This needs clarification as well as a better description or reference on what is involved and the ecological basis of a *spatial niche* approach in the evaluation of aquatic habitat. What are alternatives to the spatial niche approach and why were they not considered and the spatial niche is more appropriate?

**Response:** To fulfill the requirements of the Section 404 permit, the project team is required to look at threatened and endangered species and species of concern. The team has already determined that there are no aquatic “species of concern” in the lower Colorado River from a regulatory standpoint. Unless the regulatory agencies express concerns over non-listed aquatic species that this project may force into listing, the aquatic assessment proposed to meet the permit requirement will simply be a statement that other than the blue sucker, no aquatic T&E species, or species of concern exist. If the agencies recommend (we have not conducted the resource agency meetings yet) multiple species for additional evaluation and have strong justification, the project team proposes to evaluate habitat changes on a spatial scale via evaluation of fish guilds. If only one or two species are proposed, individual species will be evaluated again based on potential changes to habitat. The same approach will be used for the riparian corridor species. For the blue sucker, a wealth of data will be gathered and presented to meet this requirement. The key to this and the next two subtasks is the interaction with the resource agencies. Subtasks 6.1, 6.2, and 6.3 are meant to be desktop evaluations done in conjunction with the resource agencies to meet Section 404 permit requirements.

Page 16, Subtask 6.20 – Connectivity Assessment: It is not clear how a qualitative assessment can be used to determine whether significant “fragmentation” and loss of connectivity of riparian and aquatic habitat occurs nor how this determination can be made using existing information. The nature of the existing information to be used in the qualitative decision needs to be stated as well as the criteria by which a subjective decision is to be made.

**Response:** As with the previous subtask, this qualitative assessment will be made in conjunction with resource agency staff based on existing information (i.e. existing fisheries data from long-term LCRA monitoring, existing water quality information from LCRA, existing riparian corridor mapping from aerial photography, etc.) and the ongoing LSWP studies (i.e. blue sucker migration, facilities siting, water quality). The determination of impacts/benefits will fall heavily on professional judgment of the project team in conjunction with the resource agency staff.

Page 16, Subtask 6.30 - Entrainment Assessment: Do existing pumps used by irrigation districts afford any opportunity to assess actual entrainment. [Perhaps existing pumps, intake structures, etc. are so different from what will be needed for the off-channel reservoir fillings that such studies would not be relevant.] The Project Team poses a scenario where if the intake site has the potential for entrainment of larval/juvenile fish in the intake structure to fill the off-channel reservoirs and is found to be unacceptable, a new site may need to be selected. It is not clear by what criteria or analysis an intake site will be determined to be unacceptable - all sites in the river have potential to entrain fish. Decision-making criteria for acceptable/unacceptable site determination should be explained.

**Response:** Since other than the blue sucker, no aquatic T&E species or species of concern exist on the lower Colorado River, this assessment will simply focus on the availability of larval blue sucker habitat in the immediate vicinity of a proposed intake structure. That is the criteria. Should larval blue sucker habitat be identified in the immediate vicinity of the intake structure, it is likely that the structure would be moved to another location to avoid any potential impacts. The river wide larval blue sucker assessment is currently ongoing.

### **Task 7 – Intensive Site – Model Development**

Page 17 & 18, Subtask 7.20 - Hydrodynamic Model, Perform Sensitivity Analysis: It is excellent that a sensitivity analysis is being performed. The breadth of this sensitivity analysis bears closer attention as the project progresses to the point when these analyses will be performed. Part of the uncertainty analysis (which would be interpretation of the sensitivity analysis) may also need to deal with the imprecise nature of the model predictions. For example, one would anticipate that the model predicted velocity fields throughout any site would not exactly represent those of the measured calibration data. While some of this discrepancy will be associated with the inherent inaccuracies of field

measurement, some will also be due to the fact that the system cannot be exactly represented through a numerical model. Depending on how the spatial distributions of velocities are used to determine aquatic habitat, etc. model inaccuracies may (will?) result in uncertainties in the decisions determined from the model regarding availability of habitats. Also, it is envisioned that given the range of flows under which the model will be applied (10 to 3,000 cfs), that the model will be applied in an extrapolation mode, i.e., it will be difficult to capture the low end flow regimes under the present operation of the lower Colorado River system and wastewater effluents received by the system.

Extrapolation of model application to conditions outside those for which there are calibration data is intuitively more problematic than when a model is applied within the range of measured conditions used to calibrate the model, though admittedly such is often a necessity in model application and often one of the reasons to apply models.

Nonetheless, uncertainty in results and findings from application of the model in an extrapolation mode may need to be considered and to the degree possible quantified. The project team is encouraged to interact with the SRP on the sensitivity and uncertainty analysis development so that what is performed meets the approval of the SRP and indeed reflects some quantitative measure of the uncertainties associated with results and findings from the model.

**Response:** Great comment. The project team will interact with the SRP on the sensitivity and uncertainty analysis development so that what is performed meets the approval of the SRP and indeed reflects some quantitative measure of the uncertainties associated with results and findings from the model.

Overall comment: SRP was not sure how the hydrodynamic model is to be used with the fish guild information. The Conceptual Flowchart for this portion of the project readily indicates where the blue sucker data informs the hydrodynamic model, etc.; however, it is not readily apparent from the SOW or flowchart how the guild information will be used. Further explanation of this matter will be appreciated. Is the hydrodynamic model to be used to estimate LSWP impacts to the overall fish community or just the blue sucker?

**Response:** The hydrodynamic model will be used to estimate LSWP impacts/benefits to both the overall fish community and blue sucker. The fish guild information is represented in the flow chart by three boxes (existing data from Mosier and Ray, additional fisheries data from literature, and supplemental fisheries habitat data). All three boxes feed into the biological processes then to the Integrated Models then output to the box entitled, "Aquatic habitat determine relationships between changing flows and habitat availability". We will do a better job of representing this relationship in the text of future task orders and reports as the bulk of the habitat modeling is scheduled for 2006.