Review of the Instream Flow Study of the Lower San Antonio River and Lower Cibolo Creek Draft Study Design

Reviewer 2

General Comments

The objective of the *Instream Flow Study of the Lower San Antonio River and Lower Cibolo Creek* will be to determine flow conditions necessary to support a "sound ecological environment" in the lower San Antonio River sub-basin. The overarching conceptual approach of the study design is to segment rivers and use detailed investigations at representative study sites to identify flow conditions for each segment. The study plan provide detailed explanation of methods for hydraulic, biological, and geomorphic/physical process data collection, hydraulic modeling, and assessment of habitat availability in terms of depth and velocity of habitats at various flow levels.

My main concerns are that the study plan does not identify the major points of uncertainty, provide 1) an even level of methodological detail for all components, 2) the details and challenges in linking the components, or 3) contingency options when obstacles to the preferred design will be encountered. This could lead to full implementation of some components, such as hydraulic modeling, that will have limited value because of difficulties in implementing other components - specifically the analysis of physical processes and biota. Approaches for applying site-specific results across the basin should be identified (e.g., instream flow standards at select control points, expressing flow condition on unit-area basis) as the preferred approach could influence how the instream flow study is conducted.

The principal contribution from this study and the primary source of uncertainty will be the development of relations between flow and "native species and biological communities know to occur in the river and riparian zones; and (2) key habitats" (section 3.2.2, p. 51). The level of precision of this information will limit the spatial resolution of hydraulic modeling that can be justified and the acceptable error from calibration. This should be the first step and the result s should be assessed before engaging in detailed hydraulic modeling.

The conceptual approach is not explicitly introduced for example in section 3.0, p 38. This should include the premise that the primary function of flow is to maintain suitable depths and velocity of aquatic microhabitat and this function can be generalized across space. This approach should be reconciled with biological distributions that may be patchy and indicative of non-representative but biologically preferred sites. The micro-habitat approach accounts for within-site patchiness.

The site-scale "microhabitat" approach is mirrored by other study components that may not be appropriate or particularly insightful (e.g., physical processes). Additionally, the development of flow habitat suitability curves from site surveys presumes that selected sites are representative of the full distribution of conditions (including interactions of multiple factors) in the subbasin.

As an alternative, documentation of the spatial distribution of geomorphic conditions and biota at reach and segment scales may allow for stronger inference about flow requirements than microhabitat analysis. This information will also confirm that "representative" sites are biologically representative of the types of habitats being used and will inform analysis of longitudinal connectivity: what biological interactions (life stages, predator-prey, competition, invasive species) occur across the river network? are there distinct physical process domains (in sensu Montgomery, 1999) that require different flow requirements?

The conceptual model (p. 26) is driven by physical (inorganic and organic) inputs and fails to illustrate the importance of current biological conditions (availability of colonists, competitive exclusion by dominant taxa, density-dependent effects, invasive species) in biotic responses. Unfortunately, this oversight is reflected by the study design, which should address how current biological conditions may be influencing response to flow. This is an important conceptual step because biological responses to flow condition are not unconditional or deterministic. They depend on many other contributing factors. I presume that this study is focused on how flow functions given the current state of other factors given its reliance on relations between flow and biota within the study area. Note that this limits any inferential power about relations at flow that were not observed (i.e., the results cannot be extrapolated beyond observed conditions) or about relations under different water quality (i.e., temperature) or habitat conditions. As such the development of habitat suitability curves must either be stratified for different conditions or be based on a sufficient large sample to represent likely combinations of other factors that influence habitat preferences.

It is not clear how gains and losses will be incorporated. They should be analyzed with respect their spatial distribution as they are likely to be concentrated in few places (Konrad, 2006) and their dependency on flow conditions (e.g., Konrad et al., 2003). Locations with strong gains may be biologically important and more resilient to hydrologic alteration.

The proposed analysis of physical processes is ambitious and includes historical channel change analysis, sediment budgeting at multiple sites, and sediment transport modeling. The value of each should be re-evaluated vis-à-vis the study objectives and more precise products from each step should be identified.

The study plan has some vague statements of results for the analysis of physical processe that may be unrealistic or not particularly useful. For example, "a sediment transport model will be coupled with a standard one-dimensional hydraulic model to estimate the magnitude of flow that perform various geomorphic processes within each reach, such as floodplain deposition, meander migration, or bar maintenance." There is a strong lateral flow component to all of these processes, which cannot be represented by one-dimensional models (Konrad, 2009) and two-dimensional, movable boundary models are not operational for this type of application. Moreover, any inferences about flow and these processes will be based on intermittent historical channel locations from aerial photos that integrate the geomorphic impacts of a series of flows at a time scale of about a decade (Konrad et al., in press).

Alternatively, flow requirements for physical processes will be based on calculations of the spatial distribution of shear stress from a 2-D hydraulic model that represents one configuration of river channel and does not account for dynamic responses in bars or meanders during events. There may be opportunities to apply current research as identified on p. 58, but it is uncertain how the "stream power patterns and sediment movement thresholds" from bar-scale studies will applied across the study area. Integration of this information at reach and segment scales is not facilitated by detailed site-specific analysis, so the appropriate level of detail from site-specific studies that will allow integration at reach and segment scales should identified.

The analysis of overbank flows is unclear: "Differences in interval between inundation events will be evaluated spatially along the length of the river to identify break points or to identify areas where frequent inundation has significant geomorphic impact", Section 3.2.3., p. 58). Flow - not inundation - has geomorphic impacts, so its not clear that inundation analysis will be productive. LiDAR can be used to assess inundation thresholds in a spatially comprehensive manner (e.g., Jones et al., 2006), but this should not be conflated with "geomorphic impact." The study plan depends on sequential tasks, but does not list of sequence of how tasks will be implemented.

Miscellaneous questions and comments

With regard to freshwater inflows (p. 9), will inter-annual variability of inflows, material transport, or marine conditions be assessed?

The conceptual model diagram (p. 26) has all four inputs connecting through a single pathway to processes. It may be more useful to identify distinct environmental flow components supporting different processes (and maintaining habitat independently of the processes) as a way of developing testable hypotheses.

The principal geomorphologic objective under Physical Processes (p. 30) should be assessing sediment transport capacity relative to sediment supply. The other "indicators" will depend on the overall sediment balance.

The spatial extent of perennial flow could be included in Table 7 (p. 31).

Channel network characteristics and connectivity could be included in Table 9 (p. 35) rather than having connectivity as a stand alone subject (e.g., Table 11).

Habitat is specific to species or guilds, which should be identified before habitat types are characterized (p. 47).

The high resolution of study site surveys doesn't seem to be appropriate given the resolution of most of the investigation (p. 48).

I assume aerial photography (p. 48) will be stereo pairs, otherwise its not clear how aerial photography can be used to fill in DTM gaps.

I think "calibration data" (p. 48) are actually boundary conditions.

Its not clear how substrate data (p. 49) will be used in the model and there is no discussion of substrate as a response variable to flow (rather than an independent habitat feature).

Model calibration (p. 49) only needs to be a precise as the habitat requirements. If species/guilds have wide range in their habitat conditions, precise calibration of the model will be of little value.

Description of losses/gains analysis (p. 50) is vague. It should address whether gains and losses are flow dependent.

Identification of the mesohabitat units (p. 53) by field surveys may be difficult to replicate. This may be better accomplished with the hydraulic model.

Its not clear what field data (p., 58) on sediment transport will be collected. Bed load and suspended load?

The relevancy of Haschenburger and McBroom's research (p. 58) should be described specifically.