

## SCIENTIFIC REVIEW PANEL COMMENTS ON LSWP MEETING - OCTOBER 2006

### *[LSWP Study Team responses in Bold Italics in brackets]*

Overall the SRP has confidence in the leadership team and values the opportunity to serve in their independent capacity on the project.

The SRP feels that this annual meeting is important and the strong representation from SAWS enhanced the process. They were particularly appreciative of LCRA's consideration of integration, impact to wildlife, and climate change.

Lastly, the SRP continues to be impressed with the quality of the work being done by the project teams and how responsive the teams have been to their comments.

### **1. INTEGRATION –linkages, assumptions, and ramifications**

- The integration of various components of the project became evident during this meeting after discussion with the teams. It is important that the project teams make the coordination that occurs 'behind the scenes' more apparent in their presentations to the SRP. ***[The Teams will work to improve on this in upcoming communications with the SRP.]***
- Integration requires linking specific variables or how the output of one model becomes an input variable for the receiving model (e.g., how water savings feeds from rice farmers to water supply availability model; how minimum river flows and minimum water quality conditions in the Bay reduce the water supply availability by month). ***[We concur with this statement. The latter example may be oversimplified, as bay conditions are dependent on much more than water quality, and any linkage to Surface Water Availability is likely to be more complex than a simple minimum flow. This is typical of the integration issue. Some linkages are relatively straight forward, while many are not.]***
- For clarification and consistency, all projects should contain sections that address important linkages to other projects, assumptions in doing so and ramifications if assumptions are not met. It is one thing to show how projects link to one another, but that is not what is meant by "integration" in its fullest sense. Integration should be examined in a broader context than is currently defined. For example, instream flows in terms of minimum and seasonality for the river may be substantially different than those for Matagorda Bay health. Understood that such scenarios at this point may seem academic, but represent real possibilities. How then are such study results to be integrated, revised and in turn affect other project components? ***[We concur and will attempt to do so in appropriate documents and presentations. The scenario you present is not purely academic, it is in fact a very likely scenario. The most typical and important example of this type involves the balancing and optimization of multiple constraints and objectives in developing surface water availability operating scenarios.]***

- The Off Channel Storage Facility (OCSF) also represents an important nexus where feedback and inputs from other project teams affect outcomes and integration. *[We concur].*
- We should emphasize the need to have Surface Water Availability integrated better throughout the project tasks because it is central to the success of the project. There is particular concern that unengaged inflow in the lower basin was not being integrated into and used to modify the SWA. If this is done it should make the project more viable since on the average there are larger amounts of precip near the coast compared to inland areas. The Bay Health group is considering the unengaged inflow estimates but it also needs to be included in the formula for SWA and the operational plan when it is formulated. *[We concur on the importance of Surface Water Availability as the integrator for the project. In the specific example noted, the Bay Health study will in fact be the primary mechanism for integrating coastal basin inflows into Surface Water Availability. The Bay Health study will consider in its approaches and recommendations for bay inflow the inflow contributed from coastal basins. This information in turn will be provided to Surface Water Availability to help guide the flow and timing of river water to the bay which supplements the coastal basin inflows.]*

## 2. CLIMATE CHANGE –deserves a substantial amount of attention by the LSWP

- While it should not be the responsibility of the project to consider a predicted change that may occur 50-100 years from now, it is important to consider whether there are predicted climate changes in the short-term (i.e. within 20 - 25 years). *[We concur.]*
- Some aspects, such as evaporation, exotic species, and effects on the bay, should be reviewed further. The level of review should be discussed and could include:
  - Consideration of the probability and magnitude of climate changes based on literature to create scenarios. *[We concur.]*
  - Consideration of the impacts of different evaporation rates in the Highland Lakes and the OCSF. *[We concur.]*
  - Consideration of the probability that drought of record may not be the most severe scenario and such drought could occur from climate change within 25 years. *[We concur. This will likely be addressed through a combination of narrative and simplified analyses, as the Texas water rights framework provides for operating rules when droughts more extreme than the drought of record occur.]*
  - Consideration of plausible scenarios where salinity and sea levels change and their effects on fixed bay habitats can be predicted from modeling (e.g., oyster reefs, salt marshes, and low salinity freshwater marshes on the

mainland). *[We propose to address this issue in a very simplified manner. As noted, sea level rise will indeed change the dynamics of the estuary, and in a manner far more dramatic than any potential implication of this particular project. In essence, sea level rise will change the nature of the bay.]*

- For example, estimates of the range of sea level rise over the course of the next 100 years vary between roughly 1 and 3 ft (Church and Gregory, 2001), within the time span of the LSWP project. Changes in sea level alter many estuarine dynamics, including shifts in sedimentation and circulation patterns and associated habitat and wetland conditions and increased potential for higher salinities during periods of low freshwater inflow. The impacts of sea level rise are likely to be broad, but subtle due to the slow pace of change, but become significant when measured over a 50-100 year timeframe. Given the lack of visible change associated with sea level rise, institutional responses are likely to be delayed until the issue manifests itself as a regional problem. Also consider, despite model-based variations in projected precipitation and temperature, there appears to be relative consensus on two key issues: 1) climate change will manifest itself through shifts in the timing, magnitude and duration of inflows to Matagorda Bay and 2) change will lead to greater interannual variation, with the potential for increases in both critically dry and wet years. *[In response, we plan to focus our analysis of this topic primarily on the variation of inflows potentially resulting from climate change.]*
- Clearly, the combination of sea level rise and weather modification will impact the project, with respect to not only Colorado River flows, but also freshwater inflows to Matagorda Bay. Thus, an SRP concern is that is what is being modeled and recommended today for CR and MB may no longer apply to tomorrow. Thus, there is rationale for a fairly rigorous adaptive management program be in place. This issue also ties into consideration of uncertainty and risk analysis. *[We concur, and are exploring a long-term monitoring plan and adaptive management approach accordingly. That said, there is a limit to what this project can do to compensate for changes on the order of those associated with climate change.]*
- It would also be prudent for the LSWP to direct additional consideration of climate change and sea level rise for NEPA requirements. Because of the large spatial and temporal scale of the project, NEPA may require incorporation and consideration of impacts over longer time scales that will include climate change. *[We plan to address this issue in the context of NEPA. Some aspects will likely be addressed in a qualitative rather than quantitative manner.]*

#### **UNCERTAINTY AND RISK - definitions and incorporation**

- These two terms are frequently in use throughout the LSWP, and SRP gets a sense they are used in different ways and meanings among project teams. The terms have different meanings and application in different fields (ecology, impact, health and economic) and whether the terms are used empirically

(measurement) or normative (judgmental, evaluation). There needs to be greater clarity in reports when using the terms uncertainty and risk. Perhaps, actually defining the meaning as part of the report would ensure consistency. ***[We concur that different teams are using this terminology in different ways, and these approaches for different purposes. We will work with the teams as they integrate their work (primarily with the Surface Water Availability Study) to clarify and refine this issue.]***

- Where other teams generate their point estimates from statistical averages, it would be very useful for them to provide the 90% confidence interval or a standard error of their average for use by other teams in a sensitivity analysis. ***[We concur and will attempt to do this for appropriate studies.]***
- Larry Hauck has developed a preliminary "strawman" conceptual plan for this project (below). His intention is not that this conceptual risk analysis be strictly followed, but that this become the needed "nudge" to get the project team to figure out how they are going to incorporate the uncertainty for each environmental constraint into the overall determination of risk to water yield and to meeting environmental constraints. ***[We concur with the concepts discussed in the following framework, and will work to integrate these types of concepts into the studies to the extent appropriate and practicable. However given that many of the constraints in the Surface Water Availability Analysis are shaped by water law, water rights, and water contracts, which carry their own set of complexities that are not always amenable to the modeling of the types of analyses described below, we would urge caution in setting expectations for what we will be able to do as part of this project.]***

#### **"Strawman" Conceptual Framework for Integrating Uncertainty and Risk Analysis into LSWP**

##### Background

The October 2006 LCRA-SAWS/SRP meeting provided us with a good overview of the status of the project. Concerns over integration became one of several themes for SRP members going into, during, and after the meeting.

There was observed during the meetings that a concise approach was lacking to integrate the uncertainties associated with various aspects of the project. Inclusion, characterization, and cumulative implications of the uncertainty associated with individual project components require more specificity and a ready mechanism to provide quantifiable evaluation of project risks.

##### Problem Statement

The water yield available to SAWS is to be based on the amount of water remaining after numerous environmental-type constraints are met, including B&E freshwater inflows, minimum flows to maintain dissolved oxygen, required Highland Lakes water levels, to name a

few. Some of these constraints are dynamic in that they may manifest themselves into seasonal components and even components that change with rainfall-runoff conditions (e.g., a drought condition component).

Defining and quantifying these environmental constraints are the subject of the studies of the various project teams. Each of these constraints will have associated uncertainties with its quantified value. Though it is suspected that in many instances quantification of the uncertainty for a particular constraint may be difficult, nonetheless, quantification can typically occur either through direct statistical means and/or through "best professional judgement."

These various environmental constraints become "integrated" through the Surface Water Availability model, which is where the actual SAWS's water yield from the LSWP is calculated. These constraints may be viewed as input conditions to the model. However, the uncertainty associated with each constraint means that the water yield realized from the imposition of one set of constraint conditions is only one possible outcome (or quantification) of water yield. That is, because of uncertainty there exists other sets of feasible values for the constraints, and if these sets of values are imposed in the model they will result in different water yields.

There is a need to quantify the uncertainty of each project constraint by a defensible means and to impose those uncertainties within the Surface Water Availability model in a risk analysis of project water yield and environmental constraints.

#### Conceptual Framework

For complex, interactive analyses containing uncertainties, such as the LSWP, evaluation of risk can be a most informative exercise, but at the same time it can be tedious and difficult to implement. On some large projects, risk analysis capabilities are built into the project up front through linkages of various computer models, which allows an almost automated manner of conducting the analysis. This project is not as readily amenable as some projects to such automation by the nature of the assorted methods needed to develop some of the constraints and how those constraints are imposed upon the Surface Water Availability model (at least as understood by the SRP). Hence, inclusion of risk analysis within the project may likely require some departure from the conceptual framework that follows.

As presented herein the risk analysis takes the uncertainty of the environmental constraints and imposes them within the Surface Water Availability model providing a quantification of the risk to the SAWS water yield and of meeting the environmental constraints.

The broad steps required to provide this risk analysis follow:

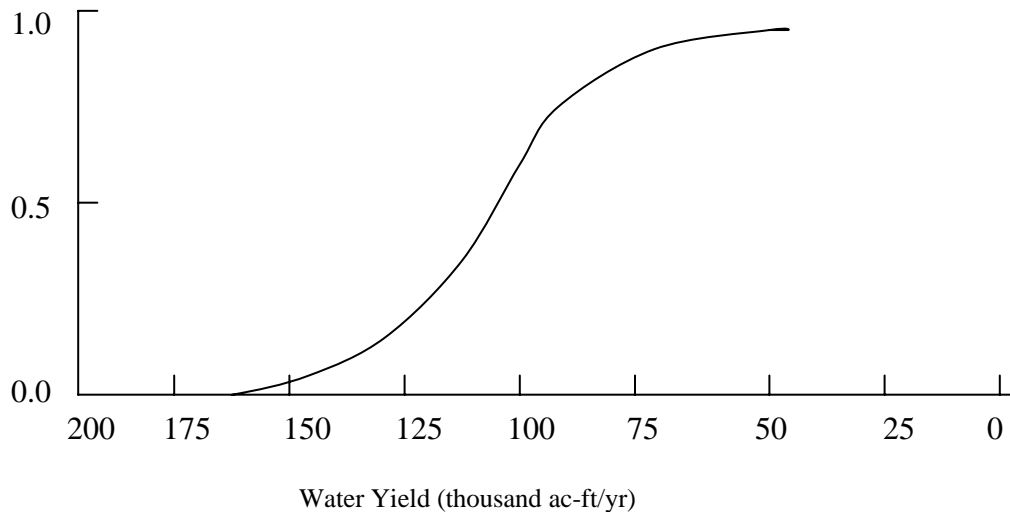
- 1) The uncertainty is quantified for each environmental constraint within the Surface Water Availability model. Ideally this quantification of uncertainty involves development of a unique probability distribution for each constraint. [As an example of quantified uncertainty for one environmental constraint, let's select the constraint of the minimum streamflow necessary in the Colorado River in July to maintain acceptable dissolved oxygen concentrations. Let's assume that the uncertainty evaluation using QUALTX indicates that at a 90% confidence interval the minimum required July flow is 800 to 1,200 acre-feet/day, the probability distribution of the possible outcomes is normal, and the mean value of minimum July flow constraint is 1,000 acre-feet/day.]
- 2) The uncertainty with each constraint is evaluated with the Surface Water Availability model through multiple simulations. Each simulation gives a unique value of water yield for a unique set of values assigned to the environmental constraints. Within this step, ideally, repeated simulations using the Surface Water Availability model are performed a predetermined number of times using a unique set values for the constraints, and each value comprising the set is randomly selected from each constraint's uncertainty probability distribution. Often Monte Carlo sampling methods, such as Latin hypercube sampling, are used to perform the random sampling of the probability distributions associated with each constraint. Under this approach, each constraint is independently being randomly sampled within its probability distribution to form a unique set of values creating sets of model input constraints. Interdependency of constraints may be included, as necessary, within the sampling method. It is suspected that some modification of this rigorous and potentially resource intensive approach will be required for this project.
- 3) The output (SAWS water yield) and input (the various sets of unique combinations of values for the environmental constraints from Monte Carlo sampling) from the multiple simulations can be used to communicate and quantify risk. The results may be presented as a probability distribution function, a cumulative distribution function, or by displaying selected fractiles.

A hypothetical example using a cumulative distribution function is provided in the figure below. The x-axis represents the water yield determined from the Surface Water Availability model, and the y-axis is the cumulative probability. Note that the x-axis for simplicity of interpretation is actually decreasing in value from left to right. To help understand the graphic a few points from the curve will be discussed. There is nearly a 0.99+ probability within this example that the water yield will be at least 50,000 acre-feet per year (ac-ft/yr). Also for the water yield of 50,000 acre-feet/year, there is less than a 0.01 (1.0 –

0.99+) probability that a set of input values will require a yield of less than 50,000 ac-ft/yr for environmental constraints to be met. There is a 0.6 probability that the water yield will be at least about 100,000 ac-ft/yr. For the conditions of a yield of 100,000 ac-ft/yr, there is a 0.4 (1.0 – 0.6) probability that a set of input values will require that the water yield be less than 100,000 ac-ft/yr for environmental constraints to be met. And conversely there is a 0.6 probability that the yield of 100,000 ac-ft/yr will allow sufficient remaining water to meet or exceed the requirements of environmental constraints. As a final example, there is a 0.1 probability that the yield will be about 130,000 acre-feet per year, but a 0.9 (1.0 – 0.1) probability that the yield will need to be less than that amount to meet environmental constraints. Or conversely, there is a 0.1 probability that 130,000 ac-ft/year of water yield will allow sufficient remaining water to meet or exceed the requirements of environmental constraints.

There may be other ways of presenting the risk analysis that better communicate the risk to water yield and to meeting environmental constraints, and exploring such is encouraged. The SRP strongly suggests that there is a very tangible value to quantifying the risk to better inform the decisions about project viability and possible adaptive management decisions.

**Figure - Cumulative Distribution Function of Water Yield – Hypothetical Example**



**3. LITERATURE REVIEWS – apparent that some studies have reviewed literature, but is needed for all projects**

- Each team needs to evaluate their results in comparison to the literature to make sure their results are consistent with the literature, and if not, provide some

rationale for why this is the case. *[We concur, and will attempt to enhance this aspect of the studies.]*

- The below was extracted from an early SRP review. From the October 2006 workshop, it still appears the MBHE team is still struggling with the term “Bay Health” and what to do with the metrics they are developing to assess health. The scientific literature as suggested in the below comment is one solution. *[We understand that this is a difficult issue to address, and are continuing to work through it. While a number of other bay studies have developed indices, none of these studies appear to address the specific issues that this study was developed to address. We have carefully considered developing a single metric or index for bay health, and after careful consideration and discussions with key agencies have instead decided to develop information on a number of key measures of bay health for consideration and evaluation. In particular, the implications of this project on the bay are potentially changing inflows. These changes in inflow have the potential to alter the nature of the bay, whereas many of the bays sited in literature are affected by water quality or habitat concerns, which have much clearer drivers and end-points that can be delineated as either positive or negative. We look forward to further discussions with the SRP on this issue.]*

**LCRA-SAWS Water Project  
Scientific Review Panel  
Draft Detailed Study Plan (11/27/02) - Evaluation and Projection of  
Bay Health  
Bay and Estuary Subcommittee Report: Montagna, Whitedge, Earl**

*Section 3.1. This section largely ignores an enormous amount of work to develop single metrics to evaluate bay health. The literature is full of papers that describe approaches to develop an “index of biotic integrity” for bays and estuaries. These approaches have already been applied to Texas bays. It is a bit stunning that these approaches are ignored. As in the HLSP, the lack of a clear definition of “bay health” is a severe shortcoming of the DSP. The lack of a clear definition of what is meant by health results in the lack of focus on what ecological indicators can be used to evaluate and predict state (or change in conditions) of the estuary after inflow reductions. Both the field of bay health and inflow indicators have grown dramatically in the last decade, and these new approaches should be incorporated into the DSP.*

- Many of the SRP panel members have reviewed National Science Foundation or Environmental Protection Agency proposals where part of the criteria for evaluation of proposals is knowledge of the appropriate technical literature. As this project continues, SRP would urge the project managers for the various components to give the technical literature due consideration in evaluating and interpreting study results and model predictions.

## 5. IMPACT OF PROJECT ON WILDLIFE

- More analysis is necessary including impact on socio-economics *[We concur.]*
- Has the potential reduction in waterfowl hunting revenues been factored into the Farm Income Maximization Model? *[Yes, it will be.]*

## 6. EXOTIC SPECIES PLANNING

- The scope and scale of the impact of exotic species on the LSWP is difficult to incorporate into the planning and impact process making it simple to ignore exotic species and presume that they will be managed adaptively as they appear. However, given their potentially large impacts on water quantity and quality in the Colorado River and consequently on flows and operation of OCSF, it would be prudent to develop plans (detection, early response, management etc.) early. There is a large scientific literature on exotic species, their ecology, risk and management. *[This is an excellent point. We will consider this in the development of the Implementation Plan.]*
- Below is something that may be of use *[Thank you for this input. We will consider this as part of our NEPA analysis.]*

### **Addressing Incomplete or Unavailable Information for Decisions and Environmental Analyses**

The Council on Environmental Quality (40 CFR 1502.22) provides some direction for addressing incomplete or unavailable information for agencies evaluating reasonably foreseeable significant adverse effects on the human environment in an environmental impact statement. The regulations state that agencies "shall always make clear when such information is lacking." The Council's direction is summarized in the following flowchart.

## Addressing Incomplete Information Under NEPA 40 CFR 1502.22

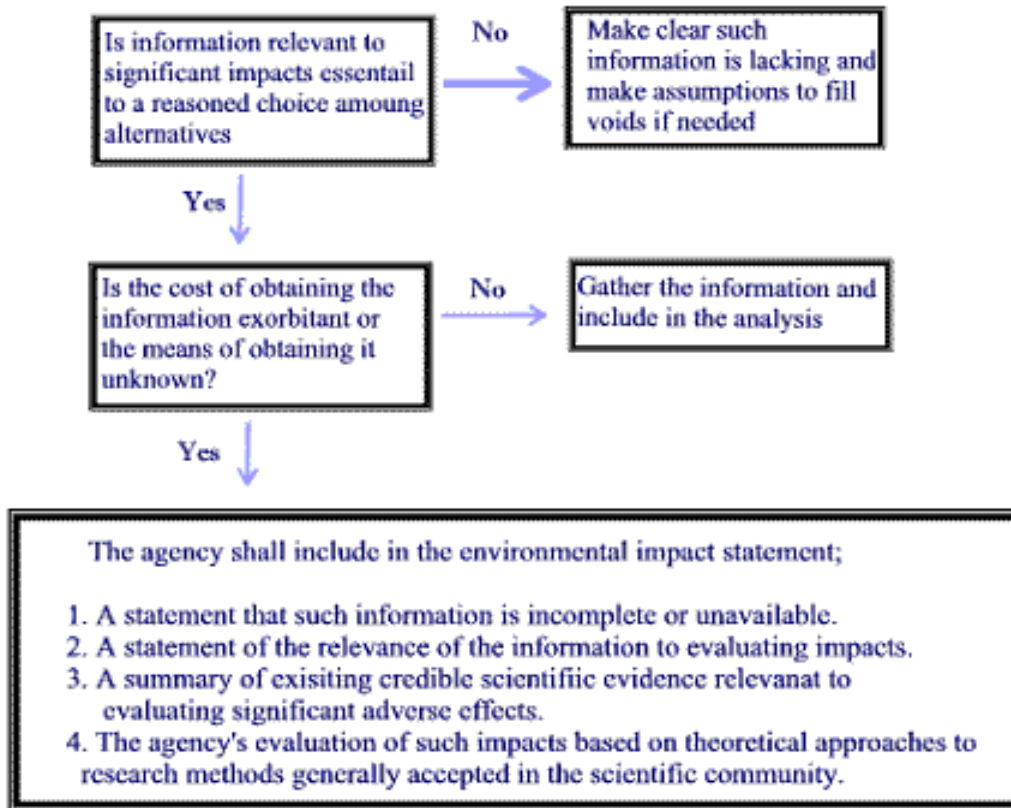


Figure 3: Addressing Incomplete Information under NEPA

This chart can also be used to document the rationale for why additional information is not needed. For example, if there is a question as to whether or not additional risk assessments are needed for a particular decision, the questions described in the chart can be answered along with the rationale for each determination. Documentation would be a part of the project record and summarized and referenced within the environmental document.

Whether one is writing an environmental assessment or an environmental impact statement, key questions to ask in relation to information needs are:

- What information is available to help characterize and predict consequences?
- How certain (confident) are you that this information is a good basis for accurately predicting consequences?

- What are important gaps in knowledge for predicting consequences?
- What uncertain events could confound your predictions?
- What information is worth acquiring to improve your predictions? What would it cost?

Answers to these questions along with rationale provides a strong basis for identifying the information necessary for an informed decision and helps support the record for such decisions.

## 7. CONSTRAINTS IN THE SURFACE WATER AVAILABILITY MODEL

The required river flows, Dissolved Oxygen, and Bay inflows necessary to prevent degradation to the river and bay need to be run as absolute constraints in the water supply availability model, so that the contracted amount of water to SAWS is the residual after meeting environmental needs as required by the legislation chartering the LCRA-SAWS study. Current practice of calculating the percentage of time DO is met or Bay inflows met are not consistent with the requirements of the legislation that mandates no degradation in river or bay environmental quality. *[The results are shown in the manner described above (for example, percentage of time that bay inflows are met) because the results of the bay study and river studies are not yet complete. In the interim, preliminary assumptions were made (to facilitate preliminary Surface Water Availability modeling) concerning bay inflow and river flow requirements consistent with the basic format and rules that are currently placed on the operation of the Highland Lakes. The Surface Water Availability modeling can be performed in any number of ways. The assumption inherent in the SRP's statement above is that meeting some minimum inflow value at all times is tantamount to protecting the river or bay environmental quality. We believe that our studies will help answer whether this approach would be sufficient. Our preliminary results indicate that there are many other facets than minimum flows to maintaining bay and river environmental quality.]*

## 8. ADAPTIVE MANAGEMENT

Need for Adaptive Management in the LCRA-SAWS determination of the amount of water available for SAWS. Given the uncertainties in all of the models, a safety valve of reserved water should be held back from the contract that can be used to augment environmental flows if monitoring shows water diversions are harming the river, aquatic life or the bay, or can be sent to SAWS if monitoring shows no deterioration in health of the river, aquatic life or the bay. *[This is one of several approaches that will be considered in developing the mitigation and implementation plans. Adaptive management will be studied as part of any approach considered. That said, the "safety valve" could be associated with water deliveries to SAWS, or water deliveries for agriculture, or stored water in the basin, or additional water sources to be developed.]*