DRAFT
Performance Criteria for
Glen Canyon Dam Long-Term Experimental and Management Plan
Environmental Impact Statement
February 21, 2013

This document describes a set of performance criteria, developed in a series of workshops among subject matter experts that is being considered for use in evaluating alternatives for the Glen Canyon Dam Long-Term Experimental and Management Plan (LTEMP) Environmental Impact Statement (EIS). The performance criteria are intended to be objective metrics of the performance of alternatives relative to goals for each resource. These draft performance criteria will be used as a comparative tool to evaluate alternatives against one another. Resources, associated goals, and performance criteria are described below.

1. **Archaeological and Cultural Resources**

   - Resource Goal: Maintain the integrity of potentially affected National Register eligible or listed historic properties in place, where possible, with preservation methods employed on a site specific basis.

   - Draft Performance Criteria:

     o Net sediment conservation (proportion of sediment conserved in each reach above the 25,000 cfs elevation minus the lateral erosion rate of banks in the reach) in Glen and Grand Canyons as related to the magnitude, duration, and frequency of high-flow events (HFEs) and characteristics of intervening flows (monthly, daily and hourly release patterns) for alternatives. The following formulas would be used:

       $\sum R_r N_r W_r$, where R_r=the reach specific net sediment conservation value for reach r (see equation below), N_r=ranking of reach r according to number of sites or site density, W_r=weighting reflecting the value of resources in reach r according to NHPA, tribal, or information potential.

       $R_r = S_r D_r - E_r H_r$, where S_r=amount of sediment conserved in reach r, D_r=proportion of sediment conserved about the 25,000 cfs elevation, E_r=rate of erosion in reach r, and H_r=frequency of HFEs.

       Model output from the sand budget model would be used to determine sediment conservation and erosion rates for each alternative.

2. **Natural Processes**

   - Resource Goal: Restore, to the extent practicable, ecological patterns and processes within their range of natural variability, including the natural abundance, diversity, and genetic and ecological integrity of the plant and animal species native to those ecosystems.

- Draft Performance Criteria:

  o Measures of deviation from a natural (i.e., unregulated) pattern for five biophysical parameters (flow, sediment, turbidity, temperature, and nutrients/ aquatic invertebrate communities), combined in a way that reflects the need for all processes to be operating. For each alternative, the difference between predicted and natural values for the five parameters, and their component metrics, would be calculated and summed for the LTEMP period. An index of deviation for each parameter would be calculated (i.e., individual metrics would be combined) and then these five parameter indices combined into a single weighted index that reflects overall deviation from natural patterns.

3. **Humpback Chub**

- Resource Goal: Meet humpback chub recovery goals including maintaining a self-sustaining population, spawning habitat and aggregations in its natural range in the Colorado River and its tributaries below the Glen Canyon Dam.

- Draft Performance Criteria:

  o Predicted minimum number of adult chub (i.e., > 200 mm) at the Little Colorado River (LCR) confluence over the LTEMP period. (Note that higher values are considered better, i.e., we want to maximize the minimum value). Predictions would be based on an age-structured model that incorporates LCR and mainstem components of the LCR aggregation using inputs related to water temperature and trout abundance.

  o Probability of self-sustaining spawning aggregations outside of the LCR aggregation with a focus on aggregations at RM30, 88, 108, 119, 125-128, 157, 213. A simple probabilistic model would be developed for each site that considers the magnitude and timing of temperatures relative to spawning and rearing needs for mainstem spawning sites, and rearing needs alone for tributary spawning sites.

4. **Hydropower and Energy**

- Resource Goal: Maintain or increase Glen Canyon Dam electric energy generation, load following capability and ramp rate capability, and minimize emissions, and costs to the greatest extent practicable consistent with improvement and long-term sustainability of downstream resources.

- Draft Performance Criteria:
  o A single criterion would be developed that incorporates the following five parameters and their component metrics as predicted by the GTMax power systems model from monthly release patterns for the LTEMP period:
  o A single criterion would be developed that the following five parameters and their component metrics as predicted by the GTMax power systems model from monthly release patterns for the LTEMP period:

- Quantity of hydropower capacity at Glen Canyon Dam (GCD)
- Quantity of hydropower generation at GCD
- Value of hydroelectric generation at GCD
- Flexibility of operations from load following and ramp rate capabilities
- Cost to ratepayers

5. Other Native Fish

- Resource Goal: Maintain self-sustaining native fish species populations and their habitats in their natural ranges on the Colorado River and its tributaries.

- Draft Performance Criteria:

  o Relative effect of alternatives (weighted index) on mainstem flannelmouth suckers at the LCR confluence (RM 61) and near Havasu Creek (RM 157). The relative effect on growth would be predicted from the degree-days above 12C at both sites, and the degree days above 16C for spawning at Havasu only. In addition to these growth-related effects, the adverse effect of competition and predation from trout at the LCR would be inferred from predicted number of trout under different alternatives. Note that trout effects are not expected at the Havasu Creek location, and spawning is not considered possible at the LCR confluence under any alternative.

6. Recreational Experience

- Resource Goal: Maintain and improve the quality of recreational experiences for the users of the Colorado River ecosystem. Recreation includes, but is not limited to, flatwater and whitewater boating, river corridor camping, and angling in Glen Canyon.

- Draft Performance Criteria:

  o For Grand Canyon National Park (GRCA), a metric that reflects the persistence of camping area (single value, GRCA wide, with lower values preferred) . The sand budget model would be used to predict the timing and number of HFEs, the amount of sand delivered by the HFEs, and erosion rates associated with intervening flows. These predicted values will be used to develop an index of the persistence of sand bars for each alternative.

  o For Glen Canyon National Recreation Area (GLCA), an Erosion Risk Factor (single value, GLCA wide, with lower values preferred). Based on existing stage-discharge relationships at selected points, the flow levels that would result in high risk of erosion leading to a loss of established campground infrastructure and terrace sediment deposits would be predicted. Modeled daily hydrographs will be used to calculate the frequency of occurrence for critical flows for each alternative.

7. Sediment

- Resource Goal: Increase and retain fine sediment volume, area, and distribution in the Glen, Marble and Grand Canyon reaches above the elevation of the average base flow for ecological, cultural, and recreational purposes.

- Draft Performance Criteria:

  o Several metrics would be used to reflect sandbar area above 8,000 and 25,000 ft^3/sec in each key reach (RM 0-30, RM 30-61, RM 61-87, and RM 87-277) using existing sediment modeling tools:

    - Cumulative sand load for RM 0-61 transported by high flows (flows > 25,000 ft^3/sec) divided by cumulative sand load for entire alternative, measured as a ratio
    - Number of events that have peak sediment concentration for RM 0-61 during high flows greater than the average peak concentration among all alternatives
    - One of the following variables that are indicators of mass balance:
      – Number of sediment years (begin on July 1) with negative mass balance for RM 0-61
      – Number of sediment years (begin on July 1) with large negative (> median annual Paria sand supply) mass balance for RM 0-61
    - Variance and mean of peak high flow magnitudes at Dam, measured as a flow value
    - Bar half-life for RM 0-61based on erosion rates from empirical information, measured in months

  o Number of days flow is greater than threshold value (tbd) to threaten terraces in Glen Canyon

8. Tribal Perspectives

- Resource Goal: Maintain the ability of traditionally associated Indian Tribes to access and use culturally important resources, and maintain culturally appropriate resource conditions.

- Draft Performance Criteria:

  o To be developed in coordination with the tribes

9. Trout Fishery

- Resource Goal: Achieve a healthy high-quality recreational trout fishery in Glen Canyon National Recreation Area and reduce or eliminate downstream trout migration consistent with National Park Service fish management and ESA compliance.

- Draft Performance Criteria:

  o Angler catch rate (fish/hr).

  o Catch rate of fish that are $\geq$ 14 in. (10-12 fish/day/angler=optimal threshold)

  o Emigration of trout from Lees Ferry (average #trout/yr)

  A trout production model and linked migration model would be used to predict these three metrics under each alternative.

10. Riparian Vegetation

- Resource Goal: Maintain native vegetation and wildlife habitat, in various stages of maturity that is diverse, healthy, productive, self-sustaining, and ecologically appropriate.

- Draft Performance Criteria:

  o Relative change in cover of native vegetation community types on sand bars and channel margins using the total % increase in native states predicted by an existing state and transition model for riparian vegetation communities.

  o Relative change in diversity of native vegetation community types on sand bars and channel margins using the Shannon Weiner index for richness/evenness using the results of the state and transition model.

  o Relative change in the ratio of native/nonnative dominated vegetation community types on sand bars and channel margins using the ratio of native/nonnative communities predicted by the state and transition model.

  o Relative change in the open sand state on sand bars and channel margins using the total % increase in bare sand states predicted by the state and transition model.

11. Water Delivery

- Resource Goal: Ensure that water delivery continues in a manner that is fully consistent with and subject to the Colorado River Compact, the Upper Colorado River Basin Compact, the Water Treaty of 1944 with Mexico, the decree of the Supreme Court in Arizona v. California, and the provisions of the Colorado River Storage Project Act of 1956 and the Colorado River Basin Project Act of 1968 that govern allocation, appropriation, development, and exportation of the waters of the Colorado River Basin.

- Draft Performance Criteria:

- o Frequency of deviation from the No Action Alternative to Lake Powell Annual Operating Tier as specified by the 2007 Interim Guidelines. The Operating Tier is predicted using the CRSS RiverWare model.

- o Frequency and volume of exceptions to meeting the annual release target volumes specified by the 2007 Interim Guidelines. The target and actual annual release volumes are predicted using the CRSS RiverWare model.

12. Warmwater Nonnative Fish

- Draft Performance Criteria:

  - o Probability of establishment of warmwater nonnative fish and expansion of any nonnative fish that are currently part of the system. Risk of establishment or expansion of potentially invasive species would be predicted using an existing risk assessment model developed for previous temperature control device evaluations. Temperature profiles of different species would be evaluated against predicted temperatures in different reaches of the river under different alternatives to determine risk. Lake Mead levels would be considered as part of this analysis.