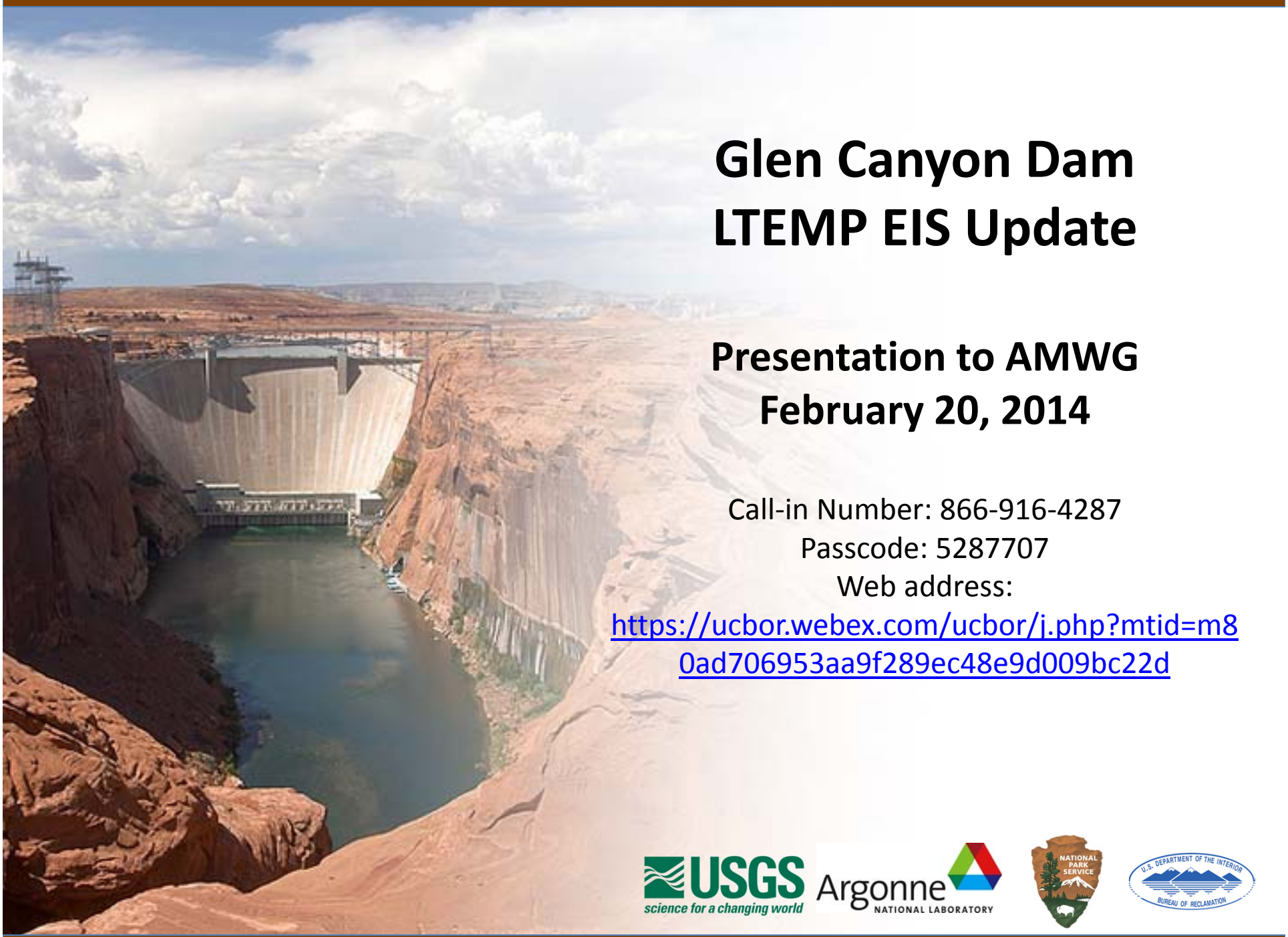


Glen Canyon Dam
LTEMP EIS Update

Presentation to AMWG
February 20, 2014

Call-in Number: 866-916-4287
Passcode: 5287707
Web address:
https://ucbor.webex.com/ucbor/j.php?mtid=m80ad706953aa9f289ec48e9d009bc22d

USGS science for a changing world
Argonne NATIONAL LABORATORY
NATIONAL PARK SERVICE
U.S. DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION

Presentation Topics

- Update on LTEMP EIS process and schedule
- Description of alternatives to be evaluated in the LTEMP EIS
- Review of resource goals and performance metrics
- Next steps in the structured decision analysis process
- Long-term strategies, expected value of information, and experimental design
- Approach to analyzing climate change

Update on LTEMP EIS Process and Schedule

Current EIS Schedule

Actions following August workshop

- Stakeholder written comments on models, metrics, and alternatives analyzed
- Input on Cooperating Agency calls analyzed
- Subject Matter Expert (SME) group discussions of model interpretations, metric and index changes
- Completed development of hypotheses for critical uncertainties
- Refined resource goals, alternatives, performance metrics, & models

Current EIS Schedule

Actions following August workshop cont.

- Initiated model peer review process – GCMRC leading model review process
- Revised alternatives based on August modeling results
- Began second phase of model analysis
- Second round of modeling is using 21 CRSS traces (as opposed to one, Trace 88)
- Second round of modeling is using 3 sediment input traces for Paria River sediment inputs including high, medium and low
- Refined climate change analysis approach

Current EIS Schedule

Additional Steps in finalizing Public Draft EIS

- March 18: Preparatory webinar for all stakeholders on second round of decision analysis
- March 31-April 1: Two-day meeting for detailed presentation of modeling results to all stakeholders
- April 1-April 14: All stakeholder swing weighting take home exercise due April 14
- Further develop experimental design and adaptive strategies

Current EIS Schedule

Additional Steps in finalizing Public Draft EIS

- Complete Expected Value of Information Analysis
- Further develop experimental design and adaptive strategies
- Additional analyses including socioeconomic, empirical data review, qualitative analysis
- Cooperating Agency Call/Meetings

Current EIS Schedule

Additional Steps in finalizing Public Draft EIS cont.

- Preparation of preliminary draft EIS **June 2014**
- Preliminary Draft EIS – circulated for Cooperating Agency Review **July 2014**
- Public Science Meeting **August 2014**
- Public Draft EIS **September 2014**
- Draft EIS public meetings and comment period **Fall 2014**

Description of Alternatives

Alternatives Modeled in August 2013

1. No-Action Alternative
2. Balanced Resource Alternative
3. Condition-Dependent Adaptive Strategy
4. Modified Low Fluctuating Flows with Extended Protocols
5. Resource Targeted Condition-Dependent Alternative
6. Seasonally Adjusted Steady Flows
7. Seasonal Fluctuations with Low Summer Flows
8. Year-Round Steady Flows

Alternatives Dropped from Consideration

- Modified Low Fluctuating Flows with Extended Protocols
  - Rationale:
    - Same as no-action except for extension of HFE and NNFC protocols and interim guidelines
    - Other alternatives with protocols that extend for the 20 year LTEMP provides analysis for NEPA purposes
- Seasonal Fluctuations with Low Summer Flows
  - Rationale:
    - Primary objective to benefit native fish not supported by modeling
    - Some similarities to seasonally adjusted steady flows with regard to impacts

Alternatives Carried Forward for Analysis in EIS

1. No-Action Alternative
2. Balanced Resource Alternative (with modification)
3. Condition-Dependent Adaptive Strategy (with modifications)
4. Resource Targeted Condition-Dependent Alternative (with modification)
5. Seasonally Adjusted Steady Flows (with modifications)
6. Year-Round Steady Flows (with modification)

- *Note that alternatives are subject to change as the NEPA process unfolds*

Some Alternatives Have Associated Long-Term Strategies

- Long-term strategies are different implementations of the alternative that are dependent on uncertainties in system response
- Uncertainties associated with
  - sediment supply
  - response of humpback chub to trout and temperature
  - effect of fall HFEs on trout
  - effectiveness of trout management flows
  - effects of increased hydropower generation
- Alternatives with long-term strategies
  - Balanced resource alternative (2)
  - Condition-dependent adaptive strategy (4)
  - Resource targeted condition dependent alternative (6)
- 15 alternative/long-term strategies to be evaluated

Elements Potentially Common to All (or Most) Alternatives

- High flow releases for sediment conservation using the HFE protocol (modified in some alternatives)
- Non-native fish control actions as analyzed and described in the Non-Native Fish Control Environmental Assessment and Finding of No Significant Impact (modified in some alternatives)
- Compliance with 2007 record of decision on Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lakes Powell and Mead (until 2026)

Elements Potentially Common to All (or Most) Alternatives (Cont.)

- NPS management activities (durations as specified in management documents)
- Appraisal study of a temperature control device (TCD) (e.g., an impeller system) as funding allows
- Consideration of minor non-flow management actions at specific sites on a case by case basis such as non-native plant removal, revegetation with native species, and mitigation at specific and appropriate cultural sites

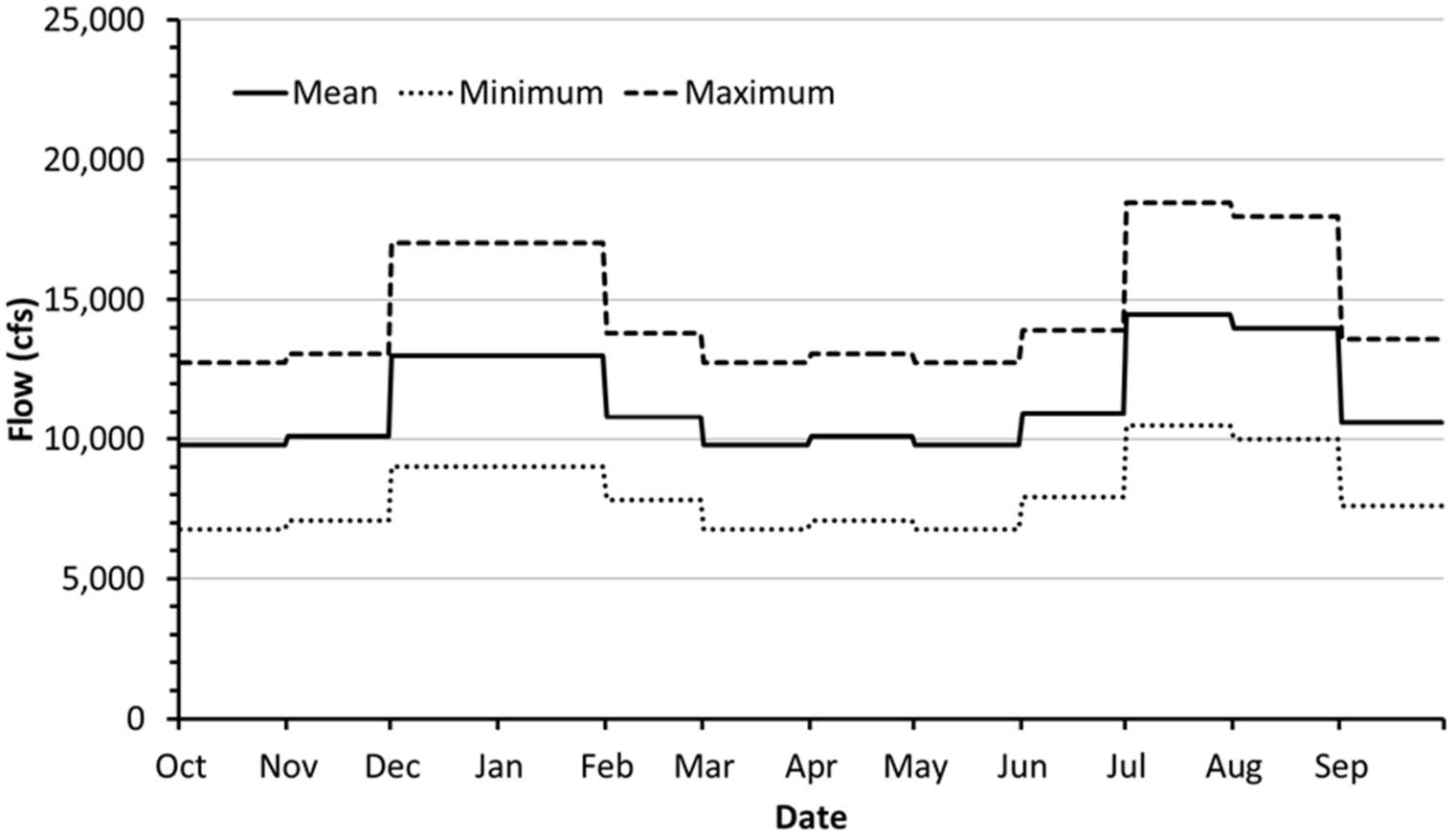
Elements Potentially Common to All (or Most) Alternatives (Cont.)

- Conservation measures discussed in the 2011 Biological Opinion (BO) on operations of Glen Canyon Dam
- Continued adaptive management that includes a resource monitoring program
- Determination of whether to establish a Recovery Implementation Program for endangered fish species below Glen Canyon Dam

No-Action

- Objective: Maintain existing operations and recent decisions without modification
- Continued operations of Glen Canyon Dam as guided by 1996 ROD and modified by recent Departmental decisions and ongoing or planned NPS activities:
  - Modified low fluctuating flows (MLFF)
  - HFE protocol, non-native fish control protocol, and experimentation per EAs (expire in 2020)

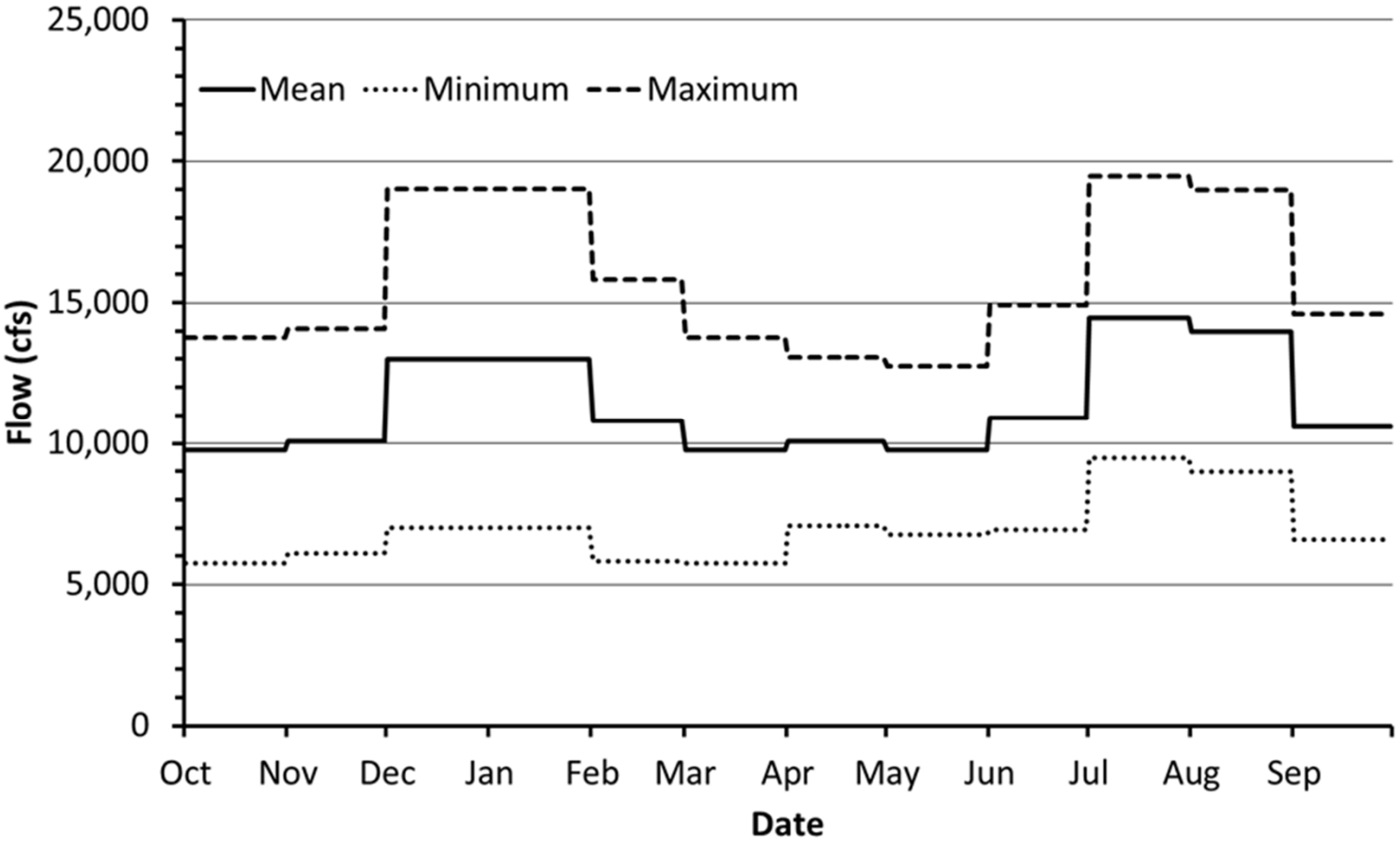
No-Action Hydrograph



Balanced Resource Alternative

- Objective: Maximize hydropower generation, while limiting impacts to other resources and relying on non-flow actions to mitigate impacts to the extent possible
- Base operations
  - Monthly volumes same as the no-action alternative
  - Increased fluctuations in 10 months (all but Apr and May)
  - Increase down-ramp rates in all months from 1,500 cfs/hr to 3,000 or 4,000 cfs/hr
  - Existing HFE protocol until 2020, but HFEs not to exceed one every other year

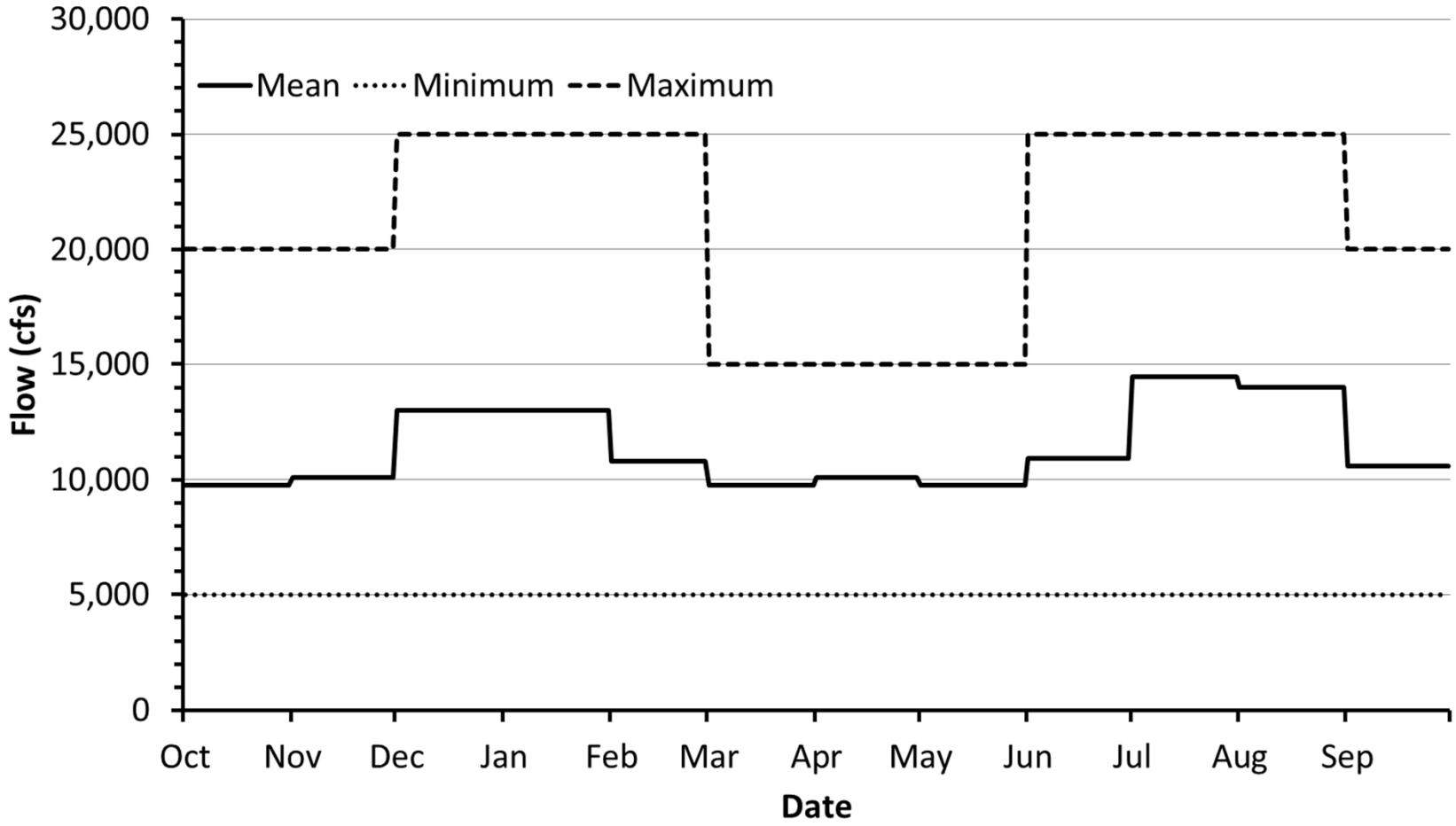
Balanced Resource Alternative Hydrograph—Base Operations



Balanced Resource Alternative (Cont.)

- Modifications to base operations:
  - Test “hydropower improvement flows” in 4, ≤ 8.23 maf years
  - Mechanical removal of trout in LCR reach
  - Testing and implementation of trout management flows
- Long-term strategies to be evaluated (2)
  - Base operations
  - Hydropower improvement flows in ≤ 8.23 maf years

Balanced Resource Alternative Hydrograph—Hydropower Improvement Flows



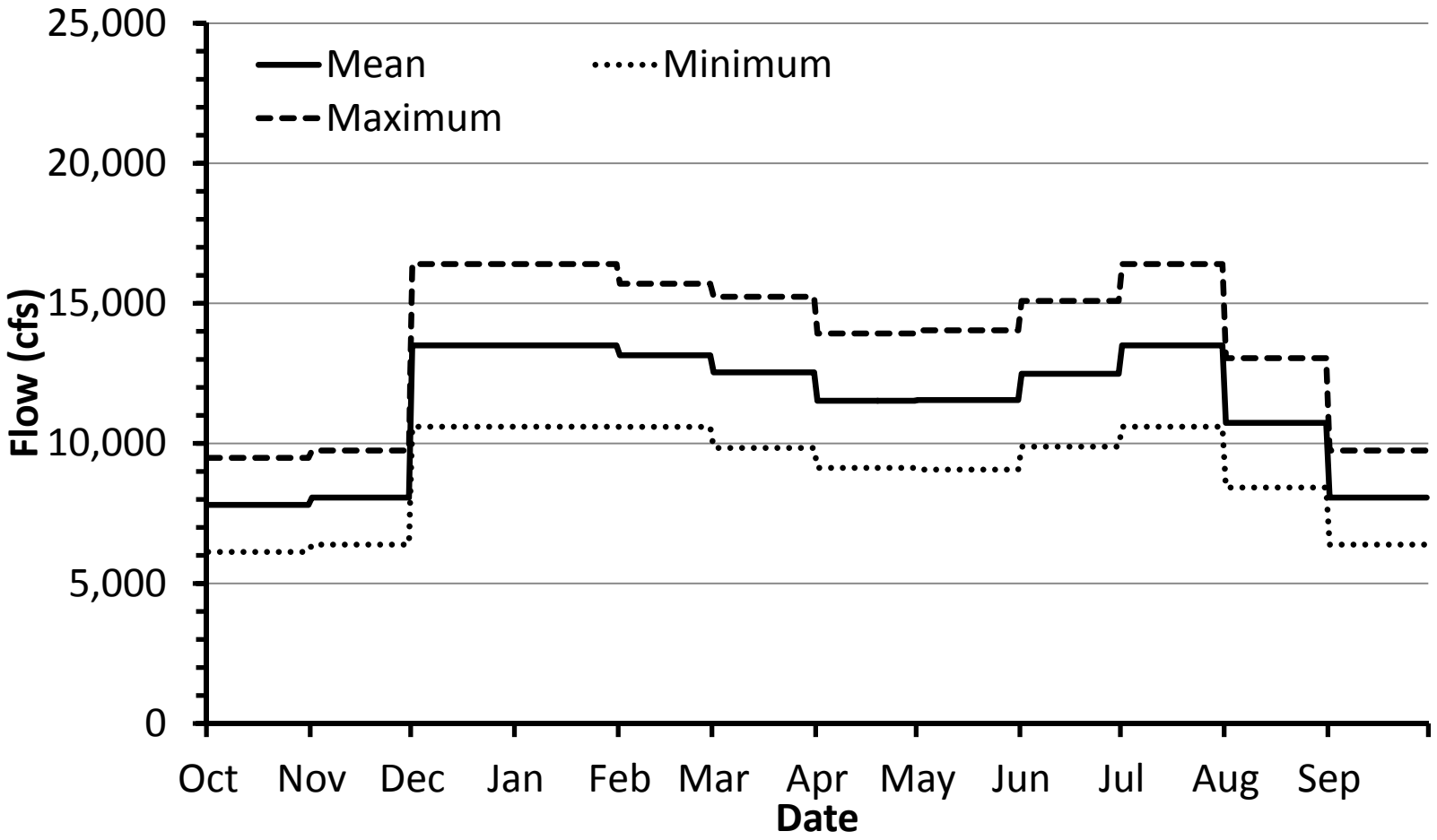
Condition-Dependent Adaptive Strategy

- Objective: Operate Glen Canyon Dam in an adaptive way to achieve balance of resource objectives with priorities placed on humpback chub, sediment, trout, and hydropower
- Changes since August 2013
  - Slight modification to monthly volume pattern to improve performance
  - Dropped sediment tiers
    - CDAS performs well with regard to sediment conservation under base operations
  - Modified HBC tiers
    - Warm temperatures at LCR mostly a result of release temperature (reservoir elevation)
    - Low summer flows effective in achieving 13^{o}C targets in relatively few years in most traces
  - Added greater flexibility to HFE duration allowing for HFEs longer than 96 hr, but limited to volume of 96-hr, 45,000 cfs flow (357,000 af)

Condition-Dependent Adaptive Strategy (Cont.)

- Base operations
  - Highest release volumes in high electric demand months of December, January, and July
  - February through June volumes proportional to contract rate of delivery
  - Lower volumes from August through November to conserve sediment inputs during monsoon period
  - Maximum daily range in flows equal to 7 × monthly volume (kaf) in all months (e.g., for an 800 kaf month, maximum daily range=5,600 cfs)
  - Increase down ramp rates from 1,500 cfs/hr to 2,500 cfs/hr in all months

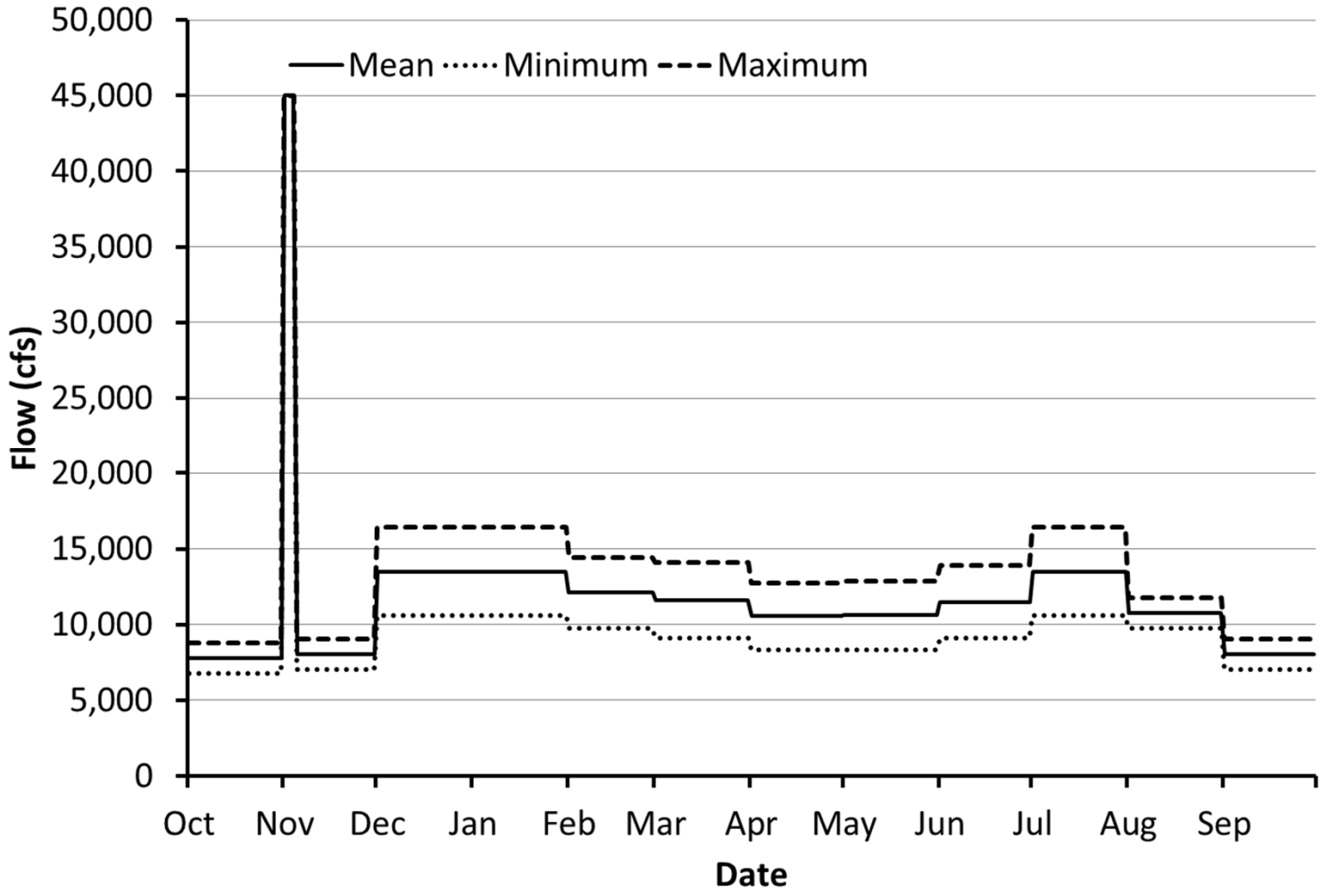
CDAS Base Operations



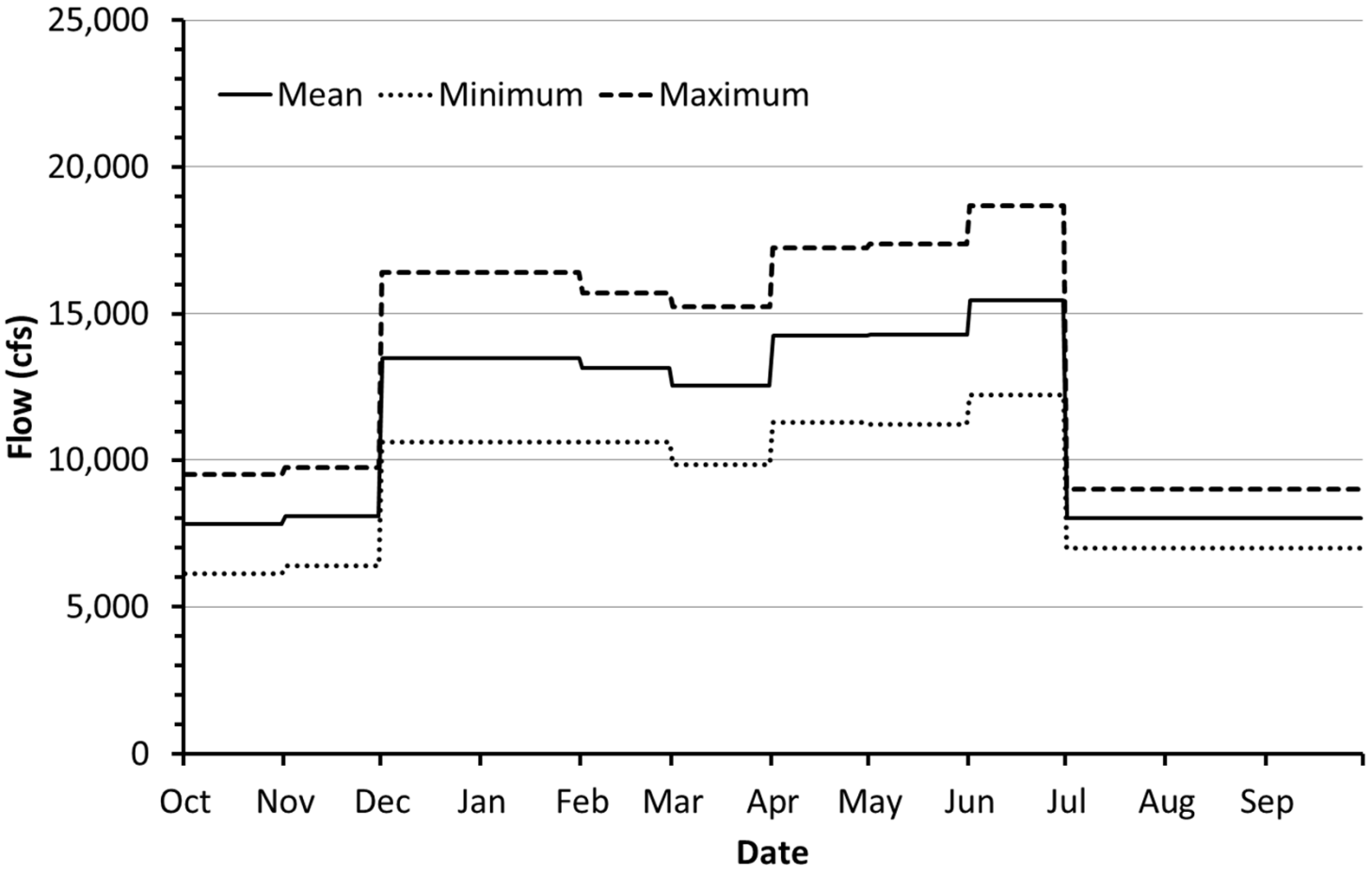
Condition-Dependent Adaptive Strategy (Cont.)

- Condition-dependent modification to base operations
  - Reduce fluctuations before spring and fall HFEs if significant input of Paria River sediment
  - Reduce fluctuations after spring and fall HFEs
  - Test spring high flow (pre-emptive strike) in high volume years prior to equalization
    - 1-day, up to 45,000 cfs
  - Low summer flows in some years to warm water if humpback chub decline
  - Mechanical removal of trout in LCR reach
  - Testing and implementation of trout management flows

CDAS with Fall HFE



CDAS with Low Summer Flows



Condition-Dependent Adaptive Strategy (Cont.)

- Long-term strategies to be evaluated (4)
  1. Fall and spring HFEs (including spring pre-emptive strikes) for entire LTEMP period, trout management flows
  2. Fall and spring HFEs (including spring pre-emptive strikes) for entire LTEMP period, low summer flows triggered by humpback chub and release temperature
  3. No HFEs, trout removal at LCR
  4. Fall HFEs only, trout removal at LCR

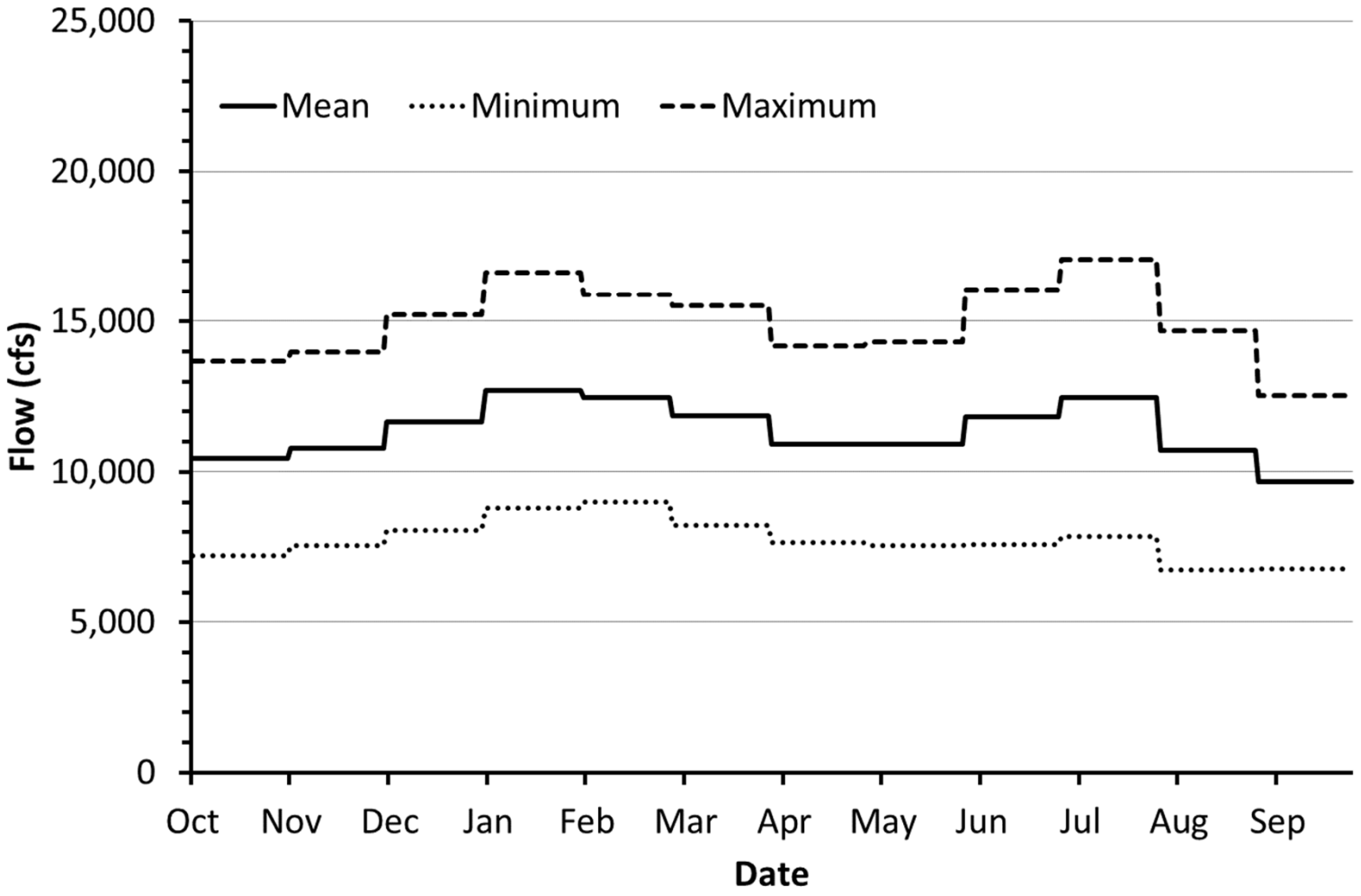
Resource-Targeted Condition-Dependent Alternative

- Objective: Provide for recovery of the humpback chub while protecting other important resources including sediment, the rainbow trout fishery at Lees Ferry, aquatic food base, and hydropower resources
- Change since August 2013
  - Slight modification to monthly volumes to achieve cumulative Oct-Dec volume of 2,000,000 af (same as no-action) in $\geq$ 8.23 maf years
  - Results in same annual release determination as no-action

Resource-Targeted Condition-Dependent Alternative

- Base operations
  - Target lower monthly water volumes in August, September, and October to conserve sediment
  - Increase hourly down-ramp rates from 1,500 cfs/hr to 2,500 cfs/hr
  - Maximum daily range in flows proportional to monthly volume
    - 12 × monthly volume [kaf] in June, July, and August
    - 10 × monthly volume [kaf] in other months
  - Increase hourly down-ramp rates in all months from 1,500 cfs/hr to 2,500 cfs/hr

RTCD Hydrograph—Base Operations



Resource-Targeted Condition-Dependent Alternative (Cont.)

- Modifications to base operations:
  - Reduce fluctuations before fall HFEs if significant input of Paria River sediment
  - No spring HFEs in first 10 years
  - Test rapid response HFE every 4th HFE
  - Mechanical removal of trout in the LCR reach
  - Test effectiveness of trout management flows
  - Test low summer flows in second 10 years if needed

Resource-Targeted Condition-Dependent Alternative (Cont.)

- Long-term strategies to be evaluated (6)
  1. Fall and spring HFEs for entire LTEMP period, trout management flows
  2. Fall and spring HFEs for entire LTEMP period, triggered low summer flows
  3. No HFEs, trout removal at LCR
  4. Fall HFEs only, trout removal at LCR
  5. Triggered low summer flows only
  6. Triggered trout management flows only

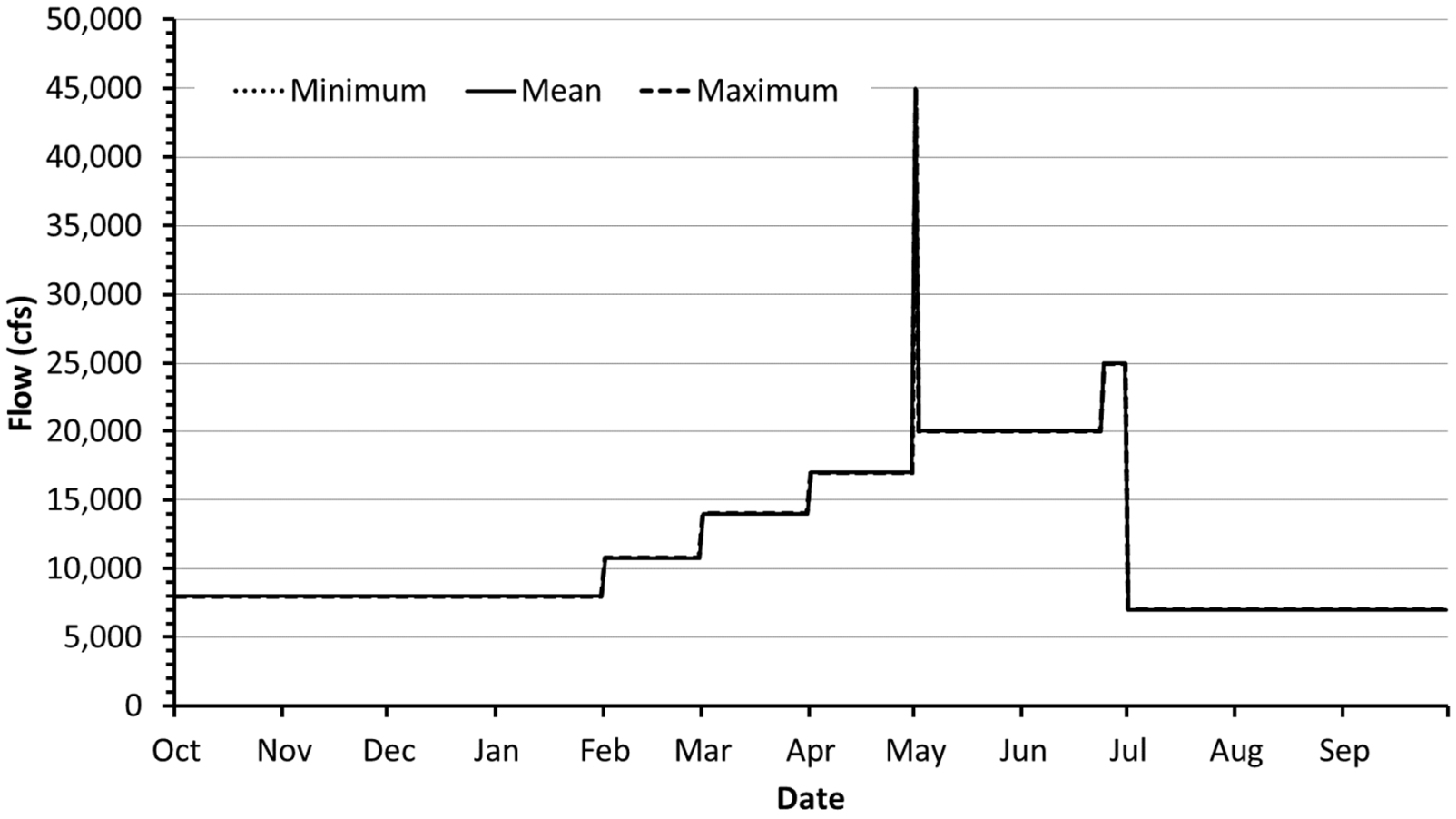
Seasonal Adjusted Steady Flow

- Objective: Provide flows that follow a natural pattern while limiting sediment transport and providing for warming in summer months
- Changes since August 2013
  - Increased peak flow magnitude and variability
  - Lowered base flows

Seasonal Adjusted Steady Flow

- Base operations:
  - Monthly volumes mimic a pre-dam pattern with peak flows provided in May and June, and base flows from July through January
  - Daily range of 0 cfs in all months
- Modifications to base operations:
  - Follows existing HFE protocol for the entire LTEMP period
  - No trout management flows or mechanical removal of trout

SASF Hydrograph—Base Operations



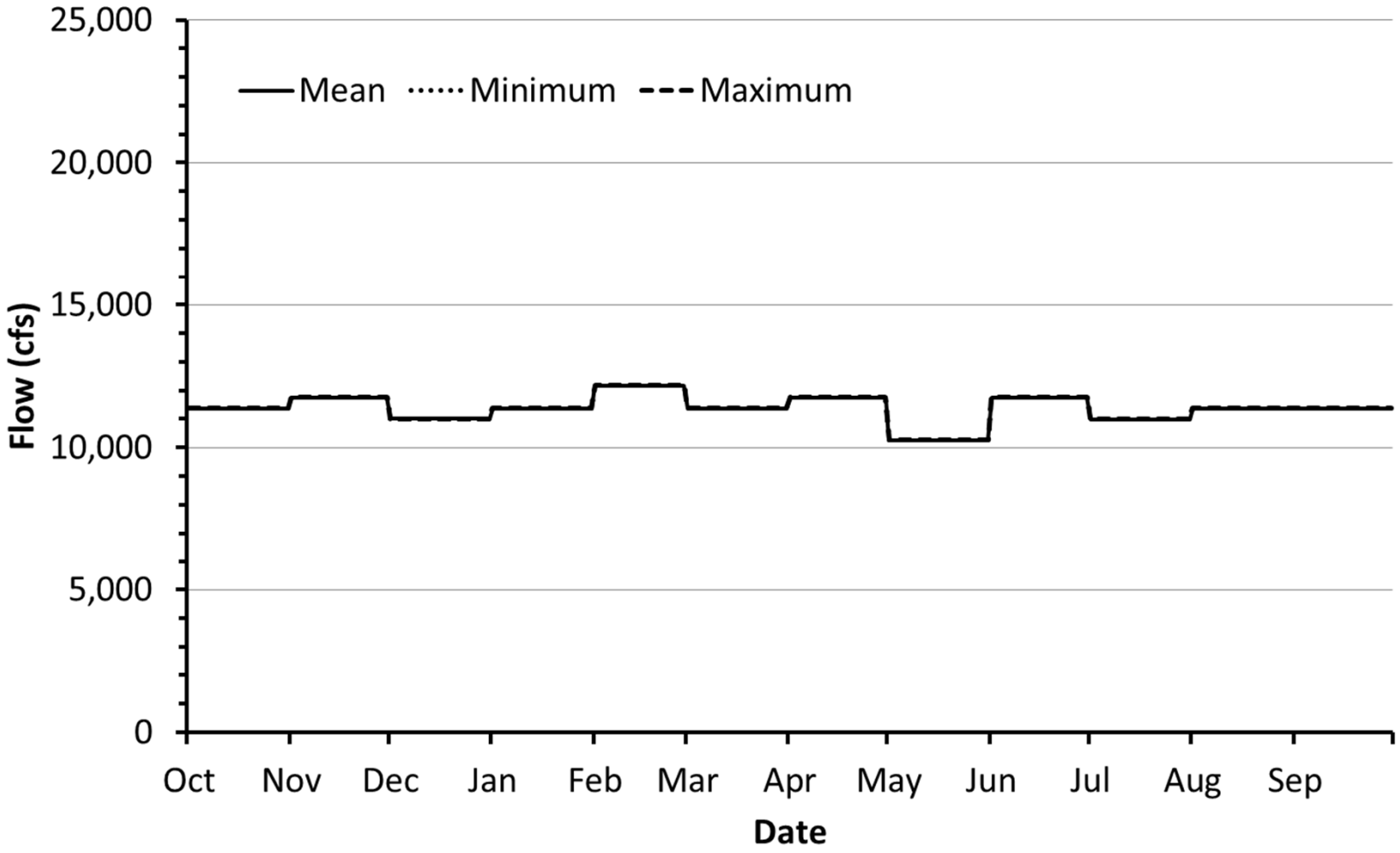
Year-Round Steady Flows

- Objective: Maximize conservation of sediment
- Changes since August 2013
  - Added greater flexibility to HFE duration allowing for HFEs longer than 96 hr
  - HFE duration dependent on sand supply, up to 336 hr (2 weeks)

Year-Round Steady Flows

- Base operations
  - Steady flow with no variation between months other than in response to changes in forecast and other operating requirements such as equalization
- Modifications to base operations
  - Follows existing HFE protocol for the entire LTEMP period, but allows for durations of HFEs up to 336 hr (2 weeks)
  - Test spring high flow (pre-emptive strike) in high volume years prior to equalization
  - Mechanical removal of trout in the LCR reach
  - Test effectiveness of trout management flows

Year-Round Steady Flow Hydrograph



Resource Goals and Performance Metrics

Resource Goals and Performance Metrics

- 12 resource goals, 33 performance metrics

- Aquatic ecology
  - Humpback chub (1 goal, 2 metrics)
  - Other native fish (1 goal, 1 metric)
  - Trout fishery (1 goal, 4 metrics)
  - Non-native aquatic species (1 goal, 2 metrics)
- Archaeological and cultural resources (1 goal, 3 metrics)
- Hydropower and energy (1 goal, 1 metric)
- Natural processes (1 goal, no metric)
- Recreational experience (1 goal, 6 metrics)
- Riparian vegetation (1 goal, 1 metric)
- Sediment (1 goal, 4 metrics)
- Tribal values and resources (9 elements to goal, 9 metrics)
- Water delivery (1 goal, no metrics)

Quantifying Performance Metrics

- Models will be used to quantify performance metrics for each alternative
- Modeling approach
  - 21 traces representing full range of hydrologic conditions
  - 3 sediment input traces to evaluate the effects of changes in sediment supply
  - Evaluation of the effects of climate change
  - Evaluation of multiple long-term strategies for each complex alternative

Quantifying Performance Metrics (Cont.)

- Existing models will be used wherever possible:
  - CRSS/RiverWare
  - GTMax
  - Sand budget model
  - Riparian vegetation state and transition model
- Some new models were developed specifically for LTEMP
  - Humpback chub-trout model (based on existing model used for non-native fish protocol development)
  - Temperature suitability model (modification of temperature-based risk model)
  - Sand bar volume model
- New models will be peer-reviewed

Quantifying Performance Metrics (Cont.)

- EIS will include impact assessments of resources not included in structured decision analysis process (e.g., regional socioeconomics, environmental justice, terrestrial wildlife, natural processes, some tribal concerns)

Aquatic Ecology

- 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
  - Performance metrics
    - Number of adult humpback chub in the LCR reach (modeled based on temperature and trout)
    - Potential for other self-sustaining aggregations of humpback chub in the mainstem Colorado River (temperature suitability)
- 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
  - Performance metric
    - Temperature suitability for warmwater native fish in mainstem Colorado River

Aquatic Ecology (Cont.)

- 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
  - Performance metrics (modeled based on flow and temperature)
    - Glen Canyon trout abundance (for age 1+ fish)
    - Catch rate (#/hr) for age 2+fish
    - Emigration estimate (number of age-0 trout moving into Marble Canyon from Glen Canyon)
    - Number of trout >16 in. total length
- Non-Native Aquatic Species
  - Resource Goal: Minimize or reduce presence and expansion of aquatic non-native invasive species
  - Performance metrics
    - Potential for establishment and expansion of non-native fish (temperature suitability)
    - Potential for establishment and expansion of aquatic parasites (temperature suitability)

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
- Performance Metrics
  - Wind transport of sediment index (sand bar volume and flow levels)
  - Flow effects on historic properties in Glen Canyon index (flow-related exposure and inundation)
  - Discretionary time off river index (flow-related travel time)

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
- Performance Metric
  - Combined value of hydropower ($) based on value of energy production, value of capacity, and value of operational flexibility

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.
- No performance metric, but will be evaluated in the EIS

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.
- Performance metrics
  - Grand Canyon metrics
    - Camping area index (sand bar volume and flow levels)
    - Navigational risk index (occurrence of very low flows)
    - Fluctuation index (high fluctuation levels at different mean daily flows)
    - Time off river index (flow-related travel time)
  - Glen Canyon metrics
    - Glen Canyon rafting use metric (HFE effect on concession operations)
    - Glen Canyon inundation index (occurrence of very low flows and very high flows)

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.
- Performance metric
  - Riparian native states and diversity index (modeled based on flow)
  - Components of index include
    - Relative change in cover of native vegetation community types
    - Relative change in diversity of native vegetation community types
    - Relative change in the ratio of native/non-native dominated vegetation community types
    - Relative change in arrowweed

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.
- Performance metrics
  - Sand load index (sand load transported by HFEs)
  - Standard deviation of high flows (variability of HFEs)
  - Sand bar volume index (modeled volume in Marble Canyon based on flow and sediment input)
  - Sand mass balance index (modeled based on flow and sediment input)

Tribal Values and Resources

- Resource Goal: Maintain the diverse values and resources of traditionally associated tribes along the Colorado River corridor through Glen and Grand Canyons by: (1) preserving and enhancing the sacred integrity of Grand, Marble, and Glen Canyons; (2) maintaining and enhancing traditional tribal connections to the canyons and maintaining the ability of traditionally associated Indian Tribes to access and use culturally important resources; (3) increasing the health of the ecosystem in the canyons; (4) preserving and enhancing respect for living things in the canyons; (5) protecting and preserving sites and resources of cultural importance; (6) maintaining and enhancing traditional stewardship opportunities; (7) maintaining tribal water rights and supply; (8) maintaining and enhancing economic opportunity; and (9) incorporating tribal input in the LTEMP process

Tribal Values and Resources (Cont.)

- Performance metrics
  - Borrowed from other resource goals
    - Wind transport of sediment index
    - Flow effects on historic properties in Glen Canyon index
    - Time off river index
    - Native fish temperature suitability index
  - Unique to tribal resources
    - Riparian diversity index
    - Marsh habitat index
    - Number of trout mechanical removal trips per year
    - Fraction of years in which trout management flows occur
    - Lake Powell water surface elevation relative to water intakes
  - *Note that all elements of the tribal values and resources goal do not have corresponding performance metrics, but all will be evaluated in the EIS*

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

- *Note that all alternatives must meet these legal requirements*

Water Delivery

- Calculated metrics
  - Frequency of deviation from the No Action Alternative to Lake Powell Annual Operating Tier as specified by the 2007 Interim Guidelines
  - Probability over time of Lake Powell being in each Operating Tier as specified in the 2007 Interim Guidelines
  - Frequency and volume of exceptions to meeting the annual release target volumes specified by the 2007 Interim Guidelines

  - *Note that these metrics will not be used in the structured decision analysis process, but will be evaluated in the LTEMP EIS*