April 19, 2019

To: Glen Canyon Leadership Team for Implementation of Experiments under the Long Term Experimental and Management Plan (LTEMP)

From: LTEMP Planning/Implementation Team

Re: Final Recommendation to Implement Macroinvertebrate Production Flow (Bug Flows) Releases at Glen Canyon Dam May – August 2019

I. Introduction

The LTEMP Planning/Implementation Team (PI Team) recommends, by consensus, that experimental Macroinvertebrate Production Flows (Bug Flows) be implemented at Glen Canyon Dam beginning May 1 through August 31, 2019.

Bug Flows consist of steady weekend releases from Glen Canyon Dam and normal fluctuating releases during the weekdays. The steady weekend flows are expected to provide favorable conditions for aquatic insects to lay eggs along the Colorado River downstream of Glen Canyon Dam, while the minimum flows on weekdays are designed to be similar to flows on the weekends. This flow regime would decrease the amount of stage change in the river on the weekends, thus preventing the insect eggs that are laid along the river margins from drying out. Technical experts at the United States Geological Survey's (USGS) Grand Canyon Monitoring and Research Center (GCMRC) and Western Area Power Administration (WAPA) have coordinated the design of the recommended experiment to optimize the benefits for insects throughout the Canyon while minimizing negative impacts to hydropower. This experiment is expected to have positive benefits to the aquatic and terrestrial ecosystems in Glen, Marble, and Grand Canyons. The purpose of the experimental flow is to test the effectiveness of Bug Flows for improving insect production and to increase the availability of food for desired fish species including the endangered humpback chub *(Gila cypha*) and rainbow trout (*Oncorhynchus mykiss*), an important sportfish, as well as terrestrial wildlife like birds and bats.

The purpose of this memorandum is to transmit this recommendation to the Glen Canyon Leadership Team for Implementation of Experiments (Leadership Team) under the LTEMP and to the Department of the Interior (Department) in accordance with the LTEMP Record of Decision (ROD). The PI Team includes technical representatives from the National Park Service (NPS), the U.S. Fish and Wildlife Service (FWS), the Bureau of Indian Affairs (BIA), USGS GCMRC, the Bureau of Reclamation (Reclamation), WAPA, the Arizona Game and Fish Department (AGFD), the seven Colorado River Basin States (States), and the Upper Colorado River Commission (UCRC).

The PI Team has worked over the past month to evaluate existing data and coordinate the potential implementation of the experiment. The PI Team incorporated the latest data from agency experts and considered multiple issues, as summarized below, in making this final recommendation.

If implemented, this will be the third experiment conducted under the LTEMP ROD, following summer Bug Flows and a fall High Flow Experiment in 2018. These examples demonstrate the utility of the LTEMP to allow for experiments when conditions warrant and when the experiment would not cause unacceptable adverse impacts to other resources. The recommended Bug Flows experiment is expected to provide resource benefits in the near term and will also provide scientific information to be used in future decision making.

II. LTEMP Process for Implementing Experiments

The 2016 LTEMP ROD provides the framework for implementing flow-based experiments at Glen Canyon Dam when resource conditions warrant. The purpose of LTEMP experiments is to learn, through adaptive management, how to better protect, mitigate adverse effects, and improve resources downstream of Glen Canyon Dam, while complying with relevant laws. Ongoing research and monitoring through the Glen Canyon Dam Adaptive Management Program (GCDAMP) ensures the best science and data are available for making decisions related to experimental releases.

Under the LTEMP ROD, the Department may conduct flow-based experiments (High Flow Experiments, Bug Flows, Trout Management Flows, and Low Summer Flows) at Glen Canyon Dam when resource conditions warrant and if it is determined that there will not be unacceptable adverse impacts on other resources. The process for recommending experiments entails outreach to GCDAMP partners through regular meetings and additional notification to Tribes inviting consultation. The process also entails coordination with the PI Team to plan for the possible experiment, evaluate the status of resources, and make a technical recommendation regarding whether to conduct an experiment. The PI Team presents its recommendation to the Leadership Team, which makes a recommendation to the Department. The PI and Leadership teams are made up of representatives from Reclamation, FWS, NPS, BIA, USGS, WAPA, AGFD, and one liaison from each Colorado River Basin State and the UCRC. The Assistant Secretary for Water and Science is the chair of the Leadership Team and makes the decision for the Department regarding the experimental release. The recommendation process used this year is consistent with the process that the Department has used in the past for making decisions regarding experiments under the LTEMP; consistent with the LTEMP ROD, the Department may choose to retain or modify this recommendation process to more efficiently coordinate with stakeholders.

III. Recommended Experiment: Bug Flows

Purpose and Goal

The purpose of Bug Flows experimentation is to determine whether stable, low flows on weekends in spring and summer months (May – August) can improve the condition of the aquatic food base that fuels growth of humpback chub, rainbow trout, and other desired fish and terrestrial wildlife species. By releasing stable and low flows every weekend, Bug Flows will provide two days of ideal egg-laying conditions each week for aquatic insects that lay their eggs along river margins and are susceptible to drying out under normal, daily hydropower flow fluctuations (see Figure 1, Kennedy and others, 2016). If successful, Bug Flows should result in a more abundant and potentially more diverse and stable aquatic food base available to fish in the

Colorado River downstream of Glen Canyon Dam. Bug flows were first tested in 2018 and preliminary data indicate that the aquatic food base responded positively, as predicted (see sections IV and V, below). As such, a second consecutive year of Bug Flows is recommended for testing in 2019.

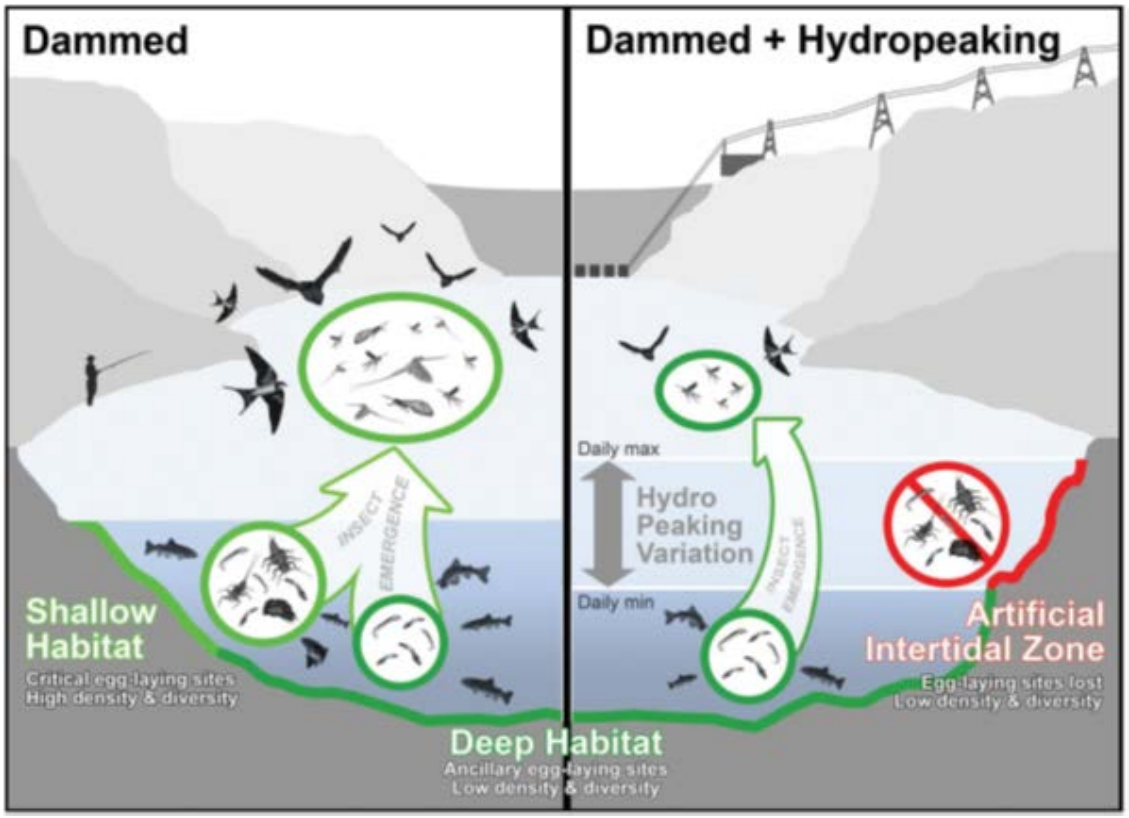

Figure 1. Aquatic insects play an essential role in river and riparian food webs. Aquatic insects are ubiquitous in freshwaters and are the primary prey for myriad species of wildlife living in and along rivers. These insects have complex life cycles that include a terrestrial winged adult life stage, whereas egg, larval, and pupal stages are aquatic. Ecologically important insect groups such as mayflies, stoneflies, and caddisflies cement their eggs along river-edge habitats, making them especially sensitive to dam water management practices such as hydropeaking that affect these edge habitats. Adapted from Kennedy and others (2016).

Experimental Design and Description

A Bug Flows hydrograph that incorporates weekend steady low flow releases that are 750 cubic feet per second (cfs) higher than weekday low flow releases in all months (May – August) is proposed for 2019 (see Figure 2). The recommended hydrograph was developed collaboratively by GCMRC and WAPA using an optimization process that determined a 750 cfs increase in weekend flows should provide better egg-laying conditions, river-wide, across all months, compared to the original Bug Flows experiment described in LTEMP. To meet downstream water delivery requirements, the stable, low flows on weekends need to be offset by relatively higher peak flows during the week than would otherwise be achieved under normal operations. As currently designed, steady low-flow releases on weekends would begin after the normal

down-ramp on Friday evening, with the down-ramp ending when flow releases match the designed Bug Flows weekend steady low flow. Dam releases would be steady throughout (except for system regulation and use of reserves) Saturday and Sunday and then dip briefly Monday morning for hydropower scheduling purposes to the designed weekday low flow, prior to ramping up at the normal rate until peaking later on Monday at the designed weekday high flow. Releases throughout the remainder of the week (Tuesday – Friday) would then be similar to releases on Monday. The exact timing of each of these peaks and low flow troughs varies from month to month according to scheduled monthly release volumes.

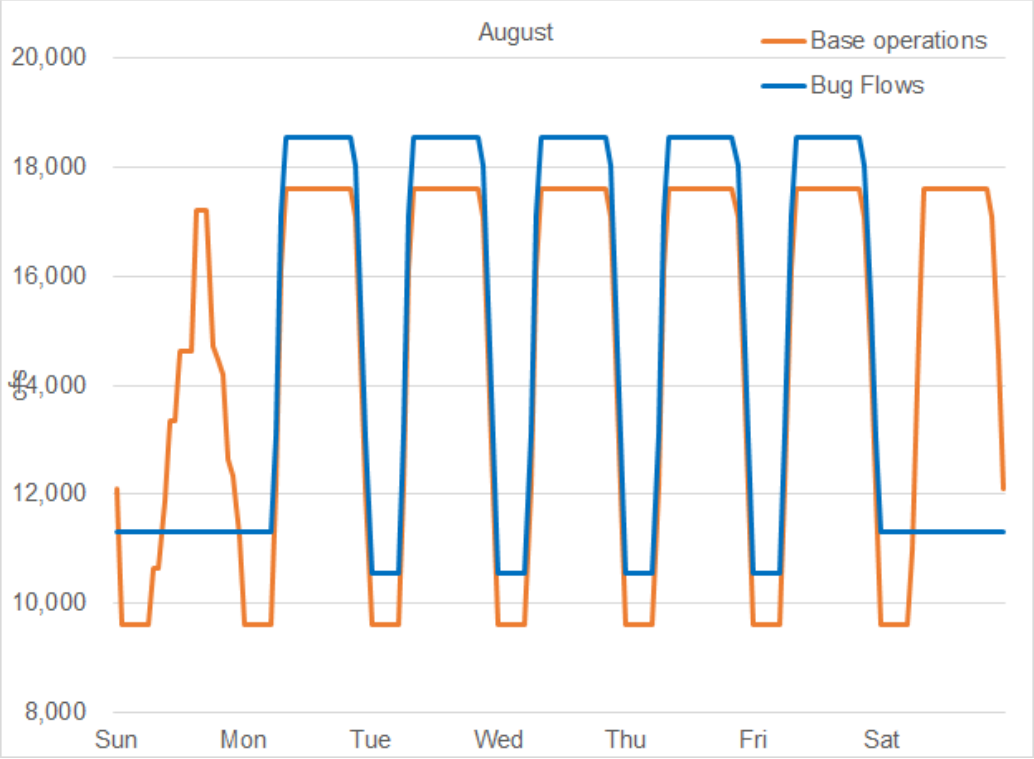

Figure 2. Proposed Bug Flows hydrograph for August under base operations (no Bug Flows) and Bug Flows scenarios. One week is shown; releases on subsequent weeks in the same month would be very similar.

Water delivery

The recommended Bug Flows experiment will not result in changes to the weekly release volume from Glen Canyon Dam, nor will it affect scheduled monthly release volumes. In addition, the experiment will have no effect on the annual release volume from Lake Powell in compliance with the 2007 Interim Guidelines. Reclamation currently projects the annual release volume for water year 2019 will be 9.0 million acre feet under the minimum, maximum, and most probable inflow scenarios.

For each month of the experimental period (May through August), weekend low, steady releases will be maintained at 750 cfs greater than the weekday low for that month. Normal fluctuating releases will be maintained during the weekdays. The LTEMP maximum ramp rates (4,000 cfs

per hour when increasing and 2,500 cfs per hour when ramping down) will be adhered to throughout the experiment, as will the maximum daily fluctuations (9 times the monthly release volume in May; and 10 times the monthly release volume in June through August). The daily fluctuating range is not to exceed 8,000 cfs. In addition, minimum releases of 5,000 cfs during the nighttime and 8,000 cfs during the daytime will be maintained.

Implementation of Bug Flows would result in the following monthly release schedule at Glen Canyon Dam:

Month	Release Volume (af)	Maximum daily fluctuation	Weekday maximum (cfs)*	Weekday minimum (cfs)*	Weekend release (cfs)*
May	720,000	6,480	15,077	10,095	10,845
June	765,000	7,800	17,535	9,735	10,485
July	860,000	8,000	18,140	10,140	10,890
August	900,000	8,000	19,000	11,000	11,750

* While the 2019 Bug Flows experiment is designed based on H750, circumstances and/or conditions may change during implementation. Per the LTEMP ROD, Reclamation, in consultation with WAPA and GCMRC, may make specific adjustments to daily and monthly release volumes for a number of reasons, including operational, resource-related, and hydropower-related issues.

Although every effort will be made to match the design of the experiment described above, Reclamation will continue to exercise the operational flexibility described in the LTEMP ROD.

IV. Monitoring Plan

If Bug Flows are approved by the Secretary, GCMRC will monitor aquatic food base response to Bug Flows using existing monitoring methods. These include citizen science light trapping of adult aquatic insects throughout Glen, Marble, and Grand Canyons, monthly aquatic invertebrate drift monitoring in Glen Canyon, multiple events of spatially-intensive drift sampling throughout Glen, Marble, and Grand Canyons, and semi-quantitative assessment of egg-laying conditions at targeted locations. These methods are cost effective and will yield robust data for quantifying the response of the aquatic food base to Bug Flows, while complying with all legal and regulatory requirements. The goals of these monitoring efforts are to document whether predicted increases in populations of extant aquatic insect species are realized, and to record any potential re-colonization of currently extirpated insect species such as caddisflies to the mainstem Colorado River.

Citizen Science Light Trapping

The principal mechanism for monitoring aquatic food base response to the recommended Bug Flows will be through citizen science light trapping. This project began in 2012 and comprises a group of river guides and student organizations that place a light trap at the river's edge every night in camp to collect adult aquatic insects. This effort yields a sample set of ~1000 traps per year throughout Glen, Marble, and Grand Canyons, predominantly during the commercial river guiding season through the spring, summer, and fall months when insects are most active. These citizen science light trapping data will be used to test the following predictions concerning insect population response to Bug Flows:

1. The overall baseline midge abundance is predicted to increase, and the "sine wave" pattern of variable midge abundance progressing downstream from Glen Canyon Dam described by Kennedy and others (2016) is predicted to flatten as midge abundance increases in areas where it is currently low. Indeed, this flattening was observed in 2018 during the first summer of Bug Flows (see Figure 3). Statistical change detection of this sine wave pattern will be carried out using current state-of-the art methods in ecology, including a combination of mixed effects models (similar to that used by Kennedy and others, 2016), and potentially Fourier analysis (Sabo and Post, 2008) and ecological forecasting metrics (Dietze, 2017) as appropriate, within an information-theoretic frequentist or Bayesian framework (Burnham and Anderson, 2002).

2. Annual average midge and caddisfly catches in light traps are predicted to show year-over-year increases and to eventually be higher than annual average catches observed in any of the six years of light trap sample collection prior to Bug Flows. Statistical analysis of these year-to-year differences will be carried out within an existing mixed effects modeling framework (Kennedy and others, 2016). Initial responses to the first summer of Bug Flows experimentation in 2018 indicate strong caddisfly population growth in 2018 (see Figure 4), although this is more rapid than was expected based on Bug Flows modeling predictions.

3. On a seasonal timescale, the currently observed peak in light trap midge abundance occurs in June every year, then declines sharply through late summer and early autumn. Under Bug Flows, midge abundance is predicted to exhibit a less dramatic decline in late summer and early autumn, as favorable conditions for egg laying during Bug Flows in early summer result in more adult midges later in the summer. Statistical analysis of these seasonal differences will be carried out using time series analysis within an existing mixed effects modeling framework (Kennedy and others, 2016; Dietze, 2017).

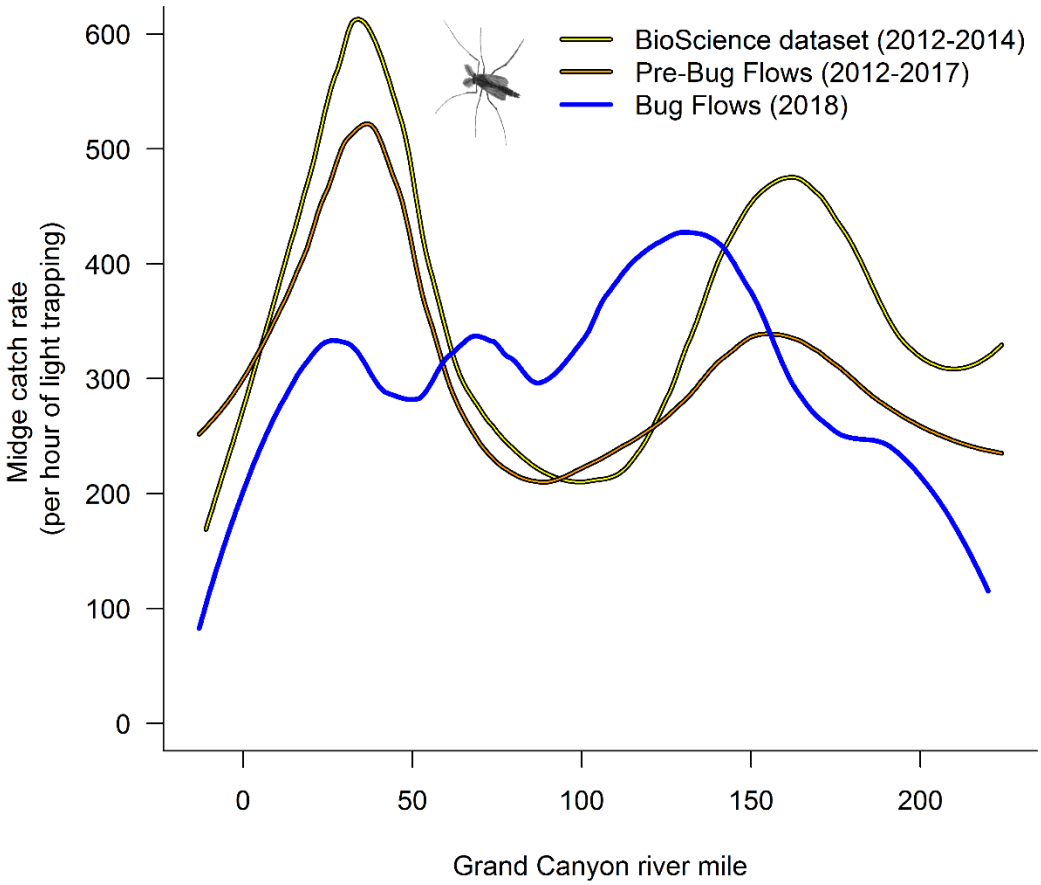

Figure 3. Spatial patterns of midge response to Bug Flows using citizen science light trapping. The yellow line is the pattern shown by Kennedy and others (2016) using pre-Bug Flows 2012–2014 data, the orange line includes data from all pre-Bug Flows years, and the blue line is the pattern observed during the first summer of Bug Flows in 2018. Note that Bug Flows modeling predicted a leveling out of the "sine wave" pattern in midge production as observed here.

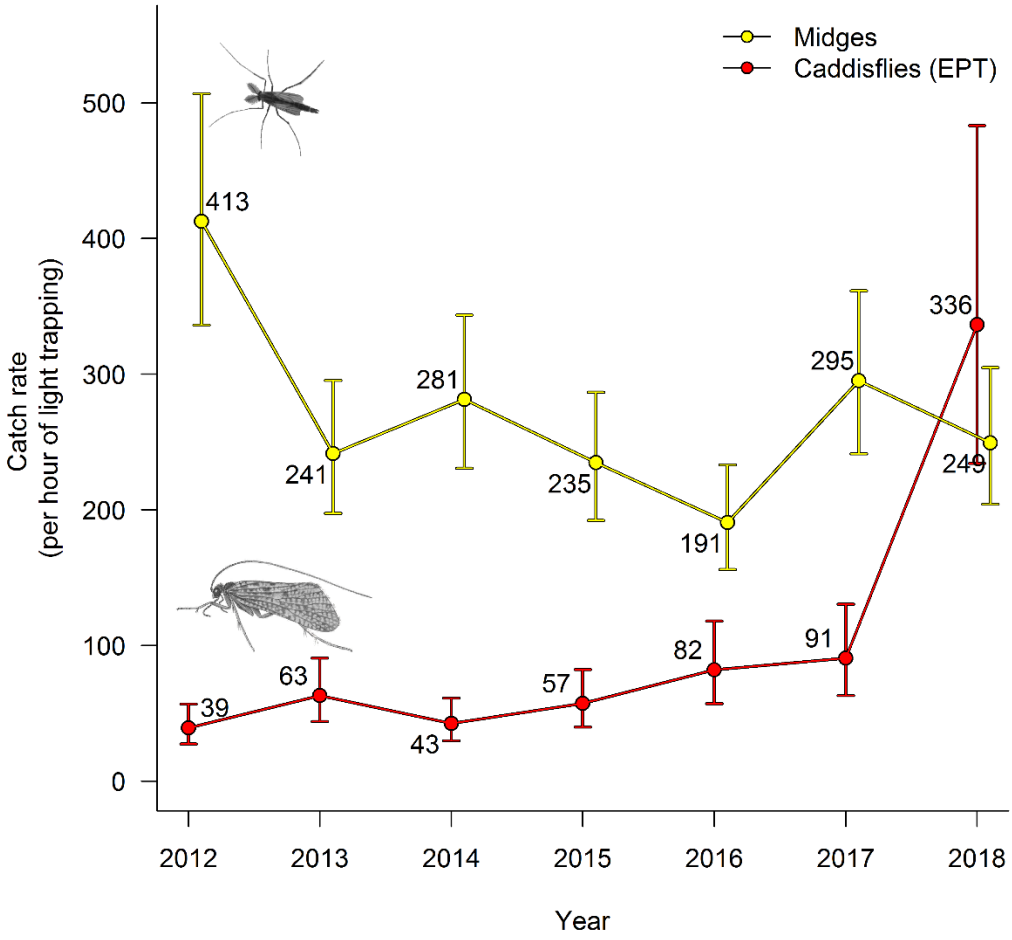

Figure 4. Average number of midges and caddisflies captured in citizen science light traps over time, including in 2018 during the first summer of Bug Flows experimentation. For the first time during citizen science light trap sample collection, caddisflies outnumbered midges river-wide on a per-trap basis.

Drift sampling

GCMRC staff will also monitor aquatic invertebrate drift monthly in Glen Canyon, and semi-annually throughout Glen, Marble, and Grand Canyons. The monthly sampling in Glen Canyon will be a continuation of monitoring that has been ongoing since 2007 and includes sampling at approximately 3-mile intervals from Glen Canyon Dam to the head of Badger Rapid, encompassing a total distance of 24 river miles. Invertebrate drift sampling will also be used to look at the variation in drift concentrations based on flow velocities between weekday fluctuating flows and weekend steady releases. These data will allow determination of the extent to which Bug Flows result in weekly, seasonal, or inter-annual increases in the abundance of aquatic insects present in the drift. This monitoring effort will also be used to test predictions 2 and 3 in the Citizen Science Light Trapping section, above.

In addition, spring and fall river trips focused on quantifying invertebrate drift will be launched in 2019, and potentially subsequent years. Invertebrate drift will be collected at approximately 3-mile intervals throughout Glen, Marble, and Grand Canyons (about 295 river miles in total) to determine the extent to which spatial patterns in aquatic invertebrate drift respond to Bug Flows, complementary to prediction 1 in the Citizen Science Light Trapping section, above. Although

aquatic insect drift concentrations are correlated with adult abundances in light traps that are deployed on land, in-river drift data are useful for more directly quantifying food availability for fish. These data will be compared to spring and fall drift sampling trips in 2017 and 2018. Combined, these trips will allow seasonal and spatial patterns in aquatic invertebrate drift to be compared under conditions with and without Bug Flows. All statistical analysis of drift data will be carried out within an existing mixed effects modeling framework that accounts for discharge at the time of drift collection, time of day, location of the drift measurement (Kennedy and others, 2014). Based on 2017 and 2018 data, the relative difference between drift from spring to fall 2018 did indeed seem to be relatively smaller than in the pre-Bug Flows 2017 year, indicating that there were relatively more drifting invertebrates in fall 2018 than would have been expected based on pre-Bug Flows sampling. This suggests a positive larval midge population response to Bug Flows, although data analysis is ongoing.

A river trip will also be launched during the first week of Bug Flows (if approved) in May 2019 to quantify changes in invertebrate drift on weekdays vs. weekends. Sampling will occur at locations of interest for native fish; namely, near the Little Colorado River confluence and near Fall Canyon where juvenile humpback chub monitoring occurs. Samples will be collected immediately before, during, and after "weekend water," which will not actually be on weekends due to the time it takes flows released from Glen Canyon Dam to propagate downstream. The goal of these trips will be to assess potential increases or decreases in invertebrate drift concentrations on Bug Flows weekends vs. weekdays, with implications for prey availability for fish. Statistical analysis of these data will be similar to the analyses described above.

Insect egg laying

During weekends of low, steady flows during the proposed Bug Flows experiment, GCMRC scientists will also pursue deploying egg-laying substrates at targeted locations along the Colorado River, particularly during the weekday vs. weekends drift study described above. These substrates will consist of 1-m long, 4-inch diameter, black ABS pipes temporarily anchored to the river bed at the shoreline for ~48 h. Previous exploratory studies in Lees Ferry have indicated that midges will effectively lay eggs on these pipes, in clutch sizes that can range up to millions of eggs. The goal of deploying these substrates will be to identify relative numbers of eggs laid during base operations and during Bug Flows weekends, and to observe the extent to which eggs laid during weekends appear to remain wetted and thus avoid the desiccation and egg mortality observed during base operations. These semi-quantitative data (i.e., relative sizes of egg masses and whether they are wetted or desiccated) will identify whether the principle mechanism identified by Kennedy and others (2016) for low aquatic insect production downstream of Glen Canyon Dam, hydropower flows-related egg mortality, can be ameliorated by Bug Flows. Following the first Bug Flows weekend in May 2018 and in subsequent weekends, a strong egg-laying response was observed on natural rock substrates, with large bands of eggs being laid and remaining wetted during low flow weekends that were not matched by weekday egg-laying during base operations (Kennedy and Muehlbauer, 2018).

V. Assessment of Resources

Consistent with the LTEMP modeling, expert resource assessment does not indicate that a Bug Flows experiment conducted May 1 through August 31, 2019 would have sufficient potential adverse effects to other resources to warrant the experiment not being conducted. In fact, several

resources, including caddisfly abundance, midge emergence on weekends, and invertebrate drift in the fall, responded positively to the 2018 Bug Flows experiment. This section summarizes the assessment of resources and expected effects of a Bug Flows experiment.

Aquatic food base

Preliminary data indicate that the aquatic food base responded positively to the 2018 Bug Flows experiment (see section IV). Notably, the average number of adult midges captured in light traps and sticky traps was significantly higher during Bug Flows weekends compared to weekdays that had routine hydropower fluctuations. Additionally, the average number of caddisflies captured in light traps increased dramatically in 2018 compared to all prior years (2012-2017). In fact, for the first time since citizen science light trapping began in 2012, the number of caddisflies captured in light traps actually exceeded the number of midges (see Figure 4).

Lees Ferry trout population

Our analysis indicates a second year of Bug Flows testing does not pose any threat to the Lees Ferry trout population. Age-0 rainbow trout are the life stage of trout that are most vulnerable to stranding. The abundance of age-0 trout typically increases in spring as larval fish emerge from the gravel, with peak abundance by mid-July. Korman and Campana (2009) studied habitat use of age-0 trout and found these young fish do not move in response to hourly flow variation. This suggests there is minimal potential for stranding of age-0 rainbow trout when weekend flows are reduced down to levels at or slightly above the weekday minimum flow (Korman and Campana, 2009; Korman and others, 2009; Korman and others, 2011). The proposed stable weekend flow levels are very unlikely to cause any stranding of larger adult trout.

Lees Ferry fishery recreation experience quality

To assess whether the 2018 Bug Flows experiment had a significant effect on angler catch rates, AGFD analyzed data from boat angler surveys conducted from April to September 2018 to determine if angler CPUE was higher on days with low, steady flows (weekends). Stepwise model selection showed that being guided explained most of the variance in angler catch on weekends when low, steady flows were occurring, but these flows also had a significant positive effect on boat angler CPUE (Boyer and Rogowski 2019). Although AGFD's long term monitoring was not designed specifically to investigate whether flow experiments achieve their objectives, this creel data suggests Bug Flows have enhanced the quality of the recreational fishing experience in Lees Ferry by improving angler catch rates on weekends (i.e., boat angler CPUE was higher on days with low, steady flows). Additionally, many anglers commented during creel interviews that they enjoyed fishing more during low, steady flows. Anglers reported that at weekend low flows experienced during the experiment (~8,900 cfs), gravel bars were shallow, and it was easier to place lures or flies where fish were holding. Conversely, guides and anglers felt that weekday high water levels made it difficult to get fishing gear into habitat where fish were, and that fishing success declined when the water was rising or falling. Discharges below 8,000 cfs can inhibit or complicate navigation for boat anglers traveling upstream from Lees Ferry as gravel bars become more exposed; however, the proposed hydrograph for 2019 bug flows should provide enough discharge as to not impede navigation. Overall, we expect either positive or no unacceptable adverse impacts on recreational fishing from a 2019 Bug Flows experiment.

Endangered humpback chub and other native fish abundance

Humpback chub populations may benefit from a second year of Bug Flows testing. The adult humpback chub population in the Little Colorado River aggregation appears to be stable and above the Tier-1 threshold of 9,000 adults identified in the Biological Opinion for the LTEMP EIS (Van Haverbeke and others, 2019). Native Colorado River fish evolved under conditions of extreme seasonal flow fluctuation and, as such, are adapted to life under changing flow conditions. Because of this, Bug Flows are unlikely to have negative effects on humpback chub or other native fish. Instability of nearshore environments arising from load following flows has been identified as a potential risk factor for survival of larval native fish in the mainstem Colorado River (Robinson and others, 1998). Bug Flows, however, create more stable nearshore environments and may reduce risks of stranding for larval native fish. If Bug Flows are successful at increasing aquatic insect populations, they may have a positive indirect effect on native fish through increases in the abundance and diversity of aquatic insects that comprise an important segment of the aquatic foodbase.

Invasive species

Warm-water invasive species are not predicted to benefit from the proposed second year of Bug Flows testing. Invasive warm-water fish are currently absent or maintained at low levels within the Colorado River in Glen, Marble, and Grand Canyons largely because of sub-optimal water temperatures for growth and reproduction. Minimizing the flow fluctuations of weekends will have the effect of making nearshore areas more stable on weekends, which may result in some slight warming of water within those shallow areas. However, Ross and Grams (2013) evaluated the effects of nearshore thermal gradients along margins of the Colorado River in Grand Canyon and concluded that warming was very minimal (< 0.2 C). Warming of this minimal magnitude only on weekends as a result of Bug Flows is unlikely to have population level effects on invasive warm-water fish. Increases in abundance and diversity of aquatic insects are not likely to have population level effects due to the small numbers of invasive warm-water fish found in the system.

Riparian vegetation

There is no evidence that a second year of Bug Flows testing will significantly impact riparian vegetation resources. The primary impact will be to slightly extend the active channel, which is the zone of daily inundation, upslope on weekdays. This may slightly extend the suitable habitat for obligate wetland herbaceous species that respond positively to inundation, though longer-lived perennial species are unlikely to respond significantly to this short-term increase in inundation (Butterfield and others, 2018). Weekend low flows are also unlikely to have a significant impact, as sufficient water for plant metabolic activity is likely to be retained within sediments for the 2-day duration of the low flows. Nonetheless, possible impacts of Bug Flows will be assessed through statistical modeling of changes in riparian vegetation composition based on 2018 vegetation surveys and hydrological variables, specifically inundation duration and elevation above base flows, calculated from the hydrograph and sandbar exceedance equations.

Sediment resources

On the basis of the 2007-2017 suspended-sand data at the Colorado River above Little Colorado River near Desert View, AZ gaging station (61 river miles downstream from Lees Ferry), it was

predicted that the 2018 Bug Flow experiment would export slightly more sand from Marble Canyon than normal operations. During May 2018, it was predicted that Bug Flows would export ~7% more sand than normal operations; during June 2018, Bug Flows were predicted to export ~4% more sand than normal operations; during July, the prediction was a ~2% increase in sand export compared to normal operations, and during August, Bug Flows were predicted to export ~5% more sand than normal operations. Water release volumes are expected to be slightly higher in May and June and identical in July and August in 2019 relative to their respective months in 2019, and it is expected that export arising from the 2019 Bug Flow experiment will be similar to the 2018 experiment. These predictions are consistent with those identified in the LTEMP EIS.

Hydropower production and marketable capacity

WAPA has firm electric power contracts and must meet these contract obligations either with generation from Colorado River Storage Project powerplants or from purchases from the wholesale electrical market. During the Bug Flows experiment, low-volume releases from Glen Canyon Dam during the weekend will require extra electrical purchases to meet WAPA's contract obligations. These expenses are offset with extra electrical production during the weekdays. The extent to which added weekend electrical expenses are offset by added electrical production during the week is a function of the difference in weekend and weekday prices. As of this writing, using projected market prices for summer, 2019, WAPA estimates that the expense of implementing the Bug Flows experiment for the four summer months of 2019 will be $332,000. The LTEMP EIS analysis anticipated Bug Flows would yield a capacity benefit. Current information indicates that electrical capacity in the Rocky Mountain and Desert Southwest Regions is in surplus and therefore, a capacity benefit is not anticipated for a Bug Flows experiment in 2019.

Water releases from Glen Canyon Dam during the Bug Flows experiment may be affected by electrical disturbances of the electrical system. Electrical system operations for these disturbances are required by Reclamation and WAPA under law, contracts, and other agreements. Changes in water releases at Glen Canyon Dam to assist in recovery from electrical system disturbances are of two types, regulation and contingency reserves; both are managed by WAPA's Western Area Colorado-Missouri (WACM) Balancing Authority. Regulation is used to respond to frequency deviations on the electrical system. Glen Canyon Dam is the only Colorado River Storage Project (CRSP) powerplant capable of the immediate responses required for regulation. These responses can either slightly increase or decrease Glen Canyon Dam water releases and can be as much as ±1,100 cfs (40 mw) for up to 1 hour and 59 minutes. Glen Canyon Dam is also normally selected to hold contingency reserves (reserves) because it typically has available electrical capacity for response to electrical system emergencies. When reserves are called upon to assist in an electrical emergency, the response is only in the upward direction (increased release) and would result in an increase in Glen Canyon Dam water release up to 800 cfs (27 mw). Under certain circumstances, WAPA may be able to move these reserves to a different CRSP powerplant in order to minimize the impacts of electrical system operations on the experiment. A change in Glen Canyon Dam water release for both regulation and reserves at the same time, in the same direction, and up to the allowed limits would be extremely rare. However, the two potential responses combined in the upward direction could ramp Glen Canyon Dam releases up by 1,900 cfs (67 mw) for up to 1 hour and 59 minutes.

WAPA estimates that the Colorado River Basin Fund will end the 2019 fiscal year with a balance of $112 Million. This does not meet WAPA's target for an end of year balance. The proposed Bug Flow experiment may reduce this balance by $332,000 but is not expected to have a substantial impact on the Basin Fund.

Cultural Resources

Impacts from Bug Flows are anticipated to be minimally beneficial to archaeological site condition and stability, particularly in the May-June time frame when sand bars may have an opportunity to dry out and windy conditions may allow for the redistribution of sand from the bars to high elevation areas containing archaeological sites. Furthermore, the lower, slower steady weekend flows may result in oar-power river runners spending more time on the water and less time on shore, thereby reducing the potential for impacting archaeologist sites though visitation.

Grand Canyon Whitewater Recreational Rafting

Impacts to the whitewater rafting recreational experience are expected to be negligible. While the weekend steady flows may require boaters to spend slightly more time rowing and less time on shore, the slightly higher low flows on weekends and weekdays may improve the navigability of some rapids. Also, the steady, low weekend flows will enhance the size of campsites slightly during the weekend flow period, while minimizing the need to move and re-tie boats during the night, as often occurs during normal fluctuating flow days.

VI. Safety Considerations

Potential, but minimal effects on public health and safety could occur in conjunction with the proposed 2019 experimental Bug Flows, primarily impacting recreational anglers, boaters, kayakers, and campers. The proposed minimum flows are within the range experienced by recreational users in the past and those currently expected on a monthly basis. Reclamation and NPS coordinate to ensure that safety measures are implemented and will provide public notice about the timing of the experimental flows. NPS Boating Safety Rules always apply to all boaters using the river. Additionally, the three park service units affected, Glen Canyon National Recreation Area (GLCA), Grand Canyon National Park (GRCA), and Lake Mead National Recreation Area (LAKE) will collaboratively inform recreational river users about the timing and purpose of the experimental Bug Flows. The parks have coordinated communications plans, medical plans, and resource capabilities for search and rescue responses.

Flow and stage change information will be provided via public media, the individual park websites, and by on-site NPS staff at Lees Ferry and Phantom Ranch. Given that experimental flows between May 1, 2019 and August 31, 2019 are likely, a press release and notifications to Colorado River permit holders and backcountry hikers within GRCA, GLCA and LAKE will occur.

In addition, safety considerations regarding sampling efforts by GCMRC have been incorporated into planning to ensure that the safety of field staff is an overarching priority. GCMRC crews deployed during the experimental flows will be made aware of the timing of the experimental

flows. The proposed minimum flows are within the range experienced by GCMRC and contracted boat operators in the past and those currently expected on a monthly basis.

VII. Communications Plan

The communications/public affairs aspect of these experimental flows will not include a public/media event at Glen Canyon Dam but will include communications product development and media coordination.

Reclamation's Upper Colorado Region Public Affairs Office, in primary coordination with National Park Service, U.S. Geological Survey, Western Area Power Administration public affairs contacts and the Department, is taking lead of communications product development. Should the Department decide to conduct these experimental Bug Flows, a detailed news release, for publication on or near the experimental Bug Flows start date (May 1, 2019), will be sent to alert media representatives and the public, with the intent of the experiment with expected start and finish dates. This may be prepared for distribution by the Secretary's Office. Social media outlets will also be used to communicate with the public leading up to and during the event—including to share imagery of the experiment.

VIII. Monitoring and Coordination During Experiment Implementation

Should the Department decide to implement the recommended Bug Flows, members of the PI Team will continue to meet regularly throughout the implementation of the four-month experiment. This will occur through the regularly scheduled monthly Glen Canyon Dam operations coordination calls. Scientists conducting field surveys during the experiment and agency technical experts will report back on data collected and preliminary results to the Department and the GCDAMP at regularly scheduled meetings. Glen Canyon Dam operations will be adjusted accordingly in the event of unexpected impacts from Bug Flows.

IX. Post Experiment-Reporting and Feedback

The PI Team will coordinate to report findings at the 2019 GCDAMP Annual Reporting Meeting in early 2020 in Phoenix, AZ. In addition, the PI Team will report ongoing findings at meetings of the GCDAMP Technical Work Group (TWG) and Adaptive Management Work Group (AMWG). Reclamation has a commitment to provide an annual monitoring report to the FWS Arizona Ecological Services Office (AESO) in compliance with the 2016 Biological Opinion; this report will also include a summary of the effects of a Bug Flows experiment conducted under the LTEMP ROD. Reclamation will use the monitoring information and feedback from AESO and GCDAMP stakeholders to inform monitoring for future experiments, and to design and implement any measures necessary to address any adverse effects that may occur due to these flows.

At the conclusion of the experiment, the PI Team will review the planning process, implementation, and monitoring activities and develop a list of "lessons learned" to inform potential future experiments and experimental planning.

X. Planning for Future Experiments

Monitoring of any aquatic invertebrate responses to Bug Flows would include citizen science light trapping and drift sampling as described in section IV. GCMRC will also collect data on water quality (including nutrients), sediment, aquatic biology, and other resources as described in the GCDAMP Fiscal Year (FY) 2018-20 Triennial Budget and Work Plan (Reclamation and GCMRC TWP, U.S. Department of the Interior, 2017). GCMRC will use the information from these studies to evaluate the effects of Bug Flow experiments on downstream resources in Glen, Marble, and Grand Canyons and to help in the design of future experiments.

Per the LTEMP ROD, 2019 Trout Management Flows were considered by the PI Team but were not recommended for this year. GCRMC is conducting additional research to inform the design of any future Trout Management Flows including studies on flow optimization and the distribution and behavior of young trout in response to various flow scenarios in Glen Canyon. GCMRC will use the information from these studies to help in the design of future experiments. In response to concerns voiced by some members of the PI Team, a technical group will be convened to follow up on potential experimentation related to Trout Management Flows.

The PI Team will meet in early 2020 to review the implementation and results of any 2019 activities, and to begin coordination on the evaluation of resources and potential experiments that may be conducted in 2020. In accordance with the LTEMP ROD, the Department may make the decision to conduct future flow-based experiments (High Flow Experiments, Bug Flows, Trout Management Flows, and Low Summer Flows) at Glen Canyon Dam if it is determined that there are no unacceptable adverse impacts on other resource conditions. Information and data from this or other experiments will be considered in future recommendations and decisions.

XI. Consultation

Reclamation and GCMRC presented much of the information in this report that was available at that time to the AMWG at its March 6-7, 2019 meeting, as well as to the Adaptive Management Program Partners at the GCDAMP Annual Reporting Meeting on March 12-13, 2109. Notification of a potential for a 2019 Bug Flow was emailed to GCDAMP stakeholders on April 2, 2019. Representatives of the Colorado River Basin states and the Arizona Game and Fish Department participated in the development of this recommendation and concur with it.

On April 2, 2019, the required 30-day advance notification and offer for consultation was emailed to the Tribes and parties to the LTEMP cultural Programmatic Agreement of the potential for a Bug Flow experiment beginning May 1, 2018. No requests for consultation were received. A follow-up notification will be sent electronically to the Programmatic Agreement signatories, including Tribes, following the Department’s decision regarding the proposed Bug Flow experiment.

XII. Conclusion

Determining whether to recommend the Bug Flows experiment required coordination of many details and effective communication among technical staff of multiple agencies. The PI Team members relied heavily on the staff in each of the agencies in making this recommendation. The PI Team has thoroughly evaluated the issues discussed above and has taken into consideration

the information and analysis included in the LTEMP EIS and ROD. Based on the careful assessment of resources and the best available science, the PI Team has reached a consensus recommendation to proceed with implementation of Bug Flows.

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