

1 Introduction

1.1 Background

The Department of the Interior (Interior), acting through the Bureau of Reclamation (Reclamation), is proposing to develop and implement a protocol for high-flow experimental releases from Glen Canyon Dam to better determine whether and how sand conservation can be improved in the Colorado River corridor downstream from Glen Canyon Dam including areas within Grand Canyon National Park. Under the concept of high-flow experimental releases, sand stored in the river channel is suspended by high-volume dam releases and a portion of the sand is redeposited in downstream reaches as sandbars and beaches, while another portion is transported downstream by river flows. These sand features and associated backwater habitats can provide key fish and wildlife habitat, potentially reduce erosion of archaeological sites, restore and enhance riparian vegetation, and provide camping opportunities and enhance wilderness values along the Colorado River in Grand Canyon National Park.

The *Federal Register* (74 FR 69361; see Appendix A), provided the public with initial information regarding the anticipated development and purpose of the High-flow Experimental Protocol (HFE Protocol). The Department is developing the HFE Protocol through a public process pursuant to NEPA, and assessing the impacts of this proposed action with this Environmental Assessment (EA). The HFE Protocol is a multi-year, multi-experiment approach and will be based on the best available scientific information developed through the GCDAMP as well as other sources of relevant information. The HFE Protocol is a component of the Department's effort to comply with the requirements and obligations established by the Grand Canyon Protection Act of 1992 (Public Law 102-575, GCPA).

The focus of the proposed action is to improve conditions downstream from the Paria River, the first major sediment-producing tributary below Glen Canyon Dam. Glen Canyon Dam impounds the Colorado River about 16 miles upstream of Lees Ferry, Coconino County, Arizona and the confluence of the Paria River. The action area or geographic scope of this environmental assessment (EA) is a 294-mile reach of the Colorado River corridor from Glen Canyon Dam downstream to the Lake Mead inflow near Pearce Ferry (Figure 1). It includes Glen Canyon National Recreation Area (GCNRA) from Glen Canyon Dam to the Paria River; and Grand Canyon National Park (GCNP), a 277-mile reach from the Paria River downstream from Lees Ferry to the Grand Wash Cliffs near Pearce Ferry.

Glen Canyon Dam was authorized by the Colorado River Storage Project Act of 1956 (CRSPA; 43 U.S.C. § 620)

“...for the purposes, among others, of regulating the flow of the Colorado River, storing water for beneficial consumptive use, making it possible for the States of the Upper Basin to utilize, consistently with the provisions of the Colorado River Compact, the apportionments made to and

among them in the Colorado River Compact and the Upper Colorado River Basin Compact, respectively providing for the reclamation of arid and semiarid land, for the control of floods, and for the generation of hydroelectric power, as an incident of the foregoing purposes...”

The CRSPA, as well as a number of Federal statutes and legislative authorities affect the manner in which Glen Canyon Dam is operated and the manner in which water is apportioned to the seven basin states and Mexico. These authorities are collectively known as the “Law of the River,” which is a collection of Federal and State statutes, interstate compacts, court decisions and decrees, an international treaty with Mexico, and criteria and regulations adopted by the Secretary. In 1970, Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs Pursuant to the Colorado River Basin Project Act of September 30, 1968 (P.L. 90-537) were established to govern operation of reservoirs along the Colorado River.

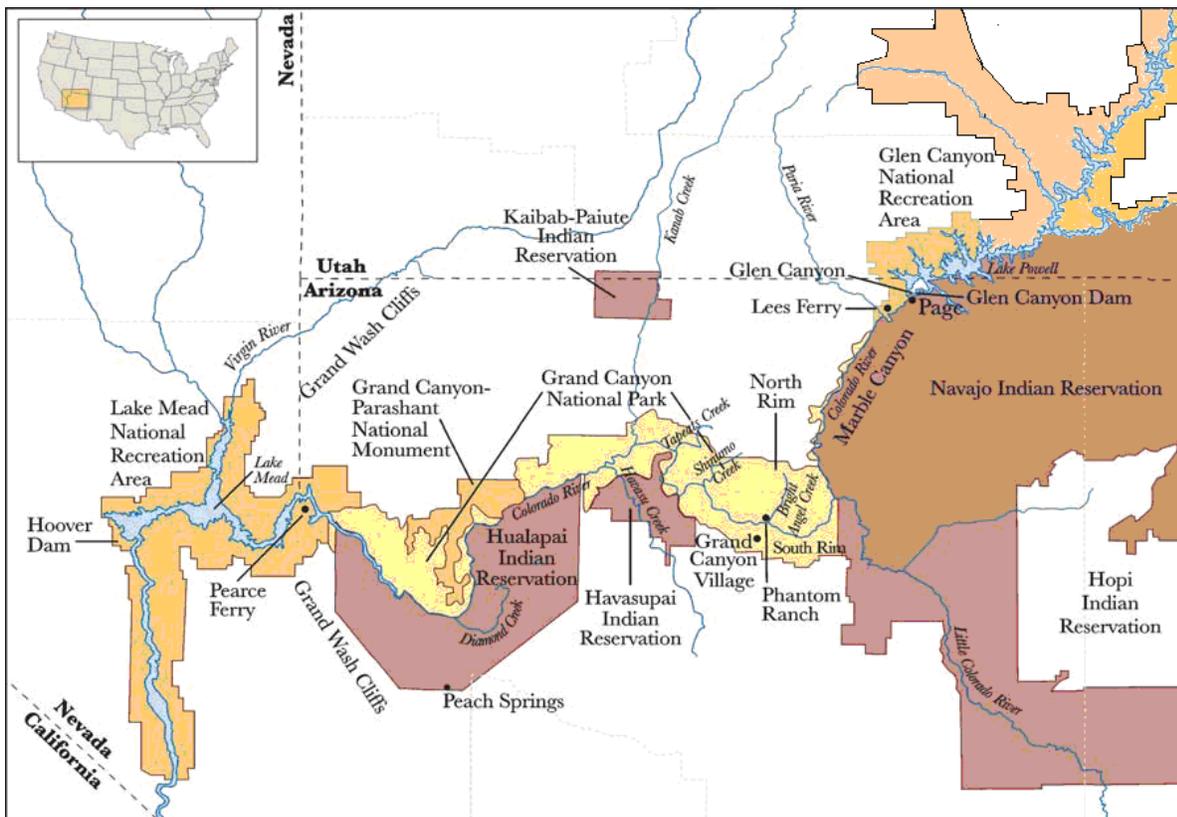


Figure 1. Geographic scope of the proposed action, showing places referenced in the text. Map courtesy of U.S. Geological Survey.

An important function and purpose of Glen Canyon Dam is to generate hydroelectric power. Water released from Lake Powell through the dam’s eight hydroelectric turbines generates power marketed by Western Area Power Administration (Western). From the time of the dam’s completion in 1963 to 1990, the dam’s daily operations were primarily undertaken to maximize generation of hydroelectric power in accordance with Section 7 of the CRSPA, which requires hydroelectric powerplants to be operated “so as to produce the greatest practicable amount of power and energy that can be sold at firm power and energy rates.”

In the early 1980s, Reclamation undertook the Uprate and Rewind Program to increase powerplant capacity at Glen Canyon Dam. As part of an Environmental Assessment and Finding of No Significant Impact (FONSI; Reclamation 1982), Reclamation agreed to not use the increased capacity until completion of a more comprehensive study on the impacts of historic and current dam operations. The Glen Canyon Dam Environmental Studies (GCES) Phases I and II were conducted from 1982 to 1995 to evaluate the effect of the proposed uprate and rewind and existing dam operations on downstream resources. The GCES concluded that dam operations were adversely affecting natural and recreational resources and that modified operations would better protect those resources (Reclamation 1988). These studies also brought forth concerns about the effects of dam operations on the resources of GCNP and GCNRA and highlighted the need to evaluate the effects on species listed pursuant to the Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. § 1531 *et seq.*). As a result of these studies, Reclamation agreed to maximum authorized releases of 31,500 cfs, and the potential of 33,200 cfs that resulted from the uprate and rewind was not implemented.

In 1992, President George H.W. Bush signed the Grand Canyon Protection Act (GCPA; Reclamation Projects Authorization and Adjustment Act Of 1992, Title XVIII – Grand Canyon Protection, §§ 1801–1809). The GCPA was enacted by Congress because of the detrimental effects of dam operations on downstream resources. Section 1802(a) of the GCPA provided that:

"The Secretary shall operate Glen Canyon Dam in accordance with the additional criteria and operating plans specified in section 1804 and exercise other authorities under existing law in such a manner as to protect, mitigate adverse impacts to, and improve the values for which Grand Canyon National Park and Glen Canyon National Recreation Area were established, including, but not limited to natural and cultural resources and visitor use."

In proposing the protocol described in this EA, it is important to recognize that all dam operations, including those proposed here, must be implemented in compliance with other specific provisions of existing federal law applicable to the operation of Glen Canyon Dam. These requirements are specifically mandated in Section 1802(b) of the GCPA.

"The Secretary shall implement this section in a manner 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."

Section 1806 of GCPA further stipulates that:

"Nothing in this title [GCPA] is intended to affect in any way—

- (1) The allocations of water secured to the Colorado Basin States by any compact, law, or decree; or
- (2) Any Federal environmental law, including the Endangered Species Act (16 U.S.C. 1531 *et seq.*)."

The GCPA also acknowledges the importance of natural and cultural resources in Grand Canyon. Section 1802(c) directs that:

“Nothing in this title alters the purposes for which the Grand Canyon National Park or the Glen Canyon National Recreation Area were established or affects the authority and responsibility of the Secretary with respect to the management and administration of the Grand Canyon National Park or the Glen Canyon National Recreation Area, including natural and cultural resources and visitor use, under laws applicable to those areas, including, but not limited to, the Act of August 25, 1916 (39 Stat. 535) as amended and supplemented.”

Section 1804(a) of the GCPA required completion of an Environmental Impact Statement (EIS) evaluating alternative operating criteria, consistent with existing law, that would determine how the dam would be operated consistent with the purposes for which the dam was authorized and the goals for protection of GCNP and GCNRA. The Operation of Glen Canyon Dam Final Environmental Impact Statement was completed in March 1995 (Reclamation 1995) with the preferred alternative, called the Modified Low Fluctuating Flow Alternative (MLFF), selected. As articulated in the Record of Decision, issued on October 9, 1996 (Interior 1996),

“The goal of selecting a preferred alternative was not to maximize benefits for the most resources, but rather to find an alternative dam operating plan that would permit recovery and long-term sustainability of downstream resources while limiting hydropower capability and flexibility only to the extent necessary to achieve recovery and long-term sustainability.”

The final EIS hypothesized that high flows were important for restoring ecological integrity, and identified these as beach-habitat building flows and habitat maintenance flows. Additionally, the 1995 Biological Opinion (U.S. Fish and Wildlife Service [USFWS] 1995) identified a program of experimental flows as an element of the Reasonable and Prudent Alternative that included provisions for high-volume dam flows termed “beach-habitat building flows” (BHBFs) and “habitat maintenance flows” (HMFs); BHBFs were releases that exceeded the powerplant capacity and were designed to build sandbars and beaches, and HMFs were releases up to powerplant capacity designed to maintain these sand features. These actions were also discussed in the EIS and the Record of Decision. This biological opinion was replaced by a new Biological Opinion in 2008 (USFWS 2008), which was subsequently supplemented in 2009 (USFWS 2009). A more complete history of high-flow releases is provided in section 1.5 of this EA.

Section 1805 of the GCPA also requires the Secretary to undertake research and monitoring to determine if dam operations are actually achieving the resource protection objectives of the Final EIS and Record of Decision, i.e., mitigating adverse impacts, protecting, and improving the natural, cultural, and recreational values for which GCNP and GCRA were established. These provisions of the GCPA were incorporated into the 1996 Record of Decision and led to the establishment of the Glen Canyon Dam Adaptive Management Program (GCDAMP; www.gcdamp.gov). The GCDAMP includes the Adaptive Management Work Group, a Federal Advisory Committee to the Secretary, and the Grand Canyon Monitoring and Research Center (GCMRC) as a research branch of the GCDAMP under the U.S. Geological Survey (USGS).

Monitoring and research conducted by these organizations since 1996 have improved the understanding of riverine geomorphology and how dam operations might assist in the conservation of sand and other natural and cultural resources below the dam.

Since 1999, the Colorado River Basin has experienced prolonged and historic drought conditions. In response to several years of below-normal runoff and declining reservoir conditions and at the direction of the Secretary, Reclamation completed a Final EIS (Reclamation 2007a), which was followed by an Interior Record of Decision on the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead (Interior 2007). These interim guidelines were adopted in December 2007 and are anticipated to be in effect through September 2026 to provide better operational management of Lake Powell and Lake Mead. The provisions of the 1995 EIS and 1996 Record of Decision that led to MLFF, as well as the 2007 EIS and Record of Decision that proposed adoption of interim guidelines and coordinated operations establish the foundation for the no action alternative defined in this EA. All HFEs will be conducted in conformance with these authorities.

This EA describes the current environmental conditions in Glen, Marble, and Grand Canyons downstream from Glen Canyon Dam, and discloses the direct, indirect, and cumulative environmental impacts that could result from the proposed action and alternatives. It describes how the proposed action (i.e., protocol for high-flow experimental releases from Glen Canyon Dam) is designed to determine how sandbar building and sand conservation can best be achieved in the Colorado River corridor in GCNP and the impacts that would result from these high-flow releases. The proposed action in this EA would occur in the same timeframe and in the same geographic area as a corollary proposal to control non-native fish in the Colorado River below Glen Canyon Dam.

1.2 Relationship between EAs for Non-native Fish Control and High-flow Experimental Protocol

Reclamation is in the process of concurrently preparing two EAs related to the ongoing implementation of the Glen Canyon Dam Adaptive Management Program. In addition to this EA that addresses the HFE Protocol, the other EA addresses Non-native Fish Control. Both efforts are designed to include important research components, with the expectation that the undertakings will improve resource conditions, and thereby provide important additional information for future decision-making within the GCDAMP. Although both EAs relate to and are part of the overall GCDAMP, Reclamation has considered the content of both efforts and believes that it is appropriate to maintain separate NEPA processes because each activity under consideration serves a different and independent purpose, has independent utility, and includes very different on the ground activities and actions (rate, duration and timing of water releases as compared with non-native fish research, management and control actions).

The HFE Protocol EA is designed to assess the effects of development and implementation of a multi-year, multi-experiment protocol for high-flow experimental releases from Glen Canyon

Dam to better determine whether and how sandbar and beach building and sand conservation can be improved in the Colorado River corridor downstream from Glen Canyon Dam including areas within Grand Canyon National Park.

The Non-native Fish Control EA is designed to control non-native fish, particularly rainbow and brown trout, in the Colorado River downstream from Glen Canyon Dam in an effort to help conserve native fish. The purpose of the action is to minimize the negative impacts of competition and predation on an endangered fish, the humpback chub (*Gila cypha*) in Grand Canyon, while addressing concerns for taking of life within a place that is sacred to American Indian tribes and fundamental in several creation beliefs.

During the first round of public review and comment on the High Flow and Non-Native control EAs, several comments from the public suggested that these high-flow dam release and fish control activities are “connected actions” or “similar actions” for NEPA purposes and therefore must be combined into a single NEPA document. The primary basis for this concern appears to be that, notwithstanding the differing nature of the experimental actions, based on a previous high-flow release, there is a concern that high-flow events during certain times of the year have the potential to increase the number of non-native trout that have been documented to upon native, endangered humpback chub.

Reclamation reviewed and considered these comments and has added this discussion to this updated Draft EA in order to provide the public with additional information with respect to the basis for the NEPA processes that are being utilized for the development of these two actions.

As an initial matter, the high flow release protocol and the non-native removal efforts are not portions of a single action. The release protocol will address multiple projected experimental operations (i.e., variable, high-flow water releases) from Glen Canyon Dam that would link high-volume releases to sediment availability in reaches downstream of Glen Canyon Dam. The high-flow releases would be conducted over a period of years and on multiple occasions to assess the ability to reduce the erosion of beach habitat in the Grand Canyon and potentially to enhance and retain beach habitat over multiple years.

Separately, the non-native research and control efforts are designed to enhance understanding of the life-cycle, movement and impacts of non-native fish on the native species in areas of the Colorado River downstream of Glen Canyon Dam. The non-native control actions are likely to address methods to reduce the population of predatory nonnative trout in areas where young-of-year native fish are located. Predation by non-native fish (both warm water and cold water species) has been identified as a primary threat to native fish in the Colorado River Basin.

Reclamation has considered the most appropriate approach to NEPA compliance for these actions and has reached a conclusion at this stage of analysis that it is not necessary to combine the EAs into a single NEPA document under the applicable NEPA regulations. Under NEPA’s implementing regulations, the question of whether the two actions must be analyzed in a single compliance document turns on whether the two actions are considered “connected actions,” “cumulative actions,” or “similar actions.” Pursuant to 40 C.F.R. § 1508.25(a)(1), connected

actions are “closely related and therefore should be discussed in the same impact statement.” The regulations go on to provide that: “Actions are connected if they: (i) Automatically trigger other actions which may require environmental impact statements. (ii) Cannot or will not proceed unless other actions are taken previously or simultaneously. (iii) Are interdependent parts of a larger action and depend on the larger action for their justification.” 40 C.F.R. § 1508.25(a)(1).

The EAs do not meet the regulatory standard for connected actions. Neither activity under consideration will automatically trigger other actions which may require environmental impact statements as part of the Glen Canyon Adaptive Management Program. Implementation of both the high flow and non-native control actions are designed and expected to advance scientific knowledge and inform future GCDAMP decision-making, and may lead to adjustments in release patterns and/or strategies to control the size and location of predatory non-native fish. However, Reclamation cannot conclude at this time that such information will automatically trigger other actions which may require EISs. Secondly, the non-native control process is not dependent on other actions being taken previously or simultaneously. Rather, the timing and manner of nonnative control will depend, in part, upon the results of monitoring efforts determining the number of trout, their location and movement, etc. While the implementation of spring high-flows has been raised as an issue, given the post-2008 monitoring results, it is clear that both warm and cold-water non-native control actions will be necessary regardless of high flow implementation. There are no other actions that are conditions precedent to the efforts proceeding, and neither action depends on a larger action for their justification.

There are some obvious relationships and linkages between the two proposed actions, but those similarities do not rise to the standard of requiring preparation of a single NEPA document as “connected actions” for NEPA purposes. Both actions are part of the overall Glen Canyon Dam Adaptive Management Program, and they share a common overall geographic area (primarily focused on the mainstem of the Colorado River below Glen Canyon Dam). In addition, there are some overlapping impact analysis issues that are discussed herein, as it is possible that certain high-flow releases may impact the size and distribution of nonnative fish that have been identified as species that prey on native fish. However, each action has independent methods (dam releases vs. fish monitoring, tracking, and potential removal actions), an independent focus (protection and enhancement of riparian habitat vs. non-native fish research, monitoring and control), and each action has independent utility whether or not the other action proceeds. Moreover, where the two proposed actions are projected to involve overlapping environmental effects (*i.e.*, potential effects on predatory non-native species), the relevant analysis of these common environmental effects is included in both EAs.

Another regulatory basis for NEPA documents to be combined is if the activities in question are “similar actions.” Pursuant to 40 C.F.R. § 1508.25(a)(3), similar actions “have similarities that provide a basis for evaluating their environmental consequences together, such as common timing or geography.” While the two efforts address areas downstream of Glen Canyon Dam (and thus share a common geography, as well as timing), there are unique areas that will be the focus of each NEPA effort. The primary action of the high flow protocol is the timing, rate and duration of releases of water from Glen Canyon Dam. In terms of downstream research and

monitoring, the high-flow protocol has a particular focus on sediment transport and geomorphological processes, and will include research and monitoring focused on the number, size and distribution of sandbars throughout Marble and Grand Canyons. In contrast, the non-native control effort is focused on biological processes and is expected to focus its analysis on particular areas that are important to both native and non-native fish species near the confluences of the Paria River and Little Colorado River with the Colorado River.

Even where two actions are deemed to be “similar actions” under the regulations, the applicable NEPA regulations go on to provide that, “[a]n agency *may wish* to analyze these actions in the same impact statement . . . when the *best way* to assess adequately the combined impacts of similar actions or reasonable alternatives to such actions is to treat them in a single impact statement.” *Id.* This regulatory provision leaves the agency decisionmakers with sufficient discretion to determine the “best way” to assess impacts of similar actions. Given the differences between the two efforts, and based on the analysis of the differing scientific focus of each experimental effort, Reclamation, based on the best available information that is available at this stage of analysis, has considered this issue and determined that the best way to analyze each action is to continue to analyze the high flow protocol and the non-native control strategy through separate and independent NEPA processes, recognizing that resource analyses that are relevant to both EAs have been documented and included in both EAs, where appropriate (e.g., potential high flow impacts on population and distribution of predatory non-native species). Reclamation is also ensuring that both EAs contain up-to-date information on resource status and impacts and has been carefully coordinating the preparation schedules of the two EAs to ensure consistency of content.

Finally, both actions do not constitute “cumulative actions” necessitating review in a single NEPA document. Nonetheless, Reclamation does address the cumulative effects from both actions in the affected environment section of each EA, under the topical discussion for each resource (*see appropriate sections, Chapter 3*). Reclamation has properly considered the cumulative effects from these two actions, and other relevant related actions, in both NEPA documents. Consistent with these analyses, at this point in the NEPA process Reclamation has not concluded that the actions have “cumulatively significant impacts” which pursuant to 40 C.F.R. § 1508.25(a)(2) would indicate that the actions “should therefore be discussed in the same impact statement.”

This EA was prepared by Reclamation in compliance with the National Environmental Policy Act of 1970 (NEPA; 42 U.S.C. 4321 *et seq.*) and the Council on Environmental Quality regulations for implementing NEPA (40 CFR 1500-1508) and the Department of the Interior regulations implementing NEPA (43 CFR Part 46). This EA is not a decision document; one of three decisions will be made based on the EA:

1. A finding of no significant impact will be issued;
2. A notice of intent to prepare an environmental impact statement if the proposed action could result in significant impacts; or

3. A decision to withdraw the proposal on the basis of environmental impacts disclosed in this document.

1.3 Relationship between this EA and the Long-Term Experimental and Management Plan

As discussed herein, there are a number of ongoing activities of the GCDAMP that complement the actions and research anticipated under the HFE Protocol EA. In addition, the Department is embarking on the first major, comprehensive analysis of the GCDAMP since 1996 with the initiation of the Glen Canyon Dam Adaptive Management Program Long Term Experimental and Management Plan (LTEMP). The Department has determined that it is appropriate and timely to undertake a new environmental impact statement (EIS) that reviews and analyzes a broad scope of Glen Canyon Dam operations and other related activities. Given that it has been 15 years since completion of the 1996 ROD on the operation of Glen Canyon Dam, the Department will study new information developed through the GCDAMP, including information on climate change, so as to more fully inform future decisions regarding the operation of Glen Canyon Dam and other management and experimental actions. The LTEMP is a component of the Department's efforts to continue to comply with the ongoing requirements and obligations established by the Grand Canyon Protection Act of 1992 (Pub. L. No. 102-575). The Department has determined that the LTEMP EIS will be co-led by the Bureau of Reclamation and the National Park Service. Reclamation and the NPS will co-lead this effort because Reclamation has primary responsibility for operation of Glen Canyon Dam and the NPS has primary responsibility for Grand Canyon National Park and Glen Canyon National Recreation Area. A formal notice of intent to prepare an EIS is anticipated during the summer of 2011, which will be followed by a thorough scoping process.

The purpose of the proposed LTEMP is to utilize current, and develop additional, scientific information to better inform Departmental decisions and to operate the dam in such a manner as to improve and protect important downstream resources while maintaining compliance with relevant laws, including the GCPA, the Law of the River, and the Endangered Species Act (ESA). Information developed through this EA and through the monitoring and implementation of the HFE Protocol will be further reviewed and analyzed as part of the LTEMP process. That is, while this EA is designed to analyze and adopt an approach to high-flow experimental releases, the effectiveness of such actions will also be further analyzed, integrated and potentially refined and/or modified as part of the LTEMP NEPA process. Scientific and resource information developed through this EA, and the implementation of the HFE Protocol are essential to ensuring that fully informed decisions are made as part of the LTEMP process. Accordingly, Reclamation has determined that it is essential and appropriate to move forward with this EA because it will provide important information related to multi-year, multi-experiment high-flow releases from Glen Canyon Dam. This information is important for independent reasons described throughout this EA, and it will also aid in future decisions associated with the LTEMP process. Continuing with the EA to learn more information about Glen Canyon Dam operations is consistent with the principles of adaptive management, which have guided decision making since the 1996 Record of Decision.

1.4 Purpose of and Need for Action

The Colorado River downstream from Glen Canyon Dam is depleted of its natural sediment load due to the presence of the dam, and ongoing dam releases further deplete sediment delivered to the main channel by periodic tributary floods. High dam releases mobilize sand stored in the river channel and redeposit it as sandbars and beaches that form associated backwater and riparian habitats. These sand formations are further reworked to varying degrees by wind (aeolian) forces (Draut et al. 2010). Sandbars and beaches can provide key fish and wildlife habitat, protect archeological sites and vegetation structure, and provide camping opportunities in Grand Canyon. One of the best tools available for rebuilding sandbars is to use dam operations to release short-duration high flows, preferably after sediment-laden tributary floods deposit new sand into the main channel. Conservation of fine sediment and building of sandbars and beaches has not occurred to the degree anticipated in the 1996 Record of Decision. Further research is needed to determine whether multiple HFEs during sediment-enriched periods can better achieve this goal.

The goal of the proposed action is directed at improving sediment conservation downstream from the Paria River, because sediment inputs are very limited upstream of that tributary. In the 2011 USGS Report on the Effects of Three High-Flow Experiments on the Colorado River Ecosystem (Melis et al. 2011), USGS concluded the three high flow experiments that occurred in 1996, 2004 and 2008 showed that individual HFEs are effective at building sandbars, particularly if conducted soon after Colorado River tributaries have deposited sediment inputs in the main channel bed. However, sandbars tend to erode in the weeks and months following HFEs. The goal of the HFE Protocol is to maintain and increase sandbars and beaches through a long-term, sustainable strategy of conducting more frequent HFEs when conditions are favorable.

Reclamation is proposing to develop and implement a protocol for HFEs from Glen Canyon Dam for a 10-year period, 2011–2020. This protocol takes a multi-year, multi-experimental approach using short-duration, high-volume releases from Glen Canyon Dam during sediment²-enriched conditions in the channel of the Colorado River downstream from the dam.

The purposes of this action are: (1) to develop and implement a protocol that determines when and under what conditions to conduct experimental high volume releases, and (2) to evaluate the parameters of high-flow releases in conserving sediment to benefit downstream resources in Glen, Marble, and Grand Canyons.

² For the purpose of this EA, the term “sediment” means the solid inorganic and organic material that comes from weathering of rocks and vegetation and is carried by and settled in water (Webster’s Unabridged Dictionary). In this case, sediment consists of a mixture of varying coarseness of clay, silt, and sand (inorganic material) and fine and coarse particulate organic matter (organic material consisting mostly of plant matter). The terms sand and sediment are used interchangeably in this EA, unless otherwise specified. In practicality, the sediment that is transported during an HFE will contain lower percentages of particles finer than sand as the time since it was received from the tributary and deposited in the river channel increases. Therefore, HFEs conducted during (rapid response) or soon after tributary inputs will contain higher percentages of fine organic matter, silts and clays than HFEs that occur after these finer particles have been transported downstream.

The need for the proposed action is to take advantage of future sediment-enriched conditions in the Colorado River by implementing experimental high flow tests to improve the understanding of the relationships between high dam releases of up to 45,000 cfs and sediment conservation for the benefit of resources downstream of Glen Canyon Dam. The information developed through this action will assist Interior in making future decisions on when and how to conduct multi-year, multi-event high flow experimental releases and how to evaluate benefits to downstream resources.

During the life of the proposed action, Interior will monitor and analyze the effectiveness of experimental high flow releases in achieving specific resource goals downstream of Glen Canyon Dam. Information obtained from this monitoring and analysis will be collected in annual progress reports and incorporated into the decision making component of the HFE Protocol (*see Section on decision making*) to better inform future decision making regarding dam operations and other related management actions. Interior does not propose through this proposed action to undertake any experimental high flow tests in the absence of scientific monitoring and analysis, the results of which will be integrated into the ongoing implementation of the HFE Protocol.

In proposing this HFE Protocol, Interior is not modifying, in any manner, the current long-term management approach to implementation of “beach-habitat building flows” (BHBFs) as described in section 3 of the Operating Criteria for Glen Canyon Dam, published at 62 Fed. Reg. 9447 (Mar. 3, 1997). As provided in section 3 of the Operating Criteria, in adopting the management approach for “beach-habitat building flows” the Secretary found that releases pursuant to such an approach “are consistent with the 1956 Colorado River Storage Project Act, the 1968 Colorado River Basin Project Act, and the 1992 Grand Canyon Protection Act.” *Id.* While no modification is proposed or anticipated at this time, any future potential modification of the 1996 ROD or 1997 Glen Canyon Dam Operating Criteria would only occur after public review, comment and consultation, as well as any required environmental compliance efforts.

Interior recognizes that differences exist with respect to interpretations of certain provisions contained in the “Law of the River” related to the implementation of high flow releases in excess of power plant capacity and the proper application and interpretation of those provisions of law. In proposing the HFE Protocol, Interior does not intend to revisit or modify, in any manner, the determinations or considerations that led to the adoption of the management approach for BHBFs contained in Section 3 of the 1997 Glen Canyon Dam Operating Criteria or the 1996 ROD. Nor does Interior intend that implementation of this HFE Protocol will constitute a formal determination regarding the multiple and complex issues that would need to be considered in the event that a decision were made to revisit the BHBF management strategy contained in Section 3 of the Glen Canyon Operating Criteria. Accordingly, Interior recognizes that positions and rights concerning the issues related to BHBF management strategies as compared to experimental releases of water from Lake Powell are reserved, and that implementation of the proposed action shall not prejudice the position or interests of any stakeholder. Furthermore, the Secretary, through this proposed action, makes no determination with respect to the correctness of any interpretation or position of the individual Colorado River Basin states or any other stakeholder. Implementation of the proposed action shall not represent a formal interpretation of existing law

by the Secretary, nor predetermine in any manner, the means of operation of Glen Canyon Dam that the Secretary may adopt in the future following implementation of the proposed action, nor the design and implementation of future experimental actions.

1.5 Related Actions, Projects, Plans and Documents

Related actions, projects, plans, and documents are identified in this EA to better understand other ongoing activities that may influence, relate to, or affect the proposed action. These actions, projects, plans, and documents are related to ongoing activities of state and federal agencies, as well as American Indian Tribes.

1.5.1 Bureau of Reclamation Actions

The action proposed in this EA is tiered from two environmental impact statements—Reclamation’s 1995 EIS on the operation of Glen Canyon Dam (Reclamation 1995) and the associated 1996 Record of Decision (Interior 1996); and Reclamation’s 2007 EIS on Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lakes Powell and Mead (Reclamation 2007a) and the associated 2007 Interior Record of Decision (Interior 2007). The 1996 Record of Decision implemented the MLFF to govern releases from Lake Powell at short time increments, down to daily and hourly releases. The 2007 Record of Decision governs annual water year releases from Lake Powell in coordination with Lake Mead.

A past NEPA analysis that overlaps with the first year of this proposed action is the “Final Environmental Assessment and Finding of No Significant Impact for Experimental Releases from Glen Canyon Dam, Arizona, 2008 through 2012” (Reclamation 2008). Effects of this action are included in the resource analyses for this EA.

There are no other Reclamation EAs with FONSIIs. However, Reclamation is developing an EA for non-native fish control downstream from Glen Canyon Dam concurrent with this EA. These EAs are related because they occur in the same geographic area during the same time period and because the actions proposed in these EAs may affect each other. The present EA proposes to develop and implement a protocol of experimental high-flow releases that is likely to increase the numbers of rainbow trout in the Lees Ferry reach and may also cause greater downstream dispersal of trout into reaches of the Colorado River that are occupied by humpback chub (Korman et al. 2011, Yard et al. 2011). One of the purposes of the non-native fish control EA will be to assess this effect and provide mitigation for increased predation and competition by the trout on humpback chub. This can be attempted through several means, as recently identified by Runge et al. (2011), including removal using electrofishing, modifying dam operations, electric barrier curtain, and sediment augmentation to increase turbidity. The effect of HFEs is not the only reason for the non-native fish control EA; which is required by previous biological opinions on the operation of Glen Canyon Dam. There is pre-existing information that has identified predation by rainbow trout and brown trout on young humpback chub in the vicinity of the Little Colorado River (Marsh and Douglas 1997; Valdez and Ryel 1995). Part of the reason for upstream interdiction being considered in the non-native fish control EA is to address concerns of American Indian tribes.

The non-native fish control effort arises from a conservation measure commitment made by Reclamation and contained in biological opinions issued by the USFWS in 2007 and 2008. There are several other conservation measures, all of which are intended to offset or mitigate the effects the operation of Glen Canyon Dam. Those conservation measures are identified and described in the Biological Assessment (see Appendix C) that accompanies this EA. Progress on those conservation measures is identified in the 2010 BA (Reclamation 2010a).

1.5.2 National Park Service Actions

The following documents list and describe related actions identified by the National Park Service (NPS). This EA is not expected to negatively affect or impede these management actions and plans. The NPS is a cooperating agency in this EA and all actions identified in this document are being coordinated with that agency.

GCNRA General Management Plan (GMP): The recreation area's 1979 GMP set an objective to manage the Lees Ferry and Colorado River corridor below the Glen Canyon Dam to "give primary emphasis to historical interpretation and access to recreational pursuits on the Colorado River" (NPS 1979).

GCNP General Management Plan (GMP): The 1995 GMP set as an objective the management of the Colorado River corridor through Grand Canyon National Park to protect and preserve the resource in a wild and primitive condition (NPS 1995).

GCNP Resource Management Plan (RMP): The RMP is the primary resource stewardship action plan that provides long term guidance and protection for natural, cultural and recreational resources of GCNP (NPS 1997).

GCNP Backcountry Management Plan: This plan describes provisions for resource and wilderness management, including backcountry use, within Grand Canyon National Park. The plan is being updated in 2011.

GCNP Colorado River Management Plan (CRMP): The CRMP management objectives emphasize managing river recreation to minimize impacts to resources while providing a quality river visitor experience (NPS 2006). The Colorado River corridor will be managed to provide a wilderness-type experience in which visitors can intimately relate to the majesty of the Grand Canyon and its natural and cultural resources. Visitors traveling through the canyon on the Colorado River will have the opportunity for a variety of personal outdoor experiences, ranging from solitary to social, with little influence from the modern world. The Colorado River corridor will be protected and preserved in a wild and primitive condition. To ensure these salient objectives are met, the NPS must determine, through a research and monitoring program, what impacts are occurring, how these impacts alter resource condition, and how adverse impacts can be effectively mitigated. The NPS will develop and implement a detailed plan that includes individual and integrated resource-monitoring components.

GCNP/GCNRA Draft Native Fish Management Plan (in preparation), including:

Translocation of humpback chub to Shinumo Creek and Havasu Creek: juvenile humpback chub were translocated from the Little Colorado River to Shinumo Creek in 2009 and 2010. Plans are in place to make a translocation to Shinumo Creek and Havasu Creek in 2011. This translocation action is part of a conservation measure contained in the 2008 BO and 2009 Supplemental BO.

Mechanical removal of non-native fish, primarily trout from Bright Angel Creek: Non-native fish are being removed from Bright Angel Creek to restore and enhance the native fish community that once flourished in Bright Angel Creek and to reduce predation and competition on endangered humpback chub. This action is part of a conservation measure related to the 2008 BO and 2009 Supplemental BO.

GCNP 2010 Vegetation Management Plan: The plan includes management of invasive plants along the Colorado River corridor and tributaries and targets restoration of disturbed lands with the park.

GCNRA 2010 Tamarisk Leaf Beetle Action Plan.

GCNRA 2008 Colorado River Riparian Revegetation Plan, including implementation of the 2009 Hidden Slough Environmental Assessment.

1.5.3 Arizona Game and Fish Department Actions

The Arizona Game and Fish Department (AGFD) is also a cooperating agency in this EA through the Arizona Game and Fish Commission. The following are related actions identified by the agency.

Proposed changes to bag limits: The Arizona Game and Fish Commission modified its size and bag limits for trout below Glen Canyon Dam. Regulation changes were in effect beginning January 1, 2011. This modification is designed to better manage abundance and size of trout in the blue ribbon trout fishery at Lees Ferry and to reduce the numbers of trout immigrating downstream to habitat occupied by humpback chub, where they prey upon and compete with this endangered fish species.

Stocking of sport fish in the State of Arizona by the state wildlife agency and by USFWS, Southwest Region, is undergoing Intra-Service consultation. Of particular interest to this action is the proposed stocking of salmonids (trout species) in Colorado River tributaries.

1.6 Agency Roles and Responsibilities

Five agencies within Interior and one within the U.S. Department of Energy have responsibilities under the Grand Canyon Protection Act, and undertake operations pursuant to the Act. The role of each responsible agency under the GCPA is briefly addressed below.

1.6.1 Department of the Interior

Bureau of Indian Affairs

The Bureau of Indian Affairs' (BIA) mission, among other objectives, includes enhancing quality of life, promoting economic opportunity, and protecting and improving trust assets of American Indian Tribes and individual American Indians. This is accomplished within the framework of a government-to-government relationship in which the spirit of Indian self-determination is paramount. As part of the GCDAMP, BIA's Western Regional Office is committed to working hand-in-hand with interested tribes and other participating agencies to ensure that this fragile, unique, and traditionally important landscape is preserved and protected.

Bureau of Reclamation

Reclamation operates Glen Canyon Dam in accordance with the additional criteria and operating plans specified in section 1804 of the Grand Canyon Protection Act as well as in accordance with approved experimental plans. Glen Canyon Dam is also operated consistent with and subject to numerous compacts, federal laws, court decisions and decrees, contracts and regulatory guidelines collectively known as the "Law of the River."

National Park Service

The NPS protects and manages units of the national park system and administers resource-related programs under the authority of various federal statutes, regulations, and executive orders and in accordance with written policies set forth by the Secretary and the Director of the NPS, including the NPS Management Policies 2006 and the NPS Director's Orders. The NPS manages GCNP and GCNRA under the Organic Act (16 U.S.C. §§ 1 and 2-4, as amended); other acts of Congress applicable generally to units of the national park system; and the legislation specifically establishing those park units (16 U.S.C. §§ 221-228j and 16 U.S.C. §§ 460dd through 460dd-9). The Organic Act directs the NPS to "promote and regulate the use of . . . national parks . . . in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." The agency emphasis is not only on preserving species and habitat, but also on maintaining natural processes and dynamics that are essential to long-term ecosystem perpetuation.

U.S. Fish and Wildlife Service

The USFWS provides Endangered Species Act (ESA) conservation and associated consultation and recovery leadership with various stakeholders primarily to benefit five ESA-listed species in Grand Canyon: humpback chub (*Gila cypha*), razorback sucker (*Xyrauchen texanus*), southwestern willow flycatcher (*Empidonax trailii extimus*), Kanab ambersnail (*Oxyloma haydeni kanabensis*), and California condor (*Gymnogyps californianus*).

The USFWS provides Fish and Wildlife Coordination Act (FWCA) planning assistance and recommendations to support conservation of important fish and wildlife resources. Of special concern to the USFWS is the opportunity provided under the FWCA for collaborative development of recommendations to conserve non-listed native species such that the need for listing in the future under the ESA is unnecessary.

A FWCA report (June 28, 1994) provided recommendations that included timing for flows, protection of juvenile humpback chub and other native fish, and trout management, in support of preparation of the 1995 EIS. This information was provided to support conservation of fish and wildlife, including endangered species, in GCNP and GCNRA.

U.S. Geological Survey

The Grand Canyon Monitoring and Research Center (GCMRC) of the U.S. Geological Survey (USGS) was created to fulfill the mandate in the GCPA for the establishment and implementation of a long-term monitoring and research program for natural, cultural, and recreation resources of GCNP and GCNRA. The GCMRC provides independent, policy-neutral scientific information to the GCDAMP on: (a) the effects of the operation of Glen Canyon Dam and other related factors on resources of the Colorado River Ecosystem using an ecosystem approach, and (b) the flow and non-flow measures to mitigate adverse effects. GCMRC activities are focused on: (a) monitoring the status and trends in natural, cultural and recreation resources that are affected by dam operations, and (b) working with land and resource management agencies in an adaptive management framework to carry out and evaluate the effectiveness of alternative dam operations and other resource conservation actions.

1.6.2 Department of Energy

Western Area Power Administration

Western Area Power Administration (Western) mission is to market and deliver clean, renewable, reliable, cost-based federal hydroelectric power and related services. Western's CRSP-Management Center markets power from the CRSP and its participating projects (Dolores and Seedskadee and Collbran and Rio Grande projects). These resources are provided by eleven power plants in Arizona, Colorado, New Mexico, Utah and Wyoming and are marketed together as the Salt Lake City Integrated Projects. CRSP staff also market power from the Provo River Project in Utah and the Amistad-Falcon Project in Texas.

Transmission service is provided on transmission facilities in Arizona, Colorado, Nevada, New Mexico, Texas, Utah and Wyoming. Western has built several parts of the important corridor known as Path 15 that connects power grids in the Southwest and Pacific Northwest (the rest was privately built by Pacific Gas and Electric). Western also owns and operates many electric power substations like the Mead substation to distribute power within the region. Western and its energy-producing partners are separately managed and financed. In addition, each water project maintains a separate financial system and records.

1.7 Previous High-Flow Experiments

Beginning in 1996, Reclamation and its collaborators within the GCDAMP initiated the first of several experimental high-flow releases from Glen Canyon Dam (Reclamation 1996) that have helped to inform the design of the proposed HFE Protocol described in this EA. High releases in spring and summer of 1983-1985 were not experimental in nature, but were intended to balance dam releases with inflow from high spring runoff. The terminology for experimental releases has varied, and includes beach/habitat building flows (BHBFs), habitat maintenance flows (HMFs), high-flow experiments (HFEs), as well as high-flow tests.

Starting with the 1995 EIS (Reclamation 1995), high-flow releases were described as BHBFs and HMFs. A BHBF was a scheduled high release of short duration intended to rebuild high elevation sandbars, deposit nutrients, restore backwater channels, and provide some of the dynamics of a natural system. In the EIS, a BHBF was defined as: (1) scheduled only in years when the projected storage in Lake Powell on January 1 was less than 19 million acre-feet (maf) (low reservoir condition) to avoid the risk of unscheduled releases greater than power plant capacity during high reservoir conditions, and (2) a release of water from Glen Canyon that is at least 10,000 cfs greater than the allowable peak discharge (25,000 cfs) but not greater than 45,000 cfs. In the 1996 ROD, a BHBF was changed to occur in years in which Lake Powell storage was high on January 1, to be accomplished by utilizing reservoir releases in excess of power plant capacity required for dam safety purposes. In the EIS, an HMF was a short-term high release in spring, within the powerplant capacity, intended to transport and deposit sand for maintaining camping beaches and fish and wildlife habitat. An HFE was a scheduled experimental high-flow release that could occur at reservoir elevations outside the range of BHBFs when sediment and hydrology conditions were suitable and could range from 41,000 cfs to 45,000 cfs.

The history of scheduled experimental high-flow releases is as follows:

- 1996 BHBF, 45,000 cfs for 7 days, March 26-April 2, 1996.
- 1997 HMF, 31,000 cfs for 72 hours, November 5-7, 1997.
- 2000 HMF, 31,000 cfs for 72 hours, May 2-4, 2000.
- 2000 HMF, 31,000 cfs for 72 hours, September 4-6, 2000.
- 2004 HFE, 41,000 cfs for 60 hours, November 21–23, 2004.
- 2008 HFE, 41,500 cfs for 60 hours, March 5–7, 2008.

The first BHBF was held March 26 to April 8, 1996 and included pre- and post-release steady flows of 8,000 cfs for 4 days each and a 7-day steady release of 45,000 cfs. Dam releases were increased and decreased gradually relative to the peak release in order to minimize damage to resources. The coordinated effort of scientists to evaluate the effects of the 1996 BHBF on physical, biological, cultural, and socio-economic resources was documented by Webb et al. (1999). The 1996 experiment was conducted when the Colorado River was relatively sand depleted, especially in Marble Canyon, and, as a result, the primary sources of sand for building high-elevation sandbars were the low-elevation parts of the upstream sandbars and not the channel bed (Andrews 1991; Schmidt et al. 1999; Hazel et al. 1999). During the 1996 experiment, the erosion of low-elevation sandbars actually resulted in a net reduction in overall sandbar size. Sandbars that eroded during the 1996 experiment did not recover their former sand volume during the late 1990s, in spite of above-average sand supplies and the implementation of ROD operations. These results indicated that high-flow releases conducted under sand-depleted

conditions, such as those that existed in 1996, will not successfully sustain sandbar area and volume. Scientists and managers used this information to focus their efforts on the need to strategically time high-flow releases to better take advantage of episodic tributary floods that supply new sand, particularly sand input by the Paria River, to the Colorado River downstream from Glen Canyon Dam.

The findings of the 1996 BHBF led to the decision to conduct the next HFE when a sediment-enriched condition existed (Reclamation 2002). This experiment was held November 21–23, 2004, and included a 60-hour release of 41,000 cfs (Reclamation 2004). The 2004 HFE was conducted shortly after a large amount of sediment was delivered by the Paria River and it helped test the hypothesis that maximum sediment conservation would occur with a high flow shortly after the sediment was deposited in the mainstem. Suspended sediment concentrations in the upper portion of Marble Canyon during the 2004 experiment were 60 to 240 percent greater than during the 1996 experiment, although there was less sediment in suspension below RM 42. The 2004 experiment resulted in an increase of total sandbar area and volume in the upper half of Marble Canyon, but further downstream, where sand was less abundant, a net transfer of sand out of eddies occurred that was similar to that observed during the 1996 experiment (Topping et al. 2006).

The third scheduled high release was held March 5-7, 2008, and included a 60-hour release of 41,500 cfs. The 2008 HFE was timed to take advantage of the highest sediment deposits in a decade, and was designed to better assess the ability of these releases to rebuild sandbars and beaches that provide habitat for endangered fish, particularly humpback chub, and riparian wildlife and campsites for Grand Canyon recreationists. The 2008 HFE was preceded by accumulated sediment that was greater than prior to the 2004 HFE and the net storage effect of the 2008 high flow was positive. Although sandbar erosion occurred after the March 2008 HFE due to higher monthly volumes, it was noted that the erosion rate slowed during the steady 8,000 cfs releases in September–October. Results of the 2008 HFE were summarized by Melis et al. (2010) and detailed in a number of USGS Open File Reports (Draut et al. 2010; Grams et al. 2010; Hilwig and Makinster 2010; Korman et al. 2010; Ralston 2010; Rosi-Marshall et al. 2010; Topping et al. 2010).

Three habitat maintenance flows (HMFs) were held, including one in 1997 and two in 2000. Another HMF was scheduled in the 2002 EA (Reclamation 2002, page 21) as a release that would coincide with a high Paria River inflow, but the conditions for conducting this HMF were never met. The 1997 release was held as a fall powerplant release of 31,000 cfs for 72 hours, November 5-7, 1997. The May 2-4 and September 4-6, 2000 HMFs were released in association with low, steady summer flows of 8,000 cfs from June 1 through September 4, 2000. The steady summer flows were designed to warm shoreline habitats for native and endangered fishes, especially humpback chub, and the HMFs were designed to maintain habitats, export invasive non-native fish, and evaluate ponding of tributary inflows. With respect to sediment, all flows export more sediment than they place into storage and past powerplant capacity flows have been less efficient at this than HFEs (Hazel et al. 2006).

Water stored in Lake Powell can be released through Glen Canyon Dam in three ways: (1) through eight penstocks that lead to hydroelectric generators (powerplant) with a combined authorized capacity of 31,500 cfs, (2) through the river outlet works or four bypass tubes with a combined capacity of 15,000 cfs, and (3) over the two spillways with a combined capacity of 208,000 cfs. Most releases are made through the powerplant. Spillway releases can only be made if the reservoir is sufficiently high to top the spillways. Hence, a high-flow release that exceeds the powerplant capacity would, in nearly all cases, invoke the bypass tubes to achieve the desired flow magnitude. Neither the bypass tubes nor the spillway are equipped with hydropower generating capability.

1.8 Relevant Resources and Issues

Reclamation has utilized the scoping results from prior NEPA analyses, as well as knowledge gained from prior experimental releases from the dam (e.g. Gloss et al. 2005; Korman et al. 2011; Makinster et al. 2010a, 2010b; Ralston 2010; Rosi-Marshall et al. 2010; Webb et al. 1999) to determine the relevant resources and issues for analysis in this environmental assessment. Prior high-flow experiments (HFEs) were conducted in 1996, 2004, and 2008. Table 1 presents the list of relevant resources analyzed in this EA.

Relevant resources considered in this EA are similar to those evaluated in other Reclamation EAs and considered by Ralston et al. (1998) as part of resource criteria for beach/habitat building flows. Downstream resources were categorized as physical, biological, cultural, and socio-economic, and included those identified by managers and stakeholders as resources that should be considered when making recommendations concerning operations of Glen Canyon Dam. Additional development of resource evaluations will occur during the planning and implementation phases of future HFEs if the decision is made to proceed with the HFE Protocol.

1.8.1 Authorizing Actions, Permits or Licenses

Implementation of this proposed action would require a number of authorizations or permits from various federal and state agencies and the governments of American Indian Tribes. Any field work within the boundaries of GCNP or GCNRA would require permits from the NPS. Permits from the Hualapai Tribe or Navajo Nation would be needed for any field work within reservation boundaries. The Bureau of Indian Affairs (BIA) has informed Reclamation that if field work entails cultural resource/archeological work then permits from the BIA will be required as well. Researchers working with threatened or endangered species would have to obtain a permit from the USFWS. Researchers working with resident fish or wildlife species could need an Arizona Game and Fish Department permit. No other permits are known to be required at this time.

Table 1. List of resources and issues evaluated.

PHYSICAL RESOURCES	CULTURAL RESOURCES
Water Resources	Historic Properties
Water Quality	Sacred Sites
Air Quality	SOCIO-ECONOMIC RESOURCES
Sediment	Hydropower
BIOLOGICAL RESOURCES	Recreation (including Public Safety)
Vegetation	Non-Use Values
Terrestrial Invertebrates and Herptofauna	
Aquatic Foodbase	
Fish	
• Humpback Chub	
• Razorback Sucker	
• Non-Listed Native Fishes	
• Trout	
• Other Non-native Fishes	
• Fish Habitat	
Birds	
Mammals	

1.8.2 Potential Limitations to Conducting an HFE

Dam Maintenance

The amount of water that can be released at a given time depends on the status of the release infrastructure of Glen Canyon Dam. There are eight generators (units) at the Glen Canyon Powerplant. The combined release of these eight units, when all are available and operating at full capacity, is currently 31,500 cfs. Unit 6 has been “derated,” however, and currently is capable of generating 125 MW with a maximum release of approximately 3,000 cfs (about 75 to 80 percent of its previous capacity). Thus, the present powerplant release capability is 31,000 cfs.

Maintenance at the Glen Canyon Powerplant is an ongoing activity. All units undergo annual maintenance whereby these units are unavailable for a period of about 3 weeks each year as this work is performed. Annual maintenance is not performed in the months of January, July, August, and December, as these are peak power demand months.

Ongoing maintenance also includes more substantive activities than unit annuals. The turbine runners on all 8 units at Glen Canyon are currently being replaced. Turbine runner replacement is a major activity, and it generally takes nearly a year to complete one runner replacement. Turbine runner replacement has been scheduled over an eight- year period. Four of the eight runners have now been replaced. Unit 7, the fourth of eight, was completed in February 2011. The final four turbine runner replacements are scheduled to take place between February 2011 and May 2014. There have been schedule delays in accomplishing the first four turbine runner replacements. Delays also could occur in completing the final four runner replacements.

Reclamation has a five-year maintenance schedule for the Glen Canyon Powerplant. There are scheduled outages for maintenance during the months of March/April and October/November from the present through November 2015 (Table 2). At least one unit will be unavailable during November and April through April of 2014. The five-year schedule currently shows no major maintenance beyond the spring of 2014. However, several major powerplant maintenance activities are being planned for the next 10 years, including replacement of the generator transformers and generator rewinds for 4 of the 8 units. These are major activities, which render the unit unavailable for extended periods of time (a month or more for a transformer replacement, and a year or more for a generator rewind). Additionally, mechanical or electrical failures can result in unplanned “forced outages.” In 2008, for instance, Unit 6 experienced a significant failure in the generator winding resulting in a forced outage. Unit 6 was unavailable for a period of 2 years while the generator was repaired and the turbine runner replaced.

Table 2. Glen Canyon powerplant unit outage schedule – March/April and October/November, 2011-2015 (shaded areas indicate unit outages). Kcfs = thousands of cubic feet per second.

Unit Number	Oct – Nov 2011	Mar – Apr 2012	Oct – Nov 2012	Mar – Apr 2013	Oct – Nov 2013	Mar – Apr 2014	Oct – Nov 2014	Mar – Apr 2015	Oct – Nov 2015
1									
2									
3									
4									
5									
6 (limited)									
7									
8									
Units Available	5 to 7	5 to 7	5 to 7	6 to 7	5 to 7	6 to 7	6 to 8	6 to 8	6 to 8
Powerplant Capacity	20 to 27 Kcfs	20 to 27 Kcfs	20 to 27 Kcfs	23 to 27 Kcfs	20 to 27 Kcfs	23 to 27 Kcfs	24 to 31 Kcfs	23 to 31 Kcfs	24 to 31 Kcfs
Powerplant plus River Bypass Capacity	35 to 42 Kcfs	35 to 42 Kcfs	35 to 42 Kcfs	38 to 42 Kcfs	35 to 42 Kcfs	38 to 42 Kcfs	39 to 45 Kcfs	38 to 45 Kcfs	39 to 45 Kcfs

Given the age of the powerplant (nearly 50 years), and scheduled and unplanned maintenance at the Glen Canyon Powerplant, it is reasonable to expect that in the 10-year period the HFE Protocol is in place, at least one unit would be unavailable in the months of March/April and October/November, with a powerplant capacity release not likely to be greater than 27,500 cfs and a combined powerplant and river bypass tube release capacity not likely to be greater than 42,500 cfs. High flows proposed and analyzed in this EA utilize the maximum available release

from the powerplant combined with up to 15,000 cfs from the bypass tubes. Releases greater than the combined capacity of the powerplant and river bypass tubes, which would require using spillways, are not anticipated during the period of this protocol and are not covered by the compliance in this environmental assessment.

Maintenance on the river bypass tubes and associated hollow jet valves will also be needed at some point in the future. Relining of the coating on the inside of the bypass tubes would likely be part of this maintenance as would a rebuild of the hollow jet valves. Such an activity has not been scheduled, but such a maintenance activity would render the river bypass tubes unavailable for a period of a year or more (personal communication, Lonnie Gourley, Manager, Glen Canyon Field Division).

Sediment and Flow Limitations

The principal driving variables of this HFE Protocol are sediment and flow. In order for an HFE to be conducted without creating a negative sediment mass balance, a minimum amount of sediment must be available in the river channel. A certain amount of water also must be available in the system to generate a release of sufficient magnitude and duration to resuspend and deposit the sediment stored in the river channel; however some transfer of water across months is possible to meet this need. An HFE is not likely to be conducted if these conditions of sediment and water are not suitable. The role of these variables in the decision-making process of this protocol is described in section 2.2 of this EA.

Condition of Resources

The condition of both physical and biological resources must be taken into account by Interior as part of a decision to conduct an HFE. While the condition of physical resources (i.e., sediment budget) necessary to conduct or not conduct an HFE can be determined with a relatively high degree of certainty, the condition of biological resources that might warrant reconsideration of an HFE is not as well understood. Reclamation recognizes the need to ensure that implementation of the HFE Protocol does not result in significant impacts to GCDAMP resources such as endangered humpback chub and will closely monitor both trout and chub populations to ensure that potential changes are detected as rapidly as possible. Reclamation will take a conservative approach and will re-evaluate, and suspend if necessary, the protocol, if it anticipates that significant impacts could occur that cannot be mitigated. If a specific key resource is identified in decline, it is reasonable to expect that this will be detected through core monitoring and appropriately considered in the HFE decision-making process.

Other Possible Limitations

There may be additional limitations to conducting an HFE other than those described above. Because the HFE Protocol includes a decision strategy that takes into account relevant and related actions and effects, a short-term priority may arise that could preclude an HFE.

Reclamation is also currently engaged with cooperating agencies in the development of a proposed action through a non-native fish control EA for managing the numbers of trout in Grand Canyon to reduce the effects of predation and competition on the endangered humpback chub (see section 1.3 Related Actions). Reclamation has drafted an environmental assessment

and is currently in consultation with the USFWS and in government-to-government consultation with the American Indian Tribes on this action. The series of workshops and meetings held with scientists and managers as part of this process indicate that both flow and non-flow actions could be necessary to manage trout numbers.

The proposed action regarding trout control will be important in two ways. First, the trout control efforts may involve flow-based actions. Any flow-based action will need to be analyzed to determine if it will affect sediment transport as assessed in this EA. Second, HFEs that could result from this HFE NEPA process have the possibility to increase trout numbers. Any needed measures to manage increases in trout numbers will be conducted through the nonnative fish EA. As each EA proceeds, the pertinent analyses will draw from one another.