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**GLEN CANYON NATIONAL RECREATION AREA (NRA)  
GRAND CANYON NATIONAL PARK (GRCA)**

**RESULTS OF FY96 EXPERIMENTAL FLOOD FLOW MITIGATION**

**SEPTEMBER 30, 1996**

**GLEN CANYON ENVIRONMENTAL  
STUDIES OFFICE**

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PROJECT TITLE:

Results of the Mitigation of Cultural Resources in Response to the FY96 Experimental Habitat Building Flow in Glen and Grand Canyons.

ABSTRACT:

The Bureau of Reclamation conducted an experimental habitat building flow in late March and early April, 1996, reaching a maximum of 45,000 cfs. The flow was expected to provide system-wide effects at most cultural sites in the river corridor by the accumulation of more sediment. A positive effect was assumed, but not guaranteed. A possible negative impact at eight archaeological sites along the river corridor between Glen Canyon Dam and Lake Meade was determined through previous monitoring efforts. On-site mitigation was required at those locations to fulfill federal agency responsibilities for any impacts sustained as a result of the experimental flow. This document presents the justification, objectives, design and methods, and results of the mitigation program.

IDENTIFICATION OF RESEARCHERS:

In order to mitigate the effects of the experimental habitat building flow on the cultural resources in Glen and Grand Canyons, an integrated program has incorporated the individual efforts of the programs of Glen Canyon NRA and Grand Canyon National Park. For the purposes of coordination, Signa Larralde, Regional Archaeologist, Upper Colorado Region, Bureau of Reclamation, is Principal Investigator. Co-principal investigators and staff are:

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**GLCA:** Tim W. Burchett, M.A., Archaeologist; Norm Henderson, M.S., Research Coordinator, Glen Canyon National Recreation Area, P.O. Box 1507, Page, Arizona 86040.

## INTRODUCTION:

The Glen Canyon Dam Environmental Impact Statement (GCDEIS) evaluated impacts to resources affected by flows from Glen Canyon Dam, including unusual events such as habitat maintenance and habitat building flows. Within the GCDEIS and related cultural compliance documents, consideration was made regarding impacts to cultural resources resulting from all dam operations.

The ultimate goal of the cultural resource efforts related to Glen Canyon Dam operations is preservation in-situ, with minimal impact to the integrity of the cultural resources. This framework guided the development of federal compliance responsibilities, articulated in the Programmatic Agreement on Glen Canyon Dam Operations and evaluation of impacts to sites within the GCDEIS context.

Inclusion of the habitat building and maintenance flows in the GCDEIS was, in part, due to the recognition that these flows would serve as a system-wide method to help stabilize and regenerate the predam terrace deposits on which cultural resources exist. It is essential that the effectiveness of this mitigation approach be supported by data collected as a result of the experimental habitat building flow.

The experimental flood flow that occurred in spring FY96 was an opportunity to study the effects of high flow discharge from Glen Canyon Dam on alluvial terraces and margin deposits along the river corridor. The effects of these flows on the margin deposits and terraces is an especially important area of study since many of the terraces are of relatively recent origin and contain buried cultural remains.

Although it is felt that periodic controlled high flows should have long term benefits for most of the cultural resources located along the river corridor, there may be negative impacts at specific locations along the river corridor. With the closure of Glen Canyon Dam, the pattern of deposition and erosion has been changed, creating an erosive system that depletes sediment from the terraces rather than deposits. Movement of sediment within the system by utilizing flows from Glen Canyon Dam has the potential to restore part of the natural process of the Colorado River.

Within the various reaches of the river, effects from the periodic high flows were expected to be different. Nowhere will these effects be more pronounced than in the Glen Canyon reach (mile -15 to 0). These differences are related to the varying geomorphic conditions found throughout the river corridor from Glen Canyon Dam to Lake Mead. Within the first 15 miles, for example, sediment input into the system is limited to minor tributaries and erosion of the existing terraces. Although this reach has experienced severe depletion of sediment since the

closure of Glen Canyon Dam, input of sediment into the system does occur, albeit at minimal levels. Armouring of terrace deposits have occurred at some locations, but not consistently throughout the reach. Additional investigation into the dynamics of the sediment resource within the Glen Canyon reach is critical to the understanding of stability of cultural sites within this segment of the river.

From 1990-1991 and intensive archaeological survey was conducted by the National Park Service along the Colorado River between Glen Canyon Dam and Separation Canyon. A total of 475 archaeological properties were documented. Two hundred and sixty-three of these sites are located on or within river deposited alluvium and are thus at risk to potential adverse impacts from the operations of Glen Canyon Dam. Currently, the lack of sediment within the river corridor has an adverse impact on virtually every site in the system due to the gradual depletion of surface sediment. This impact is most pronounced for those sites in proximity to the river, which were more likely to be affected by the experimental flow.

National Historic Preservation Act compliance for the experimental flow was included within the Programmatic Agreement on Glen Canyon Dam Operations. This document, along with the Monitoring and Remedial Action Plan, includes provisions for mitigation measures to be instituted based upon various flow scenarios and observed resource conditions. This mitigation program operates under a blanket permit issued under the Cooperative Agreement No. 9AA-40-07920.

JUSTIFICATION:

The experimental flow is seen as an undertaking described under 36 CFR Section 106 part 800.9, Criteria b, as:

- (b) An undertaking [is] considered to have an adverse effect when the effect on a historic property may diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association. Adverse effects on historic properties include, but are not limited to:
  - (1) Physical destruction, damage, or alteration of all or part of the property.

Eight sites could have sustained an adverse effect from the experimental flow. The on-site effects resulting from a 45,000 cfs flow may have varied from partial re-deposition to complete removal of the soil matrix, artifacts, and features. Prior to the experimental flow, these eight sites were exposed, and a high release flow created a situation in which highly vulnerable cultural resources were susceptible to loss or irreparable damage

resulting from sheet erosion, bank slumpage, and/or silt deposition. It has been documented along the Colorado and other Rivers that an elevated flow could further erode both previously recorded and undiscovered prehistoric and historic sites due to increased erosion or unacceptable alterations. (Libby Dam and Lake Kooconusa, Kootenai River, Cultural Resources, 1978).

OBJECTIVES AND/OR HYPOTHESES:

Within the entire river corridor, from Glen Canyon Dam to Lake Mead, a null and alternative hypotheses concerning the effects the experimental flow might have had upon cultural resources were stated as follows:

- Ho: The experimental flow will have no effect upon the cultural resources within Glen and Grand Canyons.
- H1: The experimental flow will have an adverse effect upon the cultural resources within Glen and Grand Canyons, evidenced by loss of sediment and/or displacement of artifacts and erosion to features.
- H2: The experimental flow will have a beneficial effect upon the cultural resources within Glen and Grand Canyons, evidenced by a net gain of sediment, thus stabilizing sites.

Monitoring of archaeological resources along the Colorado River has provided data to support the alternative hypothesis H1 stated above, that the experimental flow would have an adverse effect upon the cultural resources within Glen and Grand Canyons, evidenced by loss of sediment and/or displacement of artifacts and erosion to features. The monitoring program has determined that eight sites (four historic and four prehistoric) had the potential for inundation or erosion due primarily to bank slumpage and direct surface erosion caused by the experimental flow. These sites had the potential for catastrophic loss, requiring data recovery prior to the experimental flow

The objective of the mitigation program was to collect archaeological data at sites having the potential for catastrophic loss due to inundation or erosion caused by the experimental flow. NPS proposed to implement mitigation measures by augmenting existing monitoring and remedial action programs by focussing effort on those sites that fall within specific vertical and lateral distances from the river (7 m / 33 m).

SITE-SPECIFIC MITIGATION DESIGNS AND METHODS:

Eight sites received mitigation prior to the experimental flow. General data recovery methods included total station mapping, photo documentation, and subsurface excavation. Total station

mapping was conducted with the assistance of the GCES surveying office staff. The mapping program recorded features, the locations of excavation units, shovel test locations, and topographic information. The sites were tied into the geographic control network established by GCES.

Mitigation of the four prehistoric sites included specific data collection requirements concerning the nature, depth, and integrity of subsurface deposits, artifacts and features. Radiocarbon and botanical samples were recovered from features. In addition, information to address on-site impacts resulting from the experimental flow were. At the three historic sites, complete photo documentation and additional recording were conducted.

GRCA's photo catalog system was used to record and store photo records in the GRCA reach, and GLCA's photo catalog system was used to record and store photo records from the GLCA reach. Medium format photographs were taken at sites C:06:002 and C:06:004. Documentation included the completion of the GCES River Monitoring Form and excavation forms.

A single excavation unit was placed on each of the three sites: AZ C:13:321, AZ C:13:365, and AZ C:13:371. Three units were placed at AZ C:03:010. The excavation units straddled the appropriate feature or artifact scatter closest to the river. In addition shovel test holes were placed at intervals of one meter between the excavation unit and the waters' edge to determine if any previously undiscovered subsurface cultural materials existed. This method was less intrusive than an excavation unit and served the same purpose.

The test units measured 1 x 1 m and were dug in arbitrary 0.10 m levels except where natural stratigraphy was identified. Excavation continued until culturally sterile sediment or bedrock was reached. The excavation units and shovel tests were dug with a shovel and trowel, and the back dirt was sifted through 1/4 inch hardware mesh. Feature fill that was not collected for samples was screened through 1/8 in hardware mesh. Stratigraphy was described, drawn in profile, and photographed. Shovel test pits were placed at two meter intervals and dug to determine the extent of cultural materials. The deepest shovel test units were profiled and photographed.

No human remains were encountered. If they were, work would have been immediately halted at that location, and Tribal authorities would have been notified as soon as possible. A plan of action (or no action) would have been implemented by the Tribes in conjunction with the NPS.

## SITE-SPECIFIC MITIGATION RESULTS AND RECOMMENDATIONS:

The results of mitigation efforts at eight sites, four prehistoric and three historic, are presented below.

**AZ B:15:124**

### Site Description

This is a historic inscription in concise block print that spells out "Geo. W. Parkins Washington D.C. 1903". The entire site takes up an area of 30 x 15 cm. The recording crew was unable to identify Parkins through archival research following the survey.

### Previous and Existing Condition

The inscription is on a 70-90 degree angle on a polished schist surface approximately six ft above the 28,000 cfs level and 28 m from the river. It has been monitored in FY's 92, 93, twice in 94 and 95. The inscription is described as being in excellent condition, yet high river flows might adversely impact it. The only activity that has been occurring is from the beach directly below the inscription. There is a steady state, cyclic nature in this area of gullies forming and disappearing. This sequence is dependent upon the accumulation of new sand and water saturation.

### Photo Documentation

No subsurface excavation was conducted at the site. However, detailed before and after black and white medium format photographs were taken of the inscription. These photographs will be inserted into a Map Imaging Process System (MIPS) to generate exact replicas of the inscription. It was felt that this type of documentation would exhaust all information potential from this site. See Figure 1 for photo.

### Evaluation and Recommendation

The 45,000 cfs release did change the beach below the inscription, but the inscription is still in excellent condition.

FIGURE 1. MEDIUM FORMAT PHOTOGRAPH OF B:15:124.

**AZ C:02:011, Feature 12 -- Charles H. Spencer Steamboat**

Site Description

The Charles H. Spencer Steamboat is a feature of Spencer's gold mining operation at Lees Ferry dating to 1910-1912. Carrell (1987) provides an extensive history of the Spencer, Lees Ferry, and nearby mining operations. That study was funded by the Bureau of Reclamation Glen Canyon Environmental Studies Office and the National Park Service Submerged Cultural Resources Unit.

A variety of historic vessel resources combined with associated land resources such as mines, landings, and ferry crossings have provided considerable information toward understanding the historic use of the Colorado River region (Carrell 1987:79).

Of all the vessel types used along the Colorado River, the steamboat was used the longest, from 1854 to 1916 (Carrell 1987:79). Steamboats were of three varieties, screw-driven, sidewheelers, and sternwheelers (Carrell 1987:81). Of the 14 sternwheel steamboats known to have been used along the Colorado and Green Rivers, four hold the most promise for future research. One is located on the Green River near Green River, Wyoming; one whose location is not clear; one was wrecked near Big Bend Utah on the Colorado River; and the fourth is the Charles H. Spencer, abandoned in 1912 at Lees Ferry (Carrell 1987:79-82).

The National Register eligibility of dismantled, lost, or sunk sternwheelers is based on their physical integrity for Criteria A, and on their potential to yield information for Criteria D. Based solely on the scarcity of these resources, three of the four sternwheel steamboats noted above are considered eligible for the National Register. When Criteria B and C are considered, the significance and eligibility of these resources is enhanced (Carrell 1987:82). Indeed, the Charles H. Spencer Steamboat is listed on the National Register.

Previous and Existing Condition

The Lees Ferry mining operations were closed by the summer of 1912 (Carrell 1987:14), and the steamboat was tied up along the river bank about 1/4 mile east of Lees Ferry Fort where it is today.

Carrell's 1986 (1987:xix) study of the condition of the steamboat showed that its most detrimental impact is from wet-dry cycling, resulting from fluctuating water levels. It would be best preserved if all elements were kept submerged at all times. Lower water levels also invite adverse human impacts to the site.

At the time of the study, wooden elements of the steamboat remained hard and well-preserved, and metal components were in good condition. However, a portion of the boiler and firebox are

rusting, and the end of the bow keel is deteriorating. These elements are in poor condition because they are often above water and are exposed to wet-dry cycles (Carrell 1987:xix).

Since these impact assessments were made, the steamboat has been monitored from shore twice annually, and a monitoring dive was conducted in 1992 (Neal and Leap 1992). That monitoring episode showed that the steamboat remained in good condition when compared to the 1986 photographs, maps, and notes, but further deterioration from wet-dry cycling to the often exposed boiler, firebox, and bow keel was noted. In addition, the disarticulation of a wooden element was noted. The most notable differences were the abundance of green algae (Cladophora) growing on the steamboat and the increase in the deposition of silt on and around the steamboat (Neal and Leap 1992). The increase in sediment is considered a beneficial impact since it helps to stabilize the structural components and fabric of the Spencer.

Since the 1992 dive, surface monitoring efforts have noted the continuing increases in the amount of algae and the deposition of silt on and around the Spencer, and the bow keel has continued to deteriorate due to wet-dry cycling. Overall, the Spencer Steamboat remains in stable condition.

#### Data Recovery

It was unclear whether the experimental flow would have 1) no effect; 2) remove sediment from around the Spencer thus destabilizing it -- an adverse effect, or 3) deposit sediment thus further stabilizing it -- a beneficial effect. The Spencer is on an outside curve of the river channel, so removal of sediment was a possibility. On the other hand, the Spencer is in a backwater eddy, so deposition of sediment was also a possibility. The following null and alternative hypotheses were used to address these questions:

- H<sub>0</sub>: The experimental flow will have no effect on the Spencer Steamboat. There will be neither sediment depletion nor deposition on or around the Spencer. Also, there will be no loss of fabric from the vessel.
- H<sub>1</sub>: The experimental flow will have an adverse effect on the Spencer Steamboat, evidenced by the displacement of artifacts and/or wooden elements, and/or the depletion of sediment from around the Spencer, which will have the effect of destabilizing it, making it more receptive to erosion and displacement of fabric.
- H<sub>2</sub>: The experimental flow will have a beneficial effect on the Spencer Steamboat, evidenced by the deposition of sediment on top of and around it. This situation will

protect the steamboat from further erosion and will place wooden elements into an anerobic environment, which would slow the movement and deterioration of fabric.

To test H<sub>0</sub>, a pre-flood underwater condition assessment was made by NPS certified dive personnel before the high water release and was followed up with a second dive after the flow to evaluate its effects on the structural integrity and sediment deposition around the Spencer remains.

The dive monitoring program involved 2 divers using comparison photographs taken during the most recent dive on the Spencer (Neal and Leap 1992) to determine any changes in the erosion/deposition of sediment and/or the movement of structural elements. Also, photographs, maps, and notes from the original documentation conducted in 1986 (Carrell 1987) were used for comparison.

The pre- and post-flow dives were conducted at 8,000 cfs. At this level, the port side of the Spencer is out of the water. Recording methods included the completion of the GCES River Monitoring Form and a new photographic record. Glen Canyon NRA's photo catalog system was used to record and archive photo records. The following tasks were conducted:

- 1) For the starboard side, do underwater photography comparisons from stern to bow
- 2) For the port side, do above water photography comparisons from shore (the port side is above water at 8,000 cfs)
- 3) From underwater, photograph firebox on front of boiler
- 4) From underwater and above, photograph bow sprits
- 5) Survey for a deck beam lying diagonally across the port side aft of the northern most paddlewheel hub, noted in the most recent dive (Neal and Leap 1992). This beam was not detached in 1989 surface monitoring photographs
- 6) Survey for debris that rolled off the deck of the Spencer on the starboard side. The Spencer rests on the edge of the river channel, which drops steeply on the starboard side. The debris include various disarticulated wooden planks and pieces of decking, steam and exhaust pipes, a trottle valve, truss rods, the smoke stack funnel collar, bilge pump, and a Sampson post cap.

- 7) At specific locations on the deck of the Spencer, monitoring points were established to record the depth of sediment prior to and following the experimental flow to quantify the amount of sediment gain or loss.

#### Evaluation and Recommendations

Results of the seven tasks described above provide sufficient evidence to evaluate  $H_0$  and its alternatives. Tasks 1 through 4 used comparison photographs taken during the most recent dive on the Spencer (Neal and Leap 1992), and photographs, maps, and notes from the original documentation conducted in 1986 (Carrell 1987) were used. In general, the comparison observations determined an increase in the amount of sediment deposition on and around the Spencer, probably because it is in a backwater eddy. On the starboard side of the Spencer, only three deck board widths remain totally unburied with sediment, with the exception of the gear box, fire box, boiler, and bow sprits.

Task 5 was to survey for the disarticulated deck beam lying diagonally across the port side aft of the northern most paddlewheel hub. It was not found, but is believed to be covered with sediment in the same location.

Task 6 was to survey for debris that rolled off the deck of the Spencer on the starboard side. This debris include various disarticulated wooden planks and pieces of decking, steam and exhaust pipes, a trottle valve, truss rods, the smoke stack funnel collar, bilge pump, and a Sampson post cap. The divers observed none of these materials exposed on the river bottom. Attempts were made to locate the debris by probing, but nothing was found. The debris has apparently been covered with considerable sediment. It is also possible that due to the steep gradient of the channel, some of the debris could have slipped into the channel bottom.

Task 7 involved measuring the loss or deposition of sediment at predetermined sediment monitoring points on the Spencer. Table 3 summarizes measurements taken at 8 specific locations. These measurements indicate that at all locations, sediment increased anywhere from 2 to 15 cm.

These seven lines of evidence are inconsistent with  $H_0$ , that there would be no effect. The alternative hypothesis that best fits the evidence is  $H_2$ , that there would be a beneficial effect, evidenced by the deposition of sediment on top of and around the Spencer. The result is to protect the steamboat from further erosion and place wooden elements into an anerobic environment, slowing the movement and deterioration of wooden fabric.

This investigation has determined that there have been no adverse effects on the Charles H. Spencer Steamboat caused by the FY96 experimental habitat building flow. Indeed, the flow has been beneficial in that it has increased the amount of sediment in and around the Spencer, thus further protecting it.

Table 3. Results at sediment monitoring points on the Charles H. Spencer Steamboat, FY96 Experimental Habitat Building Flow.

Sediment Monitoring Point	Description/ Location	Pre-flow Sediment Depth	Post-flow Sediment Depth	Net Sediment Gain (Loss)
1	Pitman at starboard paddlewheel hub	Sediment 5 cm below pitman	Sediment flush with pitman	5 cm
2	Port side paddlewheel hub	Sediment at gear cog wheel shaft	Sediment 4 cm from top of cog wheel	15 cm
3	Starboard gunnel	Sediment 12 cm deep	Sediment 35 cm deep	13 cm
4	Metal object on starboard gunnel	Sediment 12 cm	Sediment 20 cm	8 cm
5	Starboard gunnel 8 2.5 m aft of boiler	Sediment 2 cm	Sediment 5 cm	3 cm
6	Metal bar protruding in front of boiler	Sediment 5 cm	Sediment 7 cm	2 cm
7	At bow, starboard gunnel to deck	Sediment 7 cm	Sediment 10 cm	3 cm
8	At bow, port gunnel to deck	Sediment 25 cm	Sediment 30 cm	5 cm

Site Description

Site AZ C:03:010 (Figure 1) consisted of a charcoal-stained area with some fire-cracked sandstone and quartzite cobbles eroding from the top of a stream terrace. Also present were a large partially buried Navajo sandstone grinding slab about one meter northeast of the stain. A few flakes were also present. Activities represented at this site include food processing and preparation, and lithic reduction for the manufacture of tools. The intensity and nature of these activities represents short-term habitation typical of a logistical camp.

Previous and Existing Condition

The site is located on a low knoll between two arroyos about 4 m above the 28,000 cfs level and 16 m from the river. The site was monitored in FY's 91, 92, 93, 94, and 95. At the time of recording in 1991, site condition was considered fair. The site was being impacted by humans and by weather. Surface erosion, gullying, and arroyo cutting were impacting the entire site, and runoff was impacting the hearth. Artifacts southwest of the site were eroding down the terrace slope. These impacts are related to river fluctuations, i.e., direct inundation of the site has occurred, but the site was also threatened by surface erosion and eolian deflation. The charcoal lens exposed in the cutbank was eroding and getting smaller. A system of trails is nearby, and foot prints were noted on site.

The monitoring episode in FY 95 showed bank slumpage around the hearth had increased. One new trail was present in the arroyo and on the north side of the hearth. Inundation, bank slumpage, and further downcutting were expected impacts from the experimental habitat building flow.

Test Excavations

The subsurface extent of this site was defined by two arroyos bordering it. Therefore, the data recovery plan does not include arial shovel testing to determine extent or site stratigraphy. The arroyos provided sufficient exposure of sediments. The plan did call for total station mapping -- conducted by Frank Protiva and crew from the GCES survey office, controlled surface collection, and excavation of several 1 x 1 m units. The mapping program recorded the location of artifacts and features and topographic information such as arroyo cuts and gullies. The site has been tied into the geographic control network established by GCES.

Artifacts were point plotted, collected, and analyzed to recover functional, chronological, subsistence, and technological information. All sediments from the excavation units were screened through 1/4 in hardware mesh (1/8 in for features). All

Figure 1. Plan Map of AZ C:03:010.

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materials are curated using NPS-ANCS standards and stored at Glen Canyon NRA's curation facility.

Features were plan mapped, profiled in cross section, and photographed. Radiocarbon and flotation samples were collected and analyzed to recover chronological and subsistence/economic information. Beta Analytic Inc. of Coral Gables, Florida conducted the radiocarbon analyses, and Western Cultural Resource Management, Inc. conducted the flotation analysis.

Recording methods included the completion of the GCES River Monitoring Form and Glen Canyon NRA excavation forms. Glen Canyon NRA's photo catalog system was used to record and store photo records. Five study units were placed and excavated as described below.

*Study Unit 1.* This mapping unit was established for recording surface features and collecting surface artifacts. Two features and 5 items were point plotted (Figure 1). Table 1 summarizes field specimens (FSS), artifacts, and samples collected from the various study units. FSS 2 through 5 were collected while recording Study Unit 1.

*Study Unit 2.* This 1 x 1 meter unit was placed over the grinding slab (FS 1) to recover it and any other artifacts nearby. Three arbitrary levels were excavated to a maximum of 53 cm below present surface. Level 1 included the entire 1 X 1 meter unit and was dug a maximum of 23 cm into a fine gray well sorted sandy loam. The grinding slab, exposed on the surface, and a mano fragment (FS 6) were collected. Level 2 was a maximum of 10 cm deep, and Level 3 was a maximum of 20 cm deep. No cultural remains were identified below Level 1. Two sediment strata were recognized. The sediments in Level 1 were a fine well sorted sandy loam, Stratum A. As depth increased into Levels 2 and 3, the silt content of the sediment increased, becoming a well sorted loam, Stratum B.

*Study Unit 3.* This is a 1 X 2 meter unit placed over Feature 1, a hearth exposed on the surface. In Level 1, the first 3 cm of sediment were removed to define a generally oval hearth measuring 60 x 24 cm. On top of the hearth, fire-cracked sandstone spalls and a fire-cracked quartzite cobble (FS 9) were present. Surrounding the hearth was a ring of charcoal-stained sands measuring 120 x 90 cm. Following photographing and plan mapping, the feature fill was removed to expose a 6 cm deep circular basin. The fill of the feature contained a sandy loam and charcoal stained sands. All fill was screened through 1/8 in hardware mesh. Both a flotation sample (FS 7) and a radiocarbon sample (FS 8) were collected.

Table 1. Artifacts and samples from AZ C:03:010.

Field Specimen	Artifact Type	Associated Study Units	Associated Feature
1	Grinding Slab	1, 2	
2	Secondary black chert flake	1	
3	White chert shatter	1	
4	Small white chert tertiary flake	1	
5	Burned quartzite cobble	1	
6	Sandstone mano	2	1
7	Sample #1 Flotation	3	1
8	Sample #2 Radiocarbon	3	1
9	Fire-cracked Rock	3	1
10	Sample #3 Radiocarbon	4	1

A preliminary scan of the flotation sample by Janet L. McVicker of Western Cultural Resource Management, Inc. indicated that it was a poor candidate for complete analysis. No charred seeds or other potentially economic plant parts were encountered. However, the sample was composed almost exclusively of saltbush/shadscale (*Atriples sp.*) charcoal. Some charred rabbitbrush (*Chrysothamnus sp.*) was also present. The prehistoric use of the hearth was probably primarily for heat. If additional uses of the hearth occurred, they are not documented by the flotation sample results. Although the results yield no subsistence information, they do indicate exploitation of the available wood in the vicinity of the site. They also suggest that the prehistoric environment was similar to that of today (McVickar 1996).

Table 2 presents the results of the radiocarbon analysis. FS 8 (Beta 94285), from the center of the hearth, was small and required extended counting. The 2 sigma 95% probability calibrated results are AD 435 to 650. This date corresponds very well with the radiocarbon sample analyzed from Study Unit 4 (FS 10) below.

*Study Unit 4.* This 1 X 1 meter unit was placed west of Study Unit 3, to expose charcoal staining shown in the wall of Study Unit 3. All sediments were screened through 1/8 in hardware mesh. Level 1 was 13 cm thick and consisted of light gray fine well sorted sandy loam, Stratum A. Below it, Level 2 consisted of Stratum B, a 3 cm mottled layer of charcoal chunks, stained sands, oxidized sands, white. The scattered/mottled nature of the deposit suggested a dump from the adjacent hearth. No artifacts were recovered, but an abundant charcoal sample (FS 10) was collected.

Again, Table 2 presents radiocarbon results from AZ C:03:010. FS 10 (Beta 94286) returned a 2 sigma 95% probability calibrated results of AD 420 to 650. This corroborates the results from the FS 8 sample from the hearth. The 1 sigma 68% probability calibrated results on Table 2 are less secure, but suggest that occupation of the site could be narrowed down to about a 100 year period in the AD 500s or 600s.

Level 3 was 20 cm deep. The sediment was a caliche-stained gray loam, Stratum C. This was a sterile deposit. Level 4 was a 50 x 50 cm shovel test placed in the middle of the 1 x 1 m unit and was 50 cm deep. Stratum C continued throughout Level 4. No cultural remains were recovered.

*Study Unit 5.* This is a profile setup to record Feature 2, a lens in the cutbank. Four strata were noted on the 1 m tall cutbank. Stratum A, at the top, was a maximum of 60 cm thick and consisted of a light gray unconsolidated silty loam. Stratum B was the charcoal lens completely within Stratum A. It appeared in profile as an upside-down lenicular basin, the shape suggesting that it was not cultural. This stain is 61 cm below the cultural horizon reported in Study Units 1 through 4. Stratum C was a thin layer below Stratum A consisting of a white caliche-stained silty clay deposit, definitely alluvial. Stratum D, below Stratum C, was the same deposit as Stratum B noted in Study Unit 2, a light gray well-sorted loam with a higher silt content. Feature 2 is a natural burn with no cultural remains associated, and predating the cultural horizon by an unknown amount of time.

Table 2. Radiocarbon results from AZ C:03:010.

Feature, Field Specimen	Beta Lab Number	Conventional Radiocarbon Age BP	Calibrated Results (2 Sigma, 95% Probability)	Calibrated Results (1 Sigma, 68% Probability)	Intercept of Radiocarbon Age and Calibration Curve
1, FS 8	94285	1510+/-50	AD 435 to 650	AD 535 to 620	AD 575
1, FS 10	94286	1520+/-60	AD 420 to 650	AD 465 to 475, AD 515 to 620	AD 560

### Evaluation and Recommendations

AZ C:03:010 was excavated prior to expected impacts from the experimental habitat building flow in Spring, 1996. All deposits have been recovered. AZ C:03:010 is included in the Grand Canyon River Corridor Archaeological District, which is being developed in conjunction with the Historic Preservation Plan. As an element of that district, and as a result of its mitigation, the site has addressed various research topics such as chronology, paleoenvironment, subsistence, and technology. Activities noted at the site include food processing, lithic reduction for the manufacture of tools, and the use of a hearth for warmth. The intensity and nature of these activities represents short-term habitation typical of a logistical camp. Botanical data from the flotation sample suggests that the environment was probably similar to that of today. The site was probably occupied sometime in the A.D. 500s to 600s.

Since all cultural materials were recovered, this data recovery program has mitigated all adverse effects the experimental habitat building flow might have had on the site. Since no cultural materials remain, no further work is recommended.

### **AZ C:06:002**

#### Site Description

This is the historic inscription carved by Peter Hansbrough on July 10, 1889 recording the drowning of F.M. Brown, President of Denver Colorado Canyon and Pacific Railroad Company.

#### Previous and Existing Condition

The inscription is located on the Supai formation and is 15 ft above the 28,000 cfs level. Under the GCES program, monitoring has occurred in FY's 92, twice in 93, 94 and 95. Yet, monitoring reports of this site began with Bob Euler in 1978 and 1979. Euler stated that the site is "more subject to erosion than to visitor impact" (Euler 1978). Euler also documented that the site is eroding, cracking, and exfoliating (Euler 1979). In 1982, Jan Balsom (Balsom 1984) reported that Duco cement was used to glue pieces of the inscribed date back in place. In 1983, the summer flood heavily impacted the inscription. Several pieces washed away and the remaining portions became much less distinguishable. It was postulated that the water and silt abraded the inscription. The GCES monitoring program has noted the presence of rock spall, but no increase. It is also a known fact that several commercial boaters show their guests the inscription, however, there is no sign of human impact.

#### Photo Documentation

Detailed before and after experimental flow medium format photos were taken. These photos will be scanned into the MIPS program

to produce replications of the inscription for future work and archival purposes. See Figure 2 for medium format photograph.

Evaluation and Recommendation

Evidence of the experimental flood overtopping the inscription was evidenced by fresh cladophera in the vegetation above the inscription. However, there was no negative impact to the inscription as portrayed in the after photograph. This is not to say that reoccurring experimental flows of more than 45,000 cfs would not have a negative effect on the rock art. This area is very fragile and subject to erosion due to the likelihood of spalling and water and sediment abrasion. The photographic work that was taken exhausts the information that can be obtained by the inscription.

FIGURE 2. MEDIUM FORMAT PHOTOGRAPH OF C:06:002.

Site Description

This site consists of a historic USGS rock hammer petroglyph most likely related to the 1923 USGS trip. The inscription is a geology hammer and the letters U S G S.

Previous and Existing Condition

The rock art is located in a small alcove on a black face of the Supai Formation and is accessible by river. It is only .85 m above the 28,000 cfs level. GCES monitoring occurred in FY's 92, 93, 94 and 95. In 1983, Balsom reported that the markings were below the water level, with the base of the rock hammer at river level. No damage to the exposed glyph was noticed, even though the entire glyph was under water at times during the summer of 1983 (Balsom 1984). The inscription is not very prominent. Actually, it is difficult to distinguish because it is pecked in fairly lightly. Several people know about the inscription but there are no signs of human disturbance.

Photo Documentation

Information potential has been exhausted at this site by the completion of medium format, black and white photographs. These photographs will be inserted into the MIPS computer program for future reference and archival purposes. See Figure 3 for the medium format photograph.

Evaluation and Recommendation

The inscription was completely inundated by the 45,000 cfs research flood, however, no damage was observed. As mentioned before, the inscription is faint therefore it would be difficult to determine how many more high water releases it could withstand before it faded away due to water and sediment abrasion. It is probable that the inscription was much more distinguishable originally but because of flooding since 1923 it is slowly, yet consistently weathering away.

FIGURE 3. MEDIUM FORMAT PHOTOGRAPH OF C:06:004.

Site Description

This is a prehistoric roaster complex containing roasting pits, hearths and a historic rubble mound. Feature 4 is a fire cracked rock feature and located approximately 30 m south of the river (Fairley, et al. 1994).

Previous and Existing Condition

The site is located among large sand dunes, approximately 29 m from the river. It is 14-22 ft above the 28,000 cfs. The site has been monitored in FY's 93, 94, 95 and 96. The majority of the features are in good condition. The most common form of site impacts are seen from eolian erosion or deposition and human traffic and collection piles at Features 4, 5 and 6.

Test Excavation

**Excavation Unit:** It was believed that the 45,000 cfs research flow would impact Feature 4 therefore an excavation unit was placed over the lower portion of Feature 4 to retrieve all cultural materials. Level 1, 0-10 cm below the surface, consisted of unconsolidated eolian sand with a fraction of overflow gravels. The fire-cracked rocks were determined not to be fire-cracked. The location of the unit was on the lee side of a large set of drift logs from the high water of the 1920's and 1950's. It is used as a sleeping spot by campers. Gravel fraction increases with depth to account for 80% of the volume. A single chert flake fragment was recovered near the surface, it was not collected.

Level 2, 10-23 cm below the surface, consisted of gravels. Eolian sand was still present. A water-proof match and a peanut were recovered at about -12 cm in the northwest quad. Also a three in piece of thin wire with blue plastic was recovered. No cultural materials or carbon were recovered in the screen.

**Shovel Tests:**

Shovel Test 1 -- 0-32 cm below surface. Sediment is fine, loose, river sand (well sorted clastic material deposited out above 45,000 cfs line in 1983-86) which has been redeposited by wind. Some roots were present. Gravels were encountered at 32 cm.

Shovel Test 2 -- 0-50 cm below surface. Sediment is fine, loose, river sand redeposited by wind. Some roots were present. Gravels encountered at 50 cm.

Shovel Test 3 -- 0-67 cm below surface. Same sediment consistency as Shovel Test 1 and 2.

Shovel Test 4 -- 0-80 cm below surface. Same sediment consistency as Shovel Test 1 and 2.

Shovel Test 5 -- 0-100 cm below surface -- furthest from the site. Sediment continues to be fine, loose, river sand, reworked by wind and water. Unit terminated at one meter without encountering rocks. No differentiated stratigraphy present.

See Appendix A for site map, excavation forms and profiles. See Appendix B for the geomorphological study conducted at C:13:321.

#### Evaluation and Recommendation

The findings at C:13:321 indicate that Feature 4 is not a prehistoric, cultural manifestation. It is an indication of gentle, downslope erosion of cultural materials from a higher elevation. The shovel tests proved that the site does not extend towards the river. No further work will be recommended for this feature.

#### AZ C:13:365

#### Site Description

This site consists of a prehistoric, ephemeral rock alignment, roasting features and artifacts. The artifact scatter extends towards the river into the boulder field (Coker et al. 1994).

#### Previous and Existing Condition

The site is situated on alluvial deposits interfingering with side canyon fan deposits and recent dunes. It is 20 ft above the 28,000 cfs level. Monitoring has occurred during FY's 92, 93 and twice in 94. Results reveal that the site is fairly stable with minor erosion and moderate sheep trailing at Features 2 and 3.

#### Test Excavation

**Excavation Unit:** A 1 x 1 m excavation unit was placed on the lower boundary of Feature 1. The surface was relatively level with unconsolidated sand. Level 1, 0-10 cm below the surface, contained unconsolidated, reworked sand from 1983-84 flooding, with rocks in the southwest corner. Plant roots were also present. Level 2, 10-20 cm below surface, consisted of unconsolidated sand with an increase in small rocks and large cobbles throughout the unit. In the south half at 19 cm the soil changed to sand with some clay. It was darker and more orange in color. This is more distinct of main channel deposition from either 1952 or 1957. This level was variable and rested on top of older debris flow deposits. Level 3, 20-30 cm below surface, had unconsolidated sand with an increase in larger rocks. A single Redwall chert flake was recovered and collected. It is a tertiary flake measuring 1.5 x 1.7 cm. No carbon was recovered.

#### **Shovel Tests:**

Shovel Test 1 -- 0-39 cm below surface.

Shovel Test 2 -- 0-32 cm below surface.

Shovel Test 3 -- 0-30 cm below surface.

Shovel Test 4 -- 0-60 cm below surface. The findings in this unit reflected all shovel units excavated. It contained poorly, consolidated sand with slight compaction with depth. Moisture content also increased with depth. Some minor rhizomes were present in the top 30 cm. The top 20-30 cm were reworked by eolian processes subsequent to 1984. The 1950's red, clay-rich sand present in the excavation unit was removed in 1983-84 and was not present on the lower beach segment. The 1983-84 deposit lays directly on older debris flow rock. The sorting and slight lamina below 30 cm indicated a slack water environment of deposition. No artifacts or carbon were recovered.

Shovel Test 5 -- 25 cm below surface.

Shovel Test 6 -- 14 cm below surface -- closest to the river.

See Appendix C for site map, excavation forms and profiles.

#### Evaluation and Recommendation

The excavation conducted at C:13:365 demonstrated the previous flooding of the Colorado River prior to the dam, more than revealing the cultural story of the area. Because no cultural features were recovered the findings suggest that the main features are contained higher up the terrace, and not in a flood zone. The collected chert flake is most likely a mere representation of sheetwash. There are also photographs that show the experimental flood of 45,000 cfs did not inundate Feature 1. No further work is recommended for this site as long as the research flows proposed in the future are no higher than 45,000 cfs.

AZ C:13:371

#### Site Description

This is a prehistoric site consisting of roomblocks, storage features, roasting pits and artifacts. Feature 8, a rubble mound, had the most potential for impact during the spike flow.

#### Previous and Existing Condition

This site is located at the mouth of a short, unnamed drainage on an alluvial/colluvial debris fan. It is 14 m from the river and 20 ft above the 28,000 cfs level. The site has been monitored twice each year during FY's 92, 93, 94, 95 and 96. The 1983 high water inundated the beach area below the site and steepened the toes of the alluvial terraces which contain cultural remains. Since then, there has been evidence of increased gullying and bank slumpage.

## Test Excavation

### **Excavation Unit:**

The 1 x 1 unit was placed over the southeast corner of Feature 8, a possible roomblock. The surface contained numerous rocks scattered across, eolian sand and one small fragment of charcoal located in the southwest corner. A single unidentifiable chert flake was collected. It is a primary flake with half of the cortex remaining, and measures 4.5 x 3.8 cm. Level 1, 0-10 cm below surface, contained mixed debris flow material of loose, sand with increasing compaction. Rocks and cobbles, approximately 5 x 10 cm, were mixed with charcoal flecks and five chert flakes lightly scattered throughout the level. All five flakes are thinning flakes of unidentifiable chert. They were collected. Oxidized rock fragments were also found in the north half of the unit.

Level 2, 10-20 cm below surface, revealed increased compaction, large debris cobbles and orange colored soil in the northwest corner. Four unidentifiable tertiary, or thinning chert flakes were recovered and collected. Limonite fragments were also lightly scattered throughout this level. Level 3, 20-30 cm below surface, contained compacted, loamy sand with cobbles as large as 20 cm in diameter. The limonite continued throughout the unit. No cultural materials or carbon were found at this level. The photograph in Figure 4 reflects the termination of the test unit.

### **Charcoal Collection:**

Two radiocarbon samples were collected and analyzed to recover chronological information. Beta Analytic Inc. of Coral Gables, Florida conducted the radiocarbon analyses. One sample came from Feature 4, a charcoal lens eroding out of a vertical cutbank. A second sample was taken from Feature 2, an badly eroding roaster feature. Table 1 presents radiocarbon results from C:13:371. Feature 2 returned a 2 sigma, 95% probability calibrated result of AD 1665 to 1950. Feature 4 returned a 2 sigma, 95% probability calibrated result of AD 1445 to 1655. The dates indicate a much more recent occupation than was expected because of the ceramics located on the surface indicate mid to late Pueblo II occupation (AD 950 - 1150).

### **Shovel Tests:**

Shovel Test 1 -- 0-16 cm below surface. Sediment consisted of fine, reworked, loose 1983-84 sand. Rocks were encountered at 16 cm below the surface.

Shovel Test 2 -- 0-60 cm below surface. Sediment consisted of fine, reworked, 1983, loose sand. Thin, (1 cm or less) lens of reddish sand associated with a root and rocks, which are encountered at 60 cm. One 1 x 1 cm fragment of charcoal was found near the surface. No collection was made.

Table 1. Radiocarbon results from C:13:371.

Feature	Beta Lab Number	Conventional Radiocarbon Age BP	Calibrated Results (2 Sigma, 95% Probability)	Calibrated Results (1 Sigma, 68% Probability)	Intercept of Radiocarbon Age and Calibration Curve
2	94284	120+/- 50	AD 1665 to 1950	AD 1680 to 1755	AD 1700, AD 1720, AD 1820, AD 1855,
4	94283	350+/-50	AD 1445 to 1655	AD 1470 to 1640	AD 1860, AD 1920 AD 1515, AD 1585, AD 1625

Shovel Test 3 -- 0-60 cm below surface. Sediment consisted of fine, loose, 1983 sand. Rocks were encountered at 60 cm.

Shovel Test 4 -- 0-75 cm below surface. The sediment contained fine, reworked, 1983 sand. The sediment was damper and slightly darker, probably due to proximity to the river. Rocks were encountered at 75 cm.

Shovel Test 5 -- 0-40 cm below surface. This unit was located at the head of a gully, 5-10 m from the river, and below water level at 45,000 cfs. The gully is 50 cm wide and 45 cm deep. Numerous roots were present due to the willows in the vicinity. Sediment consisted of loose, damp, fine 1983 sand deposits. Rocks were encountered at 40 cm.

All shovel test units contained thin, intermittent lenses of more compact sediment that was sometimes yellow, red or dark tan.

See Appendix B for geomorphological report of C:13:371. See Appendix D for the site map, excavation forms and profile.

#### Evaluation and Recommendation

C:13:371, Feature 8 was excavated prior to expected impacts from the habitat building test flow in Spring, 1996. All cultural materials found were recovered because it was unclear whether the experimental flow would have an impact to the feature. As a result, the null hypothesis that the experimental flow will have no effect on Feature 8 was true. Other information generated from the excavation and shovel test units proved that Feature 8 is not a feature but part of a debris flow. Much of the cultural material that is found on the lower terrace is a result of sheetwash of artifacts from a higher terrace. No further work will be recommended at this feature. The shovel tests proved that the site does not extend past the visible, surface features.

FIGURE 4. PHOTOGRAPH OF THE TEST UNIT AT TERMINATION.

ARCHAEOLOGICAL SUMMARY

to be completed for final

## EVALUATION SUMMARY/HYPOTHESES ASSESSMENT

The objective of the mitigation program reported here was to collect archaeological data at sites having the potential for catastrophic loss due to inundation or erosion caused by the experimental habitat building flow conducted in spring FY96. In doing so, a null and alternative hypotheses concerning the effects the experimental flow had upon cultural resources can be evaluated. These hypotheses are restated below:

- H0: The experimental flow will have no effect upon the cultural resources within Glen and Grand Canyons.
- H1: The experimental flow will have an adverse effect upon the cultural resources within Glen and Grand Canyons, evidenced by loss of sediment and/or displacement of artifacts and erosion to features.
- H2: The experimental flow will have a beneficial effect upon the cultural resources within Glen and Grand Canyons, evidenced by a net gain of sediment, thus stabilizing sites.

As noted above, monitoring of archaeological resources along the Colorado River has provided data to support the alternative hypothesis H1 stated above, that the experimental flow would have an adverse effect upon the cultural resources within Glen and Grand Canyons, evidenced by loss of sediment and/or displacement of artifacts and erosion to features. Eight sites (four historic and four prehistoric) had the potential for inundation or erosion due primarily to bank slumpage and direct surface erosion caused by the experimental flow. These sites had the potential for catastrophic loss, requiring data recovery prior to the experimental flow.

The results of the data recovery program at the seven sites below best fits H0, that the experimental flow will have no effect upon the cultural resources within Glen and Grand Canyons. At site C:03:10, the archaeological materials present were removed prior to inundation, thus preserving the scientific information. At C:13:321, the cultural remains were determined to be redeposited from above, and so were out of context. At C:13:365, excavation showed that no cultural remains would be impacted at flows of 45,000 cfs or lower. Higher flows might impact cultural remains higher up on the terrace. At C:13:371, excavation determined that the materials inundated by the 45,000 cfs flow were redeposited by erosion and sheet wash from cultural deposits higher on the terrace. They, therefore, are out of context.

Sites B:15:124, C:06:002, and C:06:004 are historic inscriptions. At B:15:124, the inscription was not inundated and it remains in excellent condition. At C:06:002 and C:06:004, the inscriptions

were inundated, but no negative impacts were portrayed in follow up photography. However, these areas are very fragile and subject to erosion due to spalling and water and sediment abrasion. Further high water flows may impact the sites by slow wet/dry cycles.

The results of the data recovery program at C:02:011, Feature 12 -- the Charles H. Spencer Steamboat, best fits H2, that the experimental flow will have a beneficial effect, evidenced by a net gain of sediment, thus stabilizing the site. It was benefited by the high water flow due to its location in a backwater eddy. More sediment was deposited, thus further protecting it from erosion and displacement of wooden elements and fabric.

In summary, the experimental habitat building flow conducted in spring FY96 had either "NO EFFECT" or a "BENEFICIAL EFFECT" to the cultural resources in Glen and Grand Canyons, due to the mitigation program reported here.

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Appendix A

C:13:321

Site Map, Excavation Forms,  
Test Unit Profile, Shovel Test Profile

Appendix B

Geomorphology of Selected Sites in Grand Canyon

Appendix C

Project Data File C:13:365

Site Map, Excavation Forms,  
Test Unit Profile, Shovel Test Profile

Appendix D

C:13:371

Site Map, Excavation Forms,  
Shovel Test Profile