

FINAL SUMMARY REPORT
FOR THE
GLEN CANYON NATIONAL RECREATION AREA (NRA)
FY93 GLEN CANYON ENVIRONMENTAL STUDIES (GCES)
MONITORING OF ARCHAEOLOGICAL SITES
FROM GLEN CANYON DAM TO THE PARIA RIFFLE

CONFIDENTIAL

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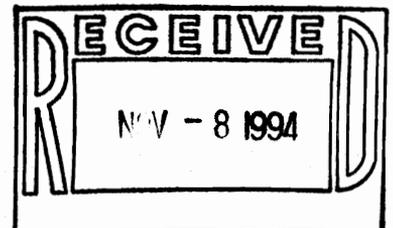
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ABSTRACT

As part of the ongoing Glen Canyon Environmental Studies (GCES) program in Glen Canyon National Recreation Area (NRA), this report summarizes the FY93 archaeological monitoring effort. On various days between May 16 and September 14, 1993, monitoring for erosional and human impacts was conducted at 38 selected locations between Glen Canyon Dam and the Paria Riffle. Glen Canyon NRA personnel included Tim W. Burchett, Christine E. Goetze, Lisa M. Leap, Nancy K. Mueller, and Kathy Stangl.

Baseline data from the FY91 inventory and the FY92 monitoring program are briefly summarized to provide context for the FY93 monitoring program, which is presented in detail. Site specific results of the FY93 monitoring effort and results from the last monitoring effort are provided to illustrate the ongoing impacts present. Recommendations for remedial actions at seven sites and future monitoring efforts for all sites inspected are suggested.

The overall trends and relationships between several environmental and impact variables are explored. The analysis suggests that surface erosion and gullies affect sites associated with Types I and II streams equally. Bank slumpage is more commonly associated with Type I streams than Type II streams. This impact does not appear to occur that often, but when it does, extensive amounts of terrace deposits are lost.

There appears to be a strong relationship between the presence of surface erosion and location of the site on Colorado River fluvial deposits. There appears to be some relationship between the presence of gullies and the fluvial deposits, but this relationship does not appear to be as strong as that between the presence of surface erosion and the fluvial deposits.

The FY94 monitoring program is briefly discussed. All monitoring locations will be inspected. A short assessment of the effectiveness of the monitoring program since its beginning is provided.

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I. INTRODUCTION

The preparation of an Environmental Impact Statement (EIS) on the effects of the operation of the Glen Canyon Dam on the downstream environmental and ecological resources and historic properties of Glen Canyon and Grand Canyon was ordered by the Secretary of the Interior. The goal of the EIS is to determine downstream specific options that could be implemented to minimize adverse impacts on the downstream environmental and cultural resources and Native American interests in Glen and Grand Canyons. To reach the objectives, a joint effort among several agencies was designed to identify and evaluate the cultural resources present within Glen and Grand Canyons. A survey gathered information on the numbers, types, location, National Register eligibility, physical condition, and extant and potential impact agents (Fairley et al. 1991:1) of 475 cultural properties (Fairley et al. 1991:268). A large portion, 336 sites, were found to be impacted to a greater or lesser extent by the Colorado River.

A monitoring and remedial action plan for monitoring the effects of the Glen Canyon Dam operations on historic properties within the Area of Potential Effects (APE) and for carrying out remedial actions to address the effects of continuing identification, inspection, analysis, evaluation and remedial protection actions, as necessary, for the preservation of the cultural properties within the river corridor.

Pursuant to that monitoring and remedial action plan, this document reports the results of the FY93 monitoring activities conducted by Glen Canyon National Recreation Area in Reach 0 from Glen Canyon Dam to the Paria Riffle. This introduction includes a brief discussion of previous monitoring work conducted during FY91 and FY92. Section II presents a scope of work including field and laboratory monitoring methods for FY93. Section III presents site-specific results and recommendations of the monitoring effort. Section IV is a summary and includes site specific remedial actions, overall trends in site stability and impact agents. A list of sites and tentative trip schedule for the FY94 monitoring effort, and an assessment of the effectiveness of the monitoring program during the past year are presented.

Previous Monitoring Activities

The purpose of the Final Monitoring and Remedial Action Plan (1994) is to generate baseline data regarding the effects of Dam operations on historic properties, identify on-going impacts to historic properties, and develop and implement remedial measures for treating historic properties subject to damage. The FY91 and FY92 efforts are briefly outlined below.

FY91 Monitoring Effort

Table 1 is a listing of 54 sites recorded by the Grand Canyon River Corridor Survey (GCRCS) in Reach 0 from Glen Canyon Dam to the mouth of the Paria Riffle during FY91. The table indicates the sites monitored during individual years, and provides land ownership information for all sites. During FY91, 69 monitoring episodes were conducted at these 54 sites. One episode was conducted at 51 sites, 12 episodes were conducted at C:2:11, and 6 episodes were conducted at C:2:60. Tasks completed during this initial recordation included: 1) recordation of archaeological information on IMACS site forms; 2) sketch mapping; 3) photographic documentation; and 4) onsite monitoring of erosional and human impacts using the GCES Archaeological River Site Monitoring Form.

Two general impact classes were evaluated. Natural impacts included surface erosion, gullyng, arroyo cutting, wind deflation, bank slumpage, dune migration, and animal-caused erosion such as trampling, trailing, and burrowing. Human impacts are indicated by the presence of collection piles, trails, evidence of on-site camping such as fire scars, rearrangement of rocks, recent trash, concentrated soil compaction, and vandalism.

FY92 Monitoring Effort

During the FY92 season, 19 monitoring episodes were conducted at 16 sites (Table 1). Tasks included: 1) photographic documentation for comparison with the previous FY91 and future monitoring episodes; 2) updating IMACS site records and maps; 3) completion of GCES Archeological River Site Monitoring Forms for continued onsite monitoring of erosional and human impacts; 4) subsurface testing and sampling of features at two sites (Leap and Neal 1992a; Neal and Leap 1992a); 5) terrestrial and underwater photography and underwater monitoring of site C:2:11, Feature 12 -- the Spencer Steamboat (Neal and Leap 1992b); 6) and film changing at three stationary camera locations (Leap and Neal 1992b).

Neal and Leap (1992c) report that compared to the 1991 GCES monitoring results, FY92 changes in site conditions were minimal. Of the 19 locations monitored in FY92, seven were actively eroding, six were eroding incipiently, and six were stable.

FY92 recommendations (Neal and Leap 1992c) called for the continuing monitoring of all sites within the Colorado River corridor. In addition to monitoring the randomly selected sites, cyclic monitoring should be conducted for the stationary camera sites, all sites described as actively eroding, sites under direct impact by the interim flows of the Colorado River, and sites with eroding charcoal features.

Table 1. Sixty-nine locations are monitored by GLCA. Fifty-three archaeological sites are present from Glen Canyon Dam down to River Mile 1.6 Right Bank below Lees Ferry. Fifty-one sites have one monitoring location, site C:2:11 has 12 monitoring locations, and site C:2:60 six monitoring locations. NN = Navajo Nation, GLCA = Glen Canyon National Recreation Area.

AZ Site Number, Feature	FY91 Monitor	FY92 Monitor	FY93 Monitor	Land Owner
C:2:11, Feature 1	x			GLCA
Feature 3	x			GLCA, NN
Feature 4	x			GLCA
Feature 5	x	x		NN
Feature 6	x	x		NN
Feature 11	x			GLCA
Feature 12	x	x	x	GLCA
Feature 13	x			GLCA
Feature 14	x	x	x	GLCA, NN
Feature 17	x			GLCA
Feature 20	x			GLCA
Feature 21	x			GLCA
C:2:12	x	x	x	NN
C:2:13	x		x	GLCA
C:2:32	x	x	x	GLCA
C:2:33	x			GLCA
C:2:35	x		x	GLCA
C:2:36	x		x	GLCA
C:2:37	x			GLCA
C:2:38	x		x	GLCA
C:2:39	x	x		GLCA
C:2:40	x			GLCA
C:2:41	x	x		NN
C:2:48	x		x	NN

AZ Site Number, Feature	FY91 Monitor	FY92 Monitor	FY93 Monitor	Land Owner
C:2:50	x			GLCA
C:2:53	x	x		GLCA
C:2:56	x			GLCA
C:2:57	x	x	x	NN
C:2:58	x		x	GLCA, NN
C:2:59	x		x	NN
C:2:60, Feature 1	x		x	NN
Feature 2	x		x	NN
Feature 4	x		x	NN
Feature 6	x		x	NN
Feature 7	x		x	NN
Feature 8	x		x	NN
C:2:70	x			GLCA
C:2:71	x		x	GLCA
C:2:72	x	x	x	NN
C:2:73	x		x	GLCA
C:2:74	x	x		GLCA
C:2:75	x	x	x	GLCA
C:2:76	x		x	NN
C:2:77	x		x	GLCA
C:2:78	x			NN
C:2:79	x			GLCA
C:2:80	x	x		GLCA
C:2:81	x		x	GLCA
C:2:82	x	x	x	NN
C:2:83	x		x	NN
C:2:84	x		x	GLCA
C:2:86	x		x	NN
C:2:87	x		x	NN

AZ Site Number, Feature	FY91 Monitor	FY92 Monitor	FY93 Monitor	Land Owner
C:2:88	x			GLCA
C:2:90	x		x	NN
C:2:91	x		x	NN
C:2:95	x	x	x	GLCA
C:2:99	x		x	NN
C:2:100	x	x	x	NN
C:2:102	x			GLCA
C:2:103	x			GLCA
C:2:104	x			GLCA
C:2:105	x			GLCA
C:2:106	x	x	x	NN
C:2:108	x			NN
C:3:3	x		x	GLCA
C:3:4	x			GLCA
C:3:6	x			GLCA
C:3:10	x	x	x	GLCA
Totals	69	19	38	

II. FY93 SCOPE OF WORK

The objectives of the FY93 monitoring season are based on the results and recommendations of the FY91 survey and FY92 monitoring activities. Five major tasks included:

- 1) continuation of on-site monitoring of erosion and human impacts;
- 2) continuation of the terrestrial photogrammetry;
- 3) collection and analysis of radiocarbon and paleoethnobotanical samples from site C:3:10;
- 4) determine the cfs flow required to keep the keel of the overturned Spencer Steamboat completely submerged, and conduct photographic recording of known cfs flow rates there; and
- 5) update the GCES monitoring data base for the sites in Reach 0, from the Glen Canyon Dam to the Paria Riffle.

Laboratory and Field Monitoring Methods

Laboratory and field methods include criteria for site selection, methods for photographic documentation, and continued terrestrial photogrammatry.

Criteria for Site Selection

For FY93, all sites described as actively eroding, sites impacted directly by the river's interim flows, and sites with eroding charcoal features were monitored. Severely eroding charcoal features were to be sampled for charcoal. Sites excluded from the FY93 monitoring program included those that are:

- 1) located below the 300,000 cfs river flow zone and are not situated in or on river alluvium;
- 2) exhibiting no apparent impact;
- 3) determined during the FY92 monitoring program to have 'Stable' current conditions;

On-Site Monitoring Activities

Table 1 lists the 38 locations at 32 sites proposed for monitoring activities during FY93, based on the above criteria. The tasks completed at each monitoring location include completion of the Archaeological River Site Monitoring Form. As in the previous monitoring year, the identification of site-specific stability and impact categories was a major objective. Site stability was determined by the presence/absence of incipient or active erosion.

Impacts are divided into two major categories, natural and human. Sites exhibit various natural impacts including: surface erosion; gullyng -- surface cuts from 10 to 100 cm deep; arroyo cutting -- surface cuts greater than 100 cm deep; animal-caused erosion; and other kinds of erosion such as wind deflation, bank slumpage, and dune migration.

At each site, an evaluation as to whether these impacts appeared to be related to fluctuations of the level of the Colorado River due to the operation of Glen Canyon Dam was given. This evaluation is specified in a number of categories -- direct inundation within the past 30 years (post-dam), bank slumpage and/or steepening adjacent to highwater zones, and headward migration of arroyos due to the lowering of the river base level. General trends of natural impacts are provided below.

Sites are also evaluated for human impacts including the presence and number of collection piles, the presence and number of distinct trails, evidence of on-site camping -- fire scars, fire pits, recent charcoal, rearrangement and/or clearing of

rocks, recent camper trash, obvious concentrated compaction of the soil suggestive of a tent site, and evidence of deliberate vandalism such as graffiti on rock art panels and subsurface disturbance caused by digging.

For on-site camping and deliberate vandalism, a subjective determination of whether the evidence appeared to be recent (less than five years old) was given. Evidence from the last monitoring visit helped to evaluate whether the impacts occurred since that last visit. General trends of human impacts are provided below.

Photographic Documentation

Photographic recording using GLCA archival procedures continued. The photographic recording effort at sites C:2:11, 12, 32, 58, 59, 106, and C:3:3, which have direct impacts and active river cutbank erosion, included documentation over Memorial Day weekend of a consistent 8000 cfs dam release from May 29 through May 31, 1993.

Terrestrial Photogrammatry

The stationary camera monitoring program involves the generation of on-site photo scales, film retrieval, and development. Two cameras overlook C:2:100; C:2:11, F.12 and F.14; and C:2:32. Film changing and development by Glen Canyon Resource Management personnel has continued. The film is changed approximately every 34 days, and it is sent to Kodak with specific processing instructions. Upon development, the uncut, unmounted processed film is sent to Brian Cluer and Mark Malone, Glen Canyon Environmental Studies, 121 E. Birch, Suite 307, Flagstaff, Arizona 86001, (602) 556-7457, for photo data analysis.

III. SITE-SPECIFIC RESULTS AND RECOMMENDATIONS

Table 1 presents all sites and locations that are inspected in the GCES monitoring program within GLCA and indicates the fiscal years they were monitored. This section briefly describes the site type, land ownership, physiographic position, stability, natural and human impacts observed during the last monitoring episode and during the FY93 monitoring episode at each site. A determination of whether the impacts are related to river fluctuations or dam operations is given. Site specific characteristics, tribal considerations, and management and remedial action recommendations are included.

AZ C:2:11, Feature 12

The Spencer Steamboat is a feature of Lee's Ferry Historic District, which sank on the right bank of the Colorado River just above the Lee's Ferry boat launch in 1914. The steamboat is partially submerged in water and present-day shoreline/fluvial deposits.

FY92 Monitoring Results

The exposed portions of the boat are slowly but actively eroding due to river fluctuations. Incipient erosion is occurring on the unexposed portions of the boat. Many of the detached wreck scatter and features have been covered by silt. It is recommended that on the next dive, some time is spent to relocate them. It is noted that people sit and stand on the boiler to fish.

FY93 Monitoring Results

Extensive river fluctuations continue to cause wet-dry cycles to the bow of the steamboat. Moss and algae in the center of the boat, growing up from the river bottom and on the port side, is not as abundant as in FY92. Human impacts have apparently reduced since FY92, when during low water, visitors have been known to stand on the boiler of the boat to fish. This was not observed in FY93, although it still may have occurred. Litter from picnickers is present on the nearby stream terrace, and visiting tour boats often float over the steamboat; their wakes cause continued movement of sediment. The steamboat is monitored by a stationary camera located on the opposite side of the river.

Overall, the Spencer appears in better condition underwater, but the portions exposed above the water's surface are being heavily impacted by wet/dry cycling from the raising and lowering of the water level and by wave action caused by passing boats. It is typical for rafters and other boaters to float over the top of the steamboat with their engines turned off. This does tend to reduce the size of the wakes that hit the exposed portions of the steamboat, usually the keel, but the wakes are still present and impacting the steamboat. Underwater silt buildup in and around the vessel has increased noticeably since last year and the amount of algae and vegetation growth has decreased.

Recommended Remedial Actions

Recommendations for best preserving the steamboat are extending the no-wake zone around the Lees Ferry boat launch area to incorporate the Spencer, and keeping the vessel underwater at all times. An "ideal" flow of 12,000 cfs or higher would accomplish the latter recommendation. The steamboat should be

monitored annually from the shore, and monitored underwater prior to and following any extremely high or low flows.

A proposed 'spike' flow of 52,000 CFS, scheduled for FY95 will have unknown impacts on the Spencer Steamboat. It is recommended underwater dive monitoring sessions be conducted prior to and following the spike flow to evaluate the impacts to the steamboat.

AZ C:2:11, Feature 14

This feature is located on the left and right banks of the Colorado River just upstream from Lee's Ferry on old alluvial terraces. It consists of the abutments of the USGS Cableway, and is included in the Lee's Ferry Historic District. The remnants on the right bank consist of concrete cable anchors, and the remnants on the left bank are on Navajo land and consist of concrete cable anchors, a still-standing A-frame tower, and a cable car.

FY92 Monitoring Results

The right bank concrete cable anchors are in stable condition. They do not appear to be threatened by either natural or human impacts.

On the left bank, there is evidence of surface erosion, gullyng, and arroyo cutting. Metal fragments are eroding into the main arroyo from both banks. A significant flood would promote headward migration on the main arroyo, eventually impacting the site.

FY93 Monitoring Results

The right bank concrete cable anchors are in stable condition. They do not appear to be threatened by either natural or human impacts. It is recommended that the right bank elements of Feature 14, the concrete cable anchors, be monitored every 3-5 years.

The remnants of Feature 14 on the left bank are on Navajo land and consist of concrete cable anchors, a still-standing A-frame tower, and a cable car. There is no change in the condition of the concrete cable anchors and the tower from previous monitoring episodes. However, the cable car has been humanly impacted since the FY92 monitoring episode. The wooden board frame on the front, back, and right sides of the cable car have been peeled away and rearranged on the ground nearby. Considering these human impacts, these elements of Feature 14, the tower and the cable car, should be monitored annually, and

the artifacts of Feature 14 should be mapped. These impacts can not be attributed to river fluctuations or dam operations.

AZ C:2:12

This historic road is the "Dugway", an alternate route built in 1898 to avoid the Lee's Backbone Road. It is located on Navajo land just downstream from Lee's Ferry on the left bank of the river on the slopes of the Moenkopi Formation.

FY92 Monitoring Results

The gullies and arroyos crossing the trail continue to cut deeper and wider and are eroding intact retaining wall segments. An aluminum can, probably from visitors walking the trail, was noted.

FY93 Monitoring Results

Natural impacts -- sheet washing, gullying, arroyo cutting, and bank slumpage -- are continuing, and further damage to existing retaining walls due to arroyo enlargement is predicted. There is minimal human impact due to camping and hiking along the trail. None of these impacts can be attributed to river fluctuations or dam operations. Due to the side arroyo erosion evident along the road, which is affecting the retaining walls and extant portions of the road, annual monitoring should continue.

Recommended Remedial Actions

The retaining walls should be stabilized.

AZ C:2:13

This prehistoric site consists of a rock shelter with a low dry-laid wall enclosing the front. A sherd and lithic artifact scatter is present along with a small petroglyph panel. The site is located on Navajo land on an alluvial terrace and talus slope where it contacts with a low Kayenta sandstone cliff face.

FY91 Monitoring Results

There is evidence of surface erosion and three gullies are present. On-site camping is also noted by fire scars. The loss of the cultural deposits due to degradation of the alluvium is a long term threat. Arroyo cutting and bank slumpage are indirectly impacting the site. There is also considerable trailing through the site.

FY93 Monitoring Results

The site is actively eroding with impacts from sheet washing, gullyng, arroyo cutting, and bank slumpage. The site exhibits extensive trampling and trailing. The bank slumpage identified at Feature 2, a rock alignment of sandstone slabs, is a result of trampling rather than water-related. The artifact scatter in front of rock art panel 1 and Feature 1, the rock shelter, is eroding through gully washing and should be monitored for new exposures of artifacts. These impacts do not appear to be related to river fluctuations or dam operations. There are no identified human impacts. Evidence of camping on the site was noted in FY91, however, no trace of that activity was noted during the FY93 monitoring session. Annual Monitoring is recommended.

AZ C:2:32

This site is a series of charcoal lenses eroding from a high cutbank of an alluvial terrace on the left bank of the river.

FY92 Monitoring Results

The site exhibits extensive surface erosion and moderate gullyng. An arroyo is located 20 m east of the site. Bank slumpage is impacting the charcoal lenses as well. The cutbank was undermined by 1983 high CFS releases, causing bank slumpage and steepening and widening of gullies and the arroyo east of the site. However, the base of the cutbank seems to be stable since the introduction of regulated flows and tamarisk have taken root. Even though the base of the cutbank seems stable, the past undercutting of the cutbank has allowed bank slumpage. The charcoal lenses were tested later in FY92 (Leap and Neal 1992a). Annual monitoring was recommended.

FY93 Monitoring Results

The site is actively eroding with natural impacts including surface erosion, gullyng, arroyo cutting, and bank slumpage. These impacts are related to river fluctuations and dam operations, specifically, direct inundation, bank slumpage and steepening adjacent to the current highwater zone, and headward migration of arroyos due to lowering base levels. A Type I arroyo is present east of the site. Although the cutbank is severely slumped, since the FY92 monitoring session, the base of the cutbank is fairly stable. Gully and arroyo cutting east of the site datum has not increased since FY92. There are no human-related impacts.

The site is being monitored by a stationary camera located on the opposite side of the river. Additionally, on-site monitoring should take place annually.

AZ C:2:35

This is a PII Anasazi site containing an extremely sparse lithic and ceramic artifact scatter with a low wall. A charcoal stain indicating a hearth is also present. The site is located in old Colorado River alluvium and covered with shallow colluvium.

FY91 Monitoring Results

Two notable gullies that border on either side of the boulder overhang are becoming more entrenched. Additionally, three or more gullies are fingering out of the midden area below the boulder overhang. Bank slumpage is present adjacent to and within the site boundary. Arroyos are just outside the site boundary, and the potential for further slope erosion is great. A single collection pile of seven flakes is in the midden area, although no trailing or historic trash is present. Annual monitoring is suggested.

FY93 Monitoring Results

The site is moderately stable in that fragile features are present but are not actively eroding. Away from the features, the site exhibits incipient erosion with surface erosion, gullyng, and arroyo cutting present. Human impacts consist of a single trail to the site, which was not noted in FY91. These impacts do not appear to be related to river fluctuations or dam operations. There is a high potential for slope erosion due to gullyng and arroyo cutting. Sherds are being washed down the gully north of the main site area. Gullyng occurs on either side of the boulder outcrop/wall area and below the wall. The few artifacts and possible charcoal-stained soil or midden area below the wall are threatened by continuing gully action. More serious undercutting of the river bank directly to the south may add to the site deterioration in the future. The wall appears unchanged from the FY91 monitoring episode. The artifact scatter in the midden area below the wall are continuing to erode downslope. Due to this erosion, it is recommended that the site be monitored annually.

AZ C:2:36

This site is an historic mining camp with a small prehistoric component, a rock alignment and hearth. The site is

on the right bank of the river on top of a Navajo sandstone terrace covered with river cobbles and fine sand.

FY91 Monitoring Results

Five arroyos are present, originating from the base of the Navajo sandstone cliff, and cutting through the site. Surface erosion is also impacting the site.

FY93 Monitoring Results

The site is stable with only punitive natural impacts effecting the features, such as sheet washing and arroyo cutting. No changes were noted to any of the features since the last monitoring episode in FY91. None of the impacts appear to be related to river fluctuations or dam operations. Since the site is stable and it does not receive visitation, it is recommended that monitoring occur every 3-5 years.

AZ C:2:38

This site is a petroglyph panel situated at the base of a vertical Navajo sandstone cliff face where it joins a fluvial terrace. There are two possible prehistoric components at this site, late Archaic and PI-PIII Anasazi.

FY92 Monitoring Results

There is heavy visitation from Wilderness River Trips tours and surface erosion is an impact to the terrace in front of the panel. New graffiti includes a "Helen" inscription on the eastern portion of the panel. Additional graffiti on the western portion of the panel is recorded. A previously incised half circle or bow has been completed since the last monitoring episode in FY91. The panel surface itself is impacted by wind, rain, and exfoliation. Retrailing, or defining the existing trail and revegetation were recommended remedial actions.

FY93 Monitoring Results

The site is stable. There is some sheet washing and wind deflation occurring to the terrace in front of the panel. Extensive trailing can be seen meandering through the tamarisks and across the terrace to the panel. Historic scratching on the panel itself, as well as the devegetation of the immediate area in front of the panel is indicative of recent human visitation. The Wilderness Rivers trips are continuing with 40,000 + visitors per year. The rock-lined trail that now leads to the panel has been kicked out and displaced, and the trail is clearly not wide enough to accommodate this number of visitors.

The dry-laid rock wall protecting the panel has been impacted by human visitation. Several of the large rocks from the top of the wall have been moved off the wall and placed on the ground. Some smaller rocks have been moved away from the wall. These impacts are not directly related to the river fluctuations or to dam operations. The site is being monitored with a stationary camera located on the opposite side of the river, and onsite annual monitoring is recommended.

Recommended Remedial Actions

An effort should be made to widen the designated trail to the panel and to obliterate the other trails that climb to the top of the terrace near the river edge. Cyclic maintenance is recommended for the rock wall.

AZ C:2:48

This is the Lee's Backbone wagon road, an historic trail built to access the ferry. The trail is located on the left bank of the river on Navajo land at the base of the Shinarump Conglomerate slope where it joins the Chinle formation.

FY91 Monitoring Results

The site condition is considered poor. It is severely eroded and often difficult to follow. Impact agents are surface erosion and gullyng.

FY93 Monitoring Results

The site is fairly stable. There is evidence of gullyng and arroyo cutting through the Shinarump Conglomerate. This erosion may threaten the wagon ruts. Evidence of human impacts since the last monitoring episode in FY91 includes graffiti on the east face of the 'E' boulder. These natural and human impacts are not related to river fluctuations and dam operations. Due to the evidence of gullyng, arroyo cutting, and new graffiti since the last monitoring episode, it is recommended that the site be monitored annually.

AZ C:2:57

This is an historic site consisting of six distinguishable structures and associated trash. It is located on the left bank of the river on Navajo land where the fluvial terrace contacts Moenkopi sandstone bedrock exposures.

FY92 Monitoring Results

There is extensive surface erosion, gullyng, minor arroyo cutting, and trailing through the site. Several gullies continue to run directly into Features 1 and 2, and a fairly active arroyo drains directly northwest of Feature 5. Also, artifacts are being washed away from the site by arroyo/gully runoff and surface erosion. The main habitation structure, Feature 2, should be stabilized soon, and all the structures should be mapped in detail. Surface collection of historic diagnostic items is also suggested. Annual monitoring is recommended.

FY93 Monitoring Results

The site is being actively eroded by surface sheet washing, gullyng, and arroyo cutting. Animal trampling through the site also occurs. While the potential for erosion due to the enlargement of gullies exists, no changes in these gullies since the FY92 monitoring episode were observed. Minimal human impacts include a trail to the east of the site that was not noted during the FY92 monitoring episode. None of these impacts are related to river fluctuations or dam operations. The historic structures are continually collapsing and should be stabilized. Mapping as a form of data recovery is recommended as well. Due to the ongoing impacts, the site should be monitored annually.

Recommended Remedial Actions

Feature 2 should be stabilized before it collapses.

AZ C:2:58

This site consists of four loci, three on the left bank on Navajo land and the fourth on the right bank. Resources include historic inscriptions, ephemeral masonry rooms, and cement cable anchors for the Bureau of Reclamation cableway on both sides of the river. The loci are located on narrow alluvial terraces and colluvial slopes above the river.

FY91 Monitoring Results

The site is being impacted by bank slumpage and arroyo cutting. One trail is present. Annual Monitoring is recommended.

FY93 Monitoring Results

Forms of erosion occurring at the loci include surface erosion, gullyng, and arroyo cutting, although there are no changes to any of the loci since the last monitoring episode in FY91. Human impacts are limited to trails on both sides of the

river. None of these impacts are related to river fluctuations or dam operations. Annual monitoring is recommended.

AZ C:2:59

This site is the Lee's Ferry gauging station on Navajo land across from Lee's Ferry. The concrete tower structure is on colluvial deposits on the edge of the river. The bottom of the gauging station is ca. 0.5 m under water.

FY91 Monitoring Results

The site is in excellent condition. The tower has incurred minimal weathering.

FY93 Monitoring Results

The site is eminently stable. Though the gauging station rests directly on the Colorado River, it does not seem threatened by the river fluctuations or dam operations. The cement tower has incurred minimal weathering. No natural or human impacts are evident. Since the site exhibits no impacts, monitoring every three to five years is recommended.

AZ C:2:60, Feature 1

Feature 1 is an historic forge and inscriptions on a Pleistocene terrace along the Stanton Road on the left bank of the river. The feature is located on Navajo land.

FY91 Monitoring Results

The east side of the feature could fail if disturbed. Wind, rain, and visitors could impact the site. There are fire scars and rearrangement of rocks, suggestive of camping. Natural impacts are considered low, and human impacts are considered high. A 1 to 3 year monitoring cycle is suggested.

FY93 Monitoring Results

The site is considered stable with only slight wind deflation occurring. Minor exfoliation of the bedrock ledges may impact the feature in the future. A trail is located just below the feature, but it is not directly impacting the feature. No new graffiti, human foot prints, or other evidence of recent human visitation is noted. Due to the stability of the site, it is recommended that it be monitored every other year.

AZ C:2:60, Feature 2

Feature 2 is a remnant masonry structure on the river edge of a narrow alluvial terrace along the Stanton Road. The feature is on the left bank of the river on Navajo land.

FY91 Monitoring Results

Bank slumpage is occurring nearby. Pre-dam floods have cut the river bank back precariously close to the structure. Some surface erosion and trailing are noted. Stabilization of the structure is recommended.

FY93 Monitoring Results

Active erosion is occurring. Pre-dam floods have cut the river bank precariously close to the structure, and fluctuating water levels may cause further bank slumpage. Surface erosion, wind deflation, and trailing also occur. There appears to be less human impacts than were observed in FY91. There is no evidence of recent human activity. Due to the possibility of continued bank slumpage, it is recommended that the structure be monitored annually.

Recommended Remedial Actions

The structure should be stabilized.

AZ C:2:60, Feature 4

Feature 4 is a stock gate located along the Stanton Road on the left bank of the river on Navajo land. The feature is on the road along a steep slope below sandstone bedrock and above the alluvial terrace.

FY91 Monitoring Results

The gate does not appear disturbed, except for some minor surface erosion, and it would probably still function with little rebuilding. The Stanton Road passes through the gate. If undercutting continues to the base of the north wall segment, it could fall off the retaining wall. Increased visitation threatens the site's integrity. Monitoring every two years is recommended.

FY93 Monitoring Results

The site is considered stable. Minor surface erosion is present eastward along the road following the bedrock bench. The stock gate is perpendicular to the road and the bench, so surface erosion may cause buildup of sediment on the upslope, or west,

side of the feature. Since the last monitoring episode in FY91, the top course rock elements on the river side of the gate have been rearranged. Wooden timbers of the gate have also been moved. Some surface erosion and trailing through the gate feature are noted impacts, which are not related to river fluctuations or dam operations. The site should be monitored annually.

Recommended Remedial Actions

The north and south wall segments of the gate should be stabilized.

AZ C:2:60, Feature 6

Feature 6 is the remains of two structures along the Stanton Road on the left bank of the river on Navajo land. The remains are located on the second terrace above the river, which is covered with sandstone boulder debris from the adjacent wash. Sandy deposits are also present. The first structure remnant includes an east wall wood log foundation. This is joined at its north end by a north wall rock foundation. Two displaced timbers are located on the inside of the L-shaped structure remnant. To the north of the L-shaped structure remnant is a scatter of large round logs with notched ends, suggestive of another structure.

FY91 Monitoring Results

The Stanton Road passes above the site, and many hikers and those who fish use the area. High flows from 1983 may have impacted the site. Surface erosion and trailing are noted impacts.

FY 93 Monitoring Results

Although the feature is in poor condition, it is stable. Trailing is the most noted impact, which is not related to river fluctuations or dam operations. Due to the trailing, it is recommended that the feature be monitored annually.

AZ C:2:60, Feature 7

Feature 7 is a series of corrals and stock pens along the Stanton Road. The feature is located on a Pleistocene terrace on the left bank of the river on Navajo land.

FY91 Monitoring Results

The structures are relatively stable. The most noted impact is trailing. Surface erosion, gullying, and arroyo cutting are incipient at this time.

FY93 Monitoring Results

The feature exhibits some incipient erosion, surface erosion and trailing. These impacts are ongoing, but there appears to be no increase since the last monitoring episode in FY91. These impacts are not related to river fluctuations or to dam operations. The site is a good candidate for instrument mapping. Monitoring is recommended every other year.

AZ C:2:60, Feature 8

Feature 8 is an historic petroglyph located on a steep Pleistocene terrace on the left bank of the river on Navajo land.

FY91 Monitoring Results

There is only slight erosion to the surface of the petroglyph panel.

FY93 Monitoring Results

The rock art element is in stable condition with no natural or human impacts evident, except for some slight surface erosion of the stone. A trail passes the glyph nearby. Feature 8 should be monitored every other year.

AZ C:2:71

This site consists of an artifact scatter and petroglyph. It is located on an alluvial terrace on the left side of the river.

FY91 Monitoring Results

Overall, the site has been heavily impacted. Locus A is impacted by humans collecting, piling, and stashing artifacts. Also, an apparent pot hole was dug at the base of the large boulder. Surface erosion is also evident. At Locus B, the anthropomorphic petroglyph panel surface is highly eroded from wind and rain. Small spalls have broken away from the cliff face on and around the figure. Monitoring for vandalism is recommended.

FY93 Monitoring Results

The site is considered to be stable. Minor impacts are restricted to surface erosion, and there is a trail nearby. The last monitoring episode was in FY91. Since then, a noted collection pile is gone. Recent trash includes one aluminum can and one plastic fork. These impacts are not related to river fluctuations or dam operations. Due to the artifact collection, monitoring should continue annually.

AZ C:2:72

This site is a prehistoric artifact scatter with associated buried hearth features. It is located on the left bank on Navajo land on the Pleistocene T-2 alluvial terrace.

FY92 Monitoring Results

Surface erosion, gullyng, arroyo cutting, and bank slumpage are all ongoing impacts. Trailing is also noted. The headward migration of arroyos is extremely active on and around the site. The main arroyo at the east-northeast site boundary drains to the Colorado River, and its mouth is not stable, it is still being impacted by fluctuating river flows. The majority of the site is highly eroded. Monitoring efforts should concentrate on the migration of side arroyos that drain into the main arroyo noted above. Annual monitoring is recommended.

FY93 Monitoring Results

The site is actively eroding. Impacts are extensive and include surface erosion, gullyng, arroyo cutting, deflation, bank slumpage, and trampling. The headward migration of arroyos is very active on and around the site. The main arroyo at the east-northeast site boundary drains to the Colorado River and its mouth is not stable. It is being impacted by fluctuating river flows. The site exhibits no human impacts. Due to the active erosion, it is recommended that monitoring continue annually.

AZ C:2:73

This is a single prehistoric petroglyph and an historic inscription situated at the base of a Navajo sandstone cliff on the left bank of the river.

FY91 Monitoring Results

Surface erosion and gullyng are noted for the terrace in front of the panel. Increased visitation threatens the site integrity.

FY93 Monitoring Results

The elements are stable. The ground surface below the element exhibits surface erosion, gullyng, and trampling. These are not the result of river fluctuation or dam operations. No human impacts are noted. No features or artifacts were noted on the heavily vegetated terrace surface; it is unknown if artifacts are present. The rock art is well hidden from view, and since it is stable, monitoring should be conducted every 2 years.

AZ C:2:75

This is a prehistoric camp and artifact scatter located on the alluvial terrace at the base of the Navajo sandstone cliff on the left bank of the river.

FY92 Monitoring Results

Surface erosion, gullyng, and arroyo cutting are noted impacts actively eroding the site. Since the FY91 monitoring episode, additional undermining and surface erosion has occurred below Locus B. A fresh single set of foot prints is noted. A very large arroyo is impacting the site. Major undercutting and washing away of artifacts has occurred since the last monitoring episode in FY91. Annual monitoring is recommended.

FY93 Monitoring Results

The site is actively eroding. Surface erosion, gullyng, arroyo cutting, wind deflation, bank slumpage, and dune migration are evident. These impacts are directly related to river fluctuations and dam operations. A deep arroyo continues to cause heavy impact with major undercutting of the terrace bank, which has caused the loss of most of the site. Slickrock runoff from the side canyons is impacting the site as well. There are no human impacts. Due to the erosional threats prevalent, the site should be monitored annually.

AZ C:2:76

This is a single slab-lined hearth with an associated artifact scatter located on the left bank of the river on Navajo land. The site is located on top of a sandy alluvial terrace near the base of Navajo sandstone cliffs.

FY91 Monitoring Results

Arroyo cutting and bank slumpage have impacted the site indirectly. Potential impact is possible because the site is buried in or located on old river alluvium. Surface erosion and

gullying are noted. Human impacts include trailing, fire scars, and recent trash. The site should be monitored periodically to check for newly exposed cultural materials.

FY93 Monitoring Results

The site exhibits some impacts from surface erosion and gullying. A small gully 6 m to the northeast of the site runs north to the drainage down Waterholes Canyon, thence to the Colorado River. Extreme fluctuations in flows may result in impacts from arroyo cutting and bank slumpage. Human impacts include trailing near the site. The last monitoring episode in FY91 noted modern campsite remains and trash nearby. These impacts were not observed in FY93. There is no evidence of human visitation. The hearth is intact with vegetation growing from the center. Due to the sensitive nature of this feature, it should be monitored annually.

AZ C:2:77

This prehistoric artifact scatter on the left bank of the river is spread over the first alluvial terrace and is eroding from the cutbank of the second alluvial terrace.

FY91 Monitoring Results

Gullying is occurring along the terrace edge, and one arroyo is present 50 m south of the site. The terrace slope is eroding from sheetwashing and human foot traffic. No trails are present at this time, just random foot prints. Gullying from heavy runoff will cause the terrace margin to retreat. Continued monitoring is suggested.

FY93 Monitoring Results

Minor impacts are caused by surface erosion and gullying, wind deflation and bank slumpage. There is recent camper trash. The impacts are not related to river fluctuations and dam operations, and they are not new since the last monitoring episode in FY91. The site should be monitored annually.

AZ C:2:81

This is a prehistoric artifact scatter buried in the uppermost alluvial terrace on the left bank of the river. Artifacts are exposed along the visitor trail to AZ C:2:38.

FY91 Monitoring Results

Heavy visitation has caused severe surface erosion all along the trail on the upper terrace. The trail is 10-50 cm below the natural grade. The site is indirectly impacted by changing river runner and visitor use patterns. Continued use of the trail will cause continued deflation. Periodic monitoring is suggested.

FY93 Monitoring Results

Natural impacts include surface erosion and wind deflation. Human impacts have caused a deeply eroding trail that is increasingly exposing the site. The trail leads to AZ C:2:38, the large petroglyph panel just downstream. In places, this trail is 70 cm deep. Since the last monitoring episode in FY91, maintenance crews lined the trail with a rock boundary to help direct visitor traffic to the petroglyph site. None of the impacts appear to be related to river fluctuations or dam operations. This site is impacted by foot traffic from 40,000 visitors per year. Continued exposure of artifacts and buried components is likely. The site should be tested to determine the nature and extent of the buried deposits and developed for public interpretation. Due to the amount of visitation, the site should be monitored biannually.

AZ C:2:82

This prehistoric rock shelter with associated masonry wall and artifact scatter is located in a small overhang of Navajo sandstone adjacent to the first alluvial terrace above the river. The site is on the left bank of the river on Navajo land.

FY92 Monitoring Results

Impacts include surface erosion, gullying, arroyo cutting, bank slumpage, and trailing. A 2-3 year monitoring cycle is recommended.

FY93 Monitoring Results

Natural impacts include surface erosion and trailing through the site. The deepening and widening of arroyos from side canyon flooding is a possible threat. The trailing appears to have dwindled since the last monitoring episode in FY92. These impacts are not related to river fluctuations or dam operations. The site should be monitored annually to record continuing impacts.

AZ C:2:83

This is a prehistoric artifact scatter with associated hearth located on the left bank of the river on Navajo land. The remains are on a talus slope at the base of the Shinarump Conglomerate above the fluvial terrace.

FY91 Monitoring Results

This area has seen much activity in the last century, including construction activity associated with Lee's Ferry, the dugway road, and a gauging station. Hikers and those who fish trail through the site as well. An arroyo is on the south end of the site, and surface erosion is extensive. A cutbank is on the eastern side of the site. The exposed surface hearth will continue to erode. Annual monitoring is suggested.

FY93 Monitoring Results

Natural impacts include surface erosion, arroyo cutting, trampling and trailing through the site. A Type I arroyo is below and northwest of the artifact scatter. Its continued erosion will eventually cut into the scatter, but surface erosion will displace the surface expression of the site prior to that. Continued use of the trail to the USGS gauging station is noted. The hearth has been extensively impacted by trampling. It is a light charcoal stained lens of sand. Three small flecks, but no chunks, of charcoal were noted. These impacts are not related to river fluctuations or dam operations. Annual monitoring is suggested.

AZ C:2:84

This prehistoric site consists of a shallow overhang with a collapsed wall, a midden, and artifact scatter located at the base of a Navajo sandstone cliff face above an alluvial terrace. The site is on the right bank of the river.

FY91 Monitoring Results

Surface erosion is impacting the midden, and one gully and one arroyo are developing. Human visitation is evident from trailing and recent trash. One small collector's pile of lithic artifacts is noted. A 3-5 year monitoring cycle is recommended.

FY93 Monitoring Results

The site is actively eroding; gullying, wind deflation, and surface erosion are the primary impacts. Human impacts include a collection pile, the same one noted in FY91. A distinct trail recorded during the FY91 monitoring episode was not present

during this monitoring episode. These impacts are not related to river fluctuations or dam operations. Due to the ongoing impacts, the site should be monitored annually.

AZ C:2:86

This prehistoric site consists of a cist, a masonry wall, and artifact scatters located on the left bank of the river on Navajo land at the mouth of Fall Canyon. The remains are on a sandy alluvial terrace next to an arroyo and under an outcropping bedrock ledge.

FY91 Monitoring Results

Surface erosion is the most predominant impact, the features and artifacts are exposed from downslope sheetwashing. Trailing through the site is also displacing artifacts and causing erosion. Bank slumpage and arroyo cutting are impacting the site indirectly. Monitoring is recommended.

FY93 Monitoring Results

The site is being actively eroded by gullying, arroyo cutting, wind deflation, dune migration, trailing, and trampling. These impacts do not appear to be related to river fluctuations or dam operations. Bank slumpage from side canyon flooding is a definite threat, and the deepening and widening of arroyos from side canyon flooding is occurring at this time. Due to the impacts occurring at the site, it should be monitored annually.

AZ C:2:87

This site consists of historic and modern artifacts and the remains of a tower located on the alluvial terrace on the left bank of the river on Navajo land.

FY91 Monitoring Results

Wind deflation is impacting the northeast end of the site, and one arroyo is cutting the southwest side. The site is visited by boaters and those who fish, and it should be monitored regularly to determine if objects are being collected by visitors. The arroyo on the south side of the site should be checked to see if it is impacting the artifact concentration.

FY93 Monitoring Results

Minor impacts include surface erosion, arroyo cutting, and wind deflation. These impacts do not appear to be related to river fluctuations or dam operations. No human impacts are

noted. Previous recommendations suggest regular monitoring to determine collection practices of visitors. The results of this monitoring session concur with that recommendation, specifically, the site should be monitored annually.

AZ C:2:90

The site consists of a group of massive sandstone boulders under which were built prehistoric dry-laid structures, a few petroglyphs, and a ceramic artifact scatter. The remains are located at the base of the Chinle Formation overlooking a narrow alluvial terrace on the left bank of the river on Navajo land.

FY91 Monitoring Results

The site is poorly preserved and exhibits spalling of the petroglyph panel surface, trailing, and modern camping evidence including fire scars and recent trash. The Stanton Road is nearby. Periodic monitoring is suggested.

FY93 Monitoring Results

Minor natural impacts include surface erosion, gullying, wind deflation, trampling, and trailing. The Stanton Road is just downslope from the site, and modern fire scars indicate camping nearby. These impacts are consistent with FY91 observations, and they do not appear to be related to river fluctuations or dam operations. Exposure and destabilization of the features by visitation is a definite threat. Therefore, it is recommended that the site be monitored annually.

AZ C:2:91

This prehistoric site consists of two loci of charcoal lenses and an associated artifact scatter located on top of an alluvial terrace. It is located on the left bank of the river on Navajo land.

FY91 Monitoring Results

Current site impacts include one minor trail leading down river to Waterholes Canyon and a 6 m deep arroyo eroding through the charcoal lenses. A 5 year monitoring schedule is suggested to record other features or structures that might be exposed in the arroyo.

FY93 Monitoring Results

The site is split by a Type I arroyo. Natural impacts are extensive and include arroyo cutting, gullying, surface erosion,

wind deflation, and bank slumpage. An ephemeral game-foot trail is present, little use is noted. These impacts do not appear to be related to river fluctuations or dam operations. However, bank slumpage and deepening and widening of the arroyo from side canyon flooding is actively occurring at this time. This is causing exposure and destabilization of the charcoal lenses and artifacts present. Annual monitoring of the collapsing arroyo banks is suggested.

AZ C:2:95

This prehistoric site consists of a small rockshelter at the base of a low Shinarump Conglomerate cliff with an associated artifact scatter eroding down an ephemeral drainage below the shelter. The site is on the right bank of the river.

FY92 Monitoring Results

Gullying, surface erosion, and animal burrowing are noted natural impacts. No significant changes are evident from the FY91 monitoring episode. Human impacts include two nearby trails and the rearrangement of rocks. A 2-3 year monitoring cycle is recommended.

FY93 Monitoring Results

Natural impacts include gullying, animal burrowing, wind deflation, and surface erosion. These impacts are not related to river fluctuations or dam operations. The degree of human impact appears unchanged since the FY92 monitoring episode. Due to the possible exposure and destabilization of features and artifacts from the continued erosion of the ephemeral drainage and possible visitation, the site should be monitored annually.

AZ C:2:99

This site has both prehistoric and historic components, artifact scatters and a rock alignment, located on a sandy dune above a flood plain. The remains are on the left bank of the river on Navajo land.

FY91 Monitoring Results

Eolian deflation is a major impact. Artifacts are exposed and buried quickly. A gully passes by the rock alignment, but is not directly impacting it. Eolian deflation/deposition will continue. The site should be monitored for newly exposed artifacts and features.

FY93 Monitoring Results

Several ephemeral drainages are present. Natural impacts include surface erosion, wind deflation, and gullyng. A distinct trail passes nearby. Since the last monitoring episode in FY91, one rock near a metate is newly exposed due to eolian deflation. The site should be monitored annually to document the possible exposure of buried materials and destabilization from wind deflation and visitation.

AZ C:2:100

This is a prehistoric site consisting of buried charcoal features and artifact scatters located on an alluvial terrace. The remains are on the left side of the river on Navajo land.

FY92 Monitoring Results

Surface sheetwashing, arroyo cutting, gullyng, and bank slumpage are impacting the charcoal features and artifacts. A gear and a bicycle frame have been plotted on a revised site map. Artifacts are expected to move downslope. The site is being monitored by stationary camera, and on-site monitoring is recommended annually.

FY93 Monitoring Results

The site is actively eroding from side draining Type I arroyos. Natural impacts include arroyo cutting, gullyng, surface erosion, wind deflation, and bank slumpage. These impacts appear to be related to river fluctuations and dam operations, based on headward migration of arroyos due to the lowering of the base level. Trampling and trailing through the site also occurs. The arroyo cut is being monitored by a stationary camera, and annual on-site monitoring is also recommended.

AZ C:2:106

This prehistoric site consists of a roasting feature and associated artifact scatter located near the base of a dune on an alluvial terrace. This roaster is the only feature of its kind between Glen Canyon Dam and the Paria Riffle. Colluvial debris from a nearby Navajo sandstone cliff is also present. The site is on the left bank of the river on Navajo land.

FY92 Monitoring Results

Surface erosion and trampling are noted impacts. A 2-3 year monitoring schedule is recommended.

FY93 Monitoring Results

Natural impacts include surface erosion and trailing through the site. These impacts do not appear to be related to river fluctuations or dam operations. Due to the possible exposure and destabilization of the feature and artifacts from erosion and trailing, the site should be monitored annually.

AZ C:3:3

This is the trail built during the time of the construction of Glen Canyon Dam as part of the development plan for a proposed marina below the dam site. The route is on the right bank of the river.

FY91 Monitoring Results

Some surface erosion, gullyng, and arroyo cutting is noted along with some collapse of the retaining walls. Culverts are exposed in several places.

FY93 Monitoring Results

Natural impacts include surface erosion, gullyng, and arroyo cutting. The top of the stairway has been eroded by alluvial forces and talus slope wash. Culverts are exposed in several places. Stone elements of the trail retaining walls have been misplaced. A rockslide has taken out a portion of the trail. Bank slumpage and deepening and widening of arroyos from side canyon flooding is actively occurring. Little or no change is noted on the photographic records from FY91. These impacts are not related to river fluctuations or operations of the dam. There are no human impacts. Recommendations include stabilizing the remaining retaining walls as needed and continued annual monitoring.

Recommended Remedial Actions

The retaining walls should be stabilized as needed.

AZ C:3:10

This prehistoric site includes a hearth with charcoal staining and associated artifact scatter. It is located on top of a dune remnant that caps an alluvial terrace on the left side of the river.

FY92 Monitoring Results

Surface erosion, gullyng, and arroyo cutting are impacting the entire site, and runoff is impacting the hearth. Artifacts southwest of the site are eroding down the terrace slope. Annual monitoring is recommended.

FY93 Monitoring Results

The terrace is being dissected by arroyos. Extensive natural impacts include surface erosion, gullyng, arroyo cutting, and wind deflation. These impacts are probably related somewhat to river fluctuations, i.e., direct inundation of the site has probably occurred, but the site is threatened more by surface erosion and eolian deflation than by dam operations. Since the last monitoring episode in FY92, no further disturbance to the metate is noted. The charcoal lens exposed in the cutbank is eroding and getting smaller. A system of trails is nearby, and foot prints were noted on site. Human visitation has increased since the FY92 monitoring episode. It is recommended that the site be monitored annually to record further degradation.

IV. FY93 SUMMARY

The FY91 cultural resources survey and monitoring data recovered along the Colorado River corridor serve as the baseline for comparison for subsequent monitoring results. These baseline data and the monitoring program from FY92 are briefly summarized to provide context for the FY93 monitoring program, which is presented in detail.

Five major tasks for the FY93 monitoring program included 1) continuation of on-site monitoring of erosion and human impacts; 2) continuation of the terrestrial photogrammetry; 3) collection and analysis of radiocarbon and paleoethnobotanical samples from site C:3:10; 4) determine the cfs flow required to keep the keel of the Spencer Steamboat completely submerged, and conduct photographic recording of known cfs flow rates there; and 5) establish and update the GCES data base for the monitoring locations in Reach 0 from the Glen Canyon Dam to the Paria Riffle. Criteria for site selection, field and laboratory methods, on-site monitoring activities, documentation procedures, natural and human impacts evaluation, and the terrestrial photography program are outlined. This summary lists recommended remedial actions and presents some trends in impacts at the sites. Recommendations for the FY94 monitoring program are presented, and an assessment of the monitoring program is offered.

Summary of Recommended Remedial Actions

As of FY93, remedial actions have been suggested for seven sites. Actions include stabilizing retaining walls and structural elements, widening a trail, and extending the no-wake zone around the Lee's Ferry boat launch to include the Spencer Steamboat. These are outlined as follows:

- AZ C:2:11, Feature 12 Recommendations for best preserving the steamboat are extending the no-wake zone around the Lees Ferry boat launch area to incorporate the Spencer, and keeping the vessel underwater at all times. An "ideal" flow of 12,000 cfs or higher would accomplish the latter recommendation.
- AZ C:2:12 The retaining walls should be stabilized.
- AZ C:2:38 An effort should be made to widen the designated trail to the panel and to obliterate the other trails that climb to the top of the terrace near the river edge. Cyclic maintenance is recommended for the rock wall.
- AZ C:2:57 Feature 2 should be stabilized before it collapses.
- AZ C:2:60, Feature 2 The structure should be stabilized.
- AZ C:2:60, Feature 4 The north and south wall segments of the gate should be stabilized.
- AZ C:3:3 The retaining walls should be stabilized as needed.

Overall Trends in Site Impacts

The FY93 program resulted in 38 monitoring locations being inspected, 26.32% (N=10) exhibiting no erosion, 31.58% (N=12) exhibiting incipient erosion, and the remaining 42.10% (N=16) exhibiting active erosion. Natural impacts include surface erosion, gullies, arroyo cutting, bank slumpage, wind deflation, dune migration, trampling/trailing, and animal burrowing. Human impacts of concern include collection piles, trailing, on-site camping, and vandalism.

Of the 13 sites/features monitored during both FY92 and FY93, 61.54% (N=8) are still actively eroding, 30.77% (N=4) still

exhibit incipient erosion, and 7.69% (N=1) is stable. These figures suggest there was no change in the stability of these 13 monitoring locations between FY92 and FY93.

Table 2 is a cross tabulation of site stability verses the presence/absence of structures. The table suggests there is no apparent difference in the stability of sites containing structures and those without structures.

Table 2. Cross tabulation of stability verses presence/absence of structures, frequency/percent.

Site Stability	Presence of Structures	Absence of Structures	Totals
Stable	5/13.16	5/13.16	10/26.32
Incipient Erosion	5/13.16	7/18.42	12/31.58
Active Erosion	9/23.68	7/18.42	16/42.10
Totals	19/50.00	19/50.00	38/100.00

Table 3 is a cross tabulation of stream type versus site stability. Of the 38 monitoring locations inspected in FY93, 39.47% (N=15) have Type I streams associated, streams that drain all the way to the Colorado River. Three of these sites with associated Type I streams are stable, three exhibit incipient erosion, and nine are actively eroding. Type I streams have the lowest effective base level, and their erosion is indirectly linked to regulated flows, and therefore, the operation of Glen Canyon Dam.

Table 3. Cross tabulation of stream type versus site stability, frequency/percent.

Stream Type	Stable	Incipient Erosion	Active Erosion	Totals
Type I	3/7.89	3/7.89	9/23.69	15/39.47
Type II	1/2.63	6/15.79	4/10.53	11/28.95
Absent	6/15.79	3/7.89	3/7.89	12/31.58
Totals	10/26.32	12/31.57	16/42.11	38/100.00

Of the 38 monitoring locations inspected, 28.95% (N=11) are associated with Type II streams (Table 3). One of the sites is stable, another six exhibit incipient erosion, and four are actively eroding. Erosion of Type II streams has no relation to regulated flows since they do not reach the River, rather their effective base level is usually well above the river emptying onto a higher terrace. Both types of streams adversely impact archaeological sites, however.

Is there a relationship between stream type and the kinds of erosion impacting the sites? Table 4 is a cross tabulation of stream type versus surface erosion, and Table 5 is a cross tabulation of stream type versus gullying. These tables suggest that surface erosion and gullies affect sites associated with Types I and II streams equally.

Table 4. Cross tabulation of stream type versus surface erosion, frequency/percent.

Stream Type	Surface Erosion Present	Surface Erosion Absent	Totals
Type I	13/34.21	2/5.26	15/39.47
Type II	11/28.95	0/0.00	11/28.95
Absent	6/15.79	6/15.79	12/31.58
Totals	30/78.95	8/21.05	38/100.00

Table 5. Cross tabulation of stream types versus presence/absence of gullies, surface cuts between 10 and 100 cm deep, frequency/percent.

Stream Type	Gullies Present	Gullies Absent	Totals
Type I	9/23.68	6/15.80	15/39.48
Type II	9/23.68	2/5.26	11/28.94
Absent	3/7.89	9/23.68	12/31.58
Totals	21/55.25	17/44.74	38/100.00

Table 6 is a cross tabulation of stream type versus presence/absence of arroyos. Type I streams are more commonly arroyos than smaller surface cuts such as gullies. Table 7 is a cross tabulation of stream type versus bank slumpage. The table shows that bank slumpage is more commonly associated with Type I streams than Type II streams, and this impact does not appear to occur that often, but when it does, extensive amounts of terrace deposits are lost.

Table 6. Cross tabulation of stream type versus presence/absence of arroyos, surface cuts greater than 100 cm deep, frequency/percent.

Stream Type	Arroyos Present	Arroyos Absent	Totals
Type I	11/28.95	4/10.53	15/39.47
Type II	4/10.53	7/18.42	11/28.95
Absent	2/5.26	10/26.32	12/31.58
Totals	17/44.74	21/55.26	38/100.00

Table 7. Cross tabulation of stream type versus presence/absence of bank slumpage, frequency/percent.

Stream Type	Bank Slumpage Present	Bank Slumpage Absent	Totals
Type I	6/15.79	9/23.68	15/39.47
Type II	2/5.26	9/23.68	11/28.95
Absent	1/2.63	11/28.95	12/31.58
Totals	9/23.68	29/76.32	38/100.00

A major concern involves the monitoring of sites/features on/in Colorado River fluvial deposits since these are directly affected by stream flows. Table 8 is a cross tabulation of site location versus stream type. The number of sites located on or buried in Colorado River fluvial deposits are equally associated with Types I and II streams, suggesting these two stream types affect sites on/in Colorado River fluvial deposits equally.

Table 8. Cross tabulation of site/feature location verses stream type, frequency/percent.

Site/Feature Location	Type I Streams	Type II Streams	Absent	Totals
On Colorado River Fluvial Deposits	11/28.95	10/26.32	5/13.16	26/68.42
Not on Colorado River Fluvial Deposits	4/10.53	1/2.63	7/18.42	12/31.58
Totals	15/39.47	11/28.95	12/31.58	38/100.00

FY94 Monitoring Program

It is recommended that all 69 monitoring locations be inspected for natural and human impacts in FY94 so that at least one monitoring record is available for comparison with the original data recovered during FY91. With at least two monitoring records for each location, trends in ongoing impacts can be established. It is these trends that are upon which future monitoring schedules should be based.

It is anticipated that beginning in FY95, recommendations for subsequent monitoring schedules will be adhered to, with some flexibility in cases of impacts to sites from intense local impacts such as seasonal monsoon rains and debris flows caused by them.

The 69 monitoring locations could be inspected in approximately 12 single day trips from below Glen Canyon Dam to the Paria Riffle. The terrestrial photogrammetry program will continue at two sites. Photographic documentation of the erosion of alluvial terraces will involve film retrieval and replacement every 34 days.

Monitoring Program Assessment

The FY93 GCES monitoring program within Glen Canyon NRA is completed. At the end of the FY93 program, 126 monitoring episodes have been conducted at the 69 locations from Glen Canyon Dam to the Paria Riffle. One monitoring episode has been conducted at 24 sites, 2 episodes have been conducted at 33 sites, and 3 episodes have been conducted at 12 sites. This suggests fairly comprehensive monitoring coverage during the first three years of the ongoing monitoring program. The FY94 monitoring program will help to fill the holes in the data base at the 24 sites that have only one monitoring record.

Since the monitoring program began in FY91, field logistics have been modified to optimize the time spent on the river, while recording methodologies have been adjusted to obtain the most important and interesting data on natural and human impacts present.

FY93 Monitoring Summary

Baseline data from the FY91 inventory and the FY92 monitoring program are briefly summarized to provide context for the FY93 monitoring program, which is presented in detail. Site-specific results of the FY93 monitoring effort and results from the last monitoring effort are provided to illustrate the ongoing natural and human impacts. Recommendations for remedial actions at seven sites and future monitoring efforts for all sites inspected are suggested. On a regional basis, the overall trends and relationships between several environmental and impact variables are explored.

V. REFERENCES CITED

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United States Department of the Interior

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Memorandum

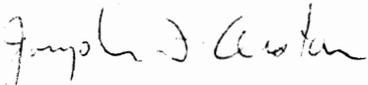
To: All on enclosed list

From: Superintendent, Glen Canyon National Recreation Area (NRA)

Subject: Glen Canyon Environmental Studies (GCES) FY93 Summary of
Archaeological Monitoring in Glen Canyon National Recreation Area

Enclosed is the Final Summary Report for the Glen Canyon NRA FY93 GCES Monitoring of Archaeological Sites From Glen Canyon Dam to the Paria Riffle. Any further modifications in format will be implemented in the FY94 Summary Report.

Please contact Tim W. Burchett of this office at 602-645-8278 if you have any questions.


Joseph F. Alston

Enclosure

