1999 Summary Report: Archaeological Site Monitoring and Management Along the Colorado River Corridor in Grand Canyon National Park

SUBMITTED BY
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EXECUTIVE SUMMARY

In the winter of 1982-83, there was an especially wet winter in the upper basin of the Colorado River, resulting in high snowpack levels that potentially would translate into greatly increased flows in the river. This potential was realized when late winter and early spring storms added to the snowpack and increased the volume and rate of runoff from the mountains into the river. The result was that Lake Powell began to fill at an alarming rate, and Reclamation was forced to release an unprecedented volume of water, up to 93,000 cubic feet per second (cfs) from Glen Canyon Dam. This unanticipated event accelerated awareness of Dam operations and their potential effects on downstream cultural resources.

The result was that a number of archaeological sites located within the Glen Canyon National Recreation Area and the Grand Canyon National Park were either freshly exposed by the clear-water flow, or were eroded and damaged by the water. GRCA personnel did initial documentation of the effects of the 1983 flood during the fall of 1983 (Balsom 1984). It was realized that cultural resources might be more abundant in the river corridor than previously assumed (including substantial habitation sites below the historic high-water marks of the river), and that Dam operations might have substantial adverse effects on such resources. Scientific studies of cultural resources obviously were needed to document the nature and scope of such potential effects.

During the 1980s, other factors promoted an increased awareness of the presence of cultural resources in the river corridor, and the potential effects of the Glen Canyon Dam on these resources. One of the factors was a growing concern among a number of constituencies regarding the practice of increasing the amount of water released from the Glen Canyon Dam to coincide with peak demands for the electrical power generated by the dam. As a hydroelectric dam, it is possible for operators of Glen Canyon Dam to time water releases so that more water is released, and thus more electricity generated, during times of highest regional power demand. These water releases, however, created unpredictable surges and drops in the river that were of great concern to a number of resource managers, environmental groups, commercial interests, Indian tribes, and others. An outcome of these expressed concerns was the creation by Reclamation of the Glen Canyon Environmental Studies (GCES) program, designed to study the effects of low and fluctuating river flows on a variety of natural resources downstream from the Glen Canyon Dam. These studies were also necessitated by a planned uprating and rewinding of the generators of the Glen Canyon Dam, which would have the effect of increasing the power generating capacity of the dam. Hence, in the early 1980s it was realized that scientific studies were needed to assess the effects of Glen Canyon Dam on downstream resources, especially regarding the issue of fluctuating flows. Cultural resources were not initially included in the list of affected resources, but a new paradigm of scientifically assessing the effects of the Dam had been created. This was an essential step toward allowing studies of cultural resources to be incorporated at a later date.

One of the first of these investigations took place in the late 1980s as a collaborative pilot study involving NPS and the U.S. Geological Survey (USGS). This study focused on only one site along the Colorado River, but its results suggested that the operation of the dam might indeed be contributing to the deterioration of archaeological sites elsewhere along the river corridor (Balsom, et al. 1989).

In July 1989 Secretary of the Interior Manuel Lujan directed Reclamation to prepare an Environmental Impact Statement (EIS) regarding the operation of the Glen Canyon Dam. Thus, more than a quarter-century after the floodgates of the dam closed, its environmental effects were to be judged scientifically. Under the National Environmental Policy Act of 1969, which authorizes the EIS process, cultural resources are an aspect of the environment worthy of study and consideration, just as are natural resources. The EIS for Glen Canyon Dam operations therefore mandated scientific studies of cultural resources within the area potentially affected by water releases. Further Glen Canyon Dam operations are considered a federal undertaking that either directly, indirectly or potentially affect cultural resources.

Acknowledgement of this enacts the National Historic Preservation Act of 1992 (amended) (NHPA). Under Section 106 of this act Reclamation is responsible for the impacts to cultural resources caused by dam operations and NPS is dually responsible for these cultural resources under Section 110.

In a joint venture, Reclamation and NPS decided that the first step in the EIS process with respect to cultural resources was to conduct an intensive inventory of archaeological sites in the river corridor. The area surveyed encompassed a 255-mile stretch of the river corridor, extending from Glen Canyon Dam to Separation Canyon. The vertical extent of the survey area was the riverine environment that incorporated all terrestrial river-derived sediments below the estimated 300,000 cfs level, as well as a few areas of eolian sand dunes lying slightly above this level. The estimated 300,000 cfs level was considered an approximation of the pre-dam flood terraces and was not considered an absolute number representing an exact elevation.

The survey was conducted from August 24, 1990 to April 30, 1991. During this time some 1,968-person days were spent surveying about 10,506 acres. The primary goal of site inventory was accomplished, with a total of 475 archaeological sites and 489 isolated occurrences of artifacts or features located and recorded. This total included 118 sites that were previously located and recorded, but it also included 357 newly discovered sites. Regarding the impacts of Dam operations on archaeological sites, it was judged initially that 336 of the 475 recorded sites existed in locations that could potentially be adversely affected by changing water releases. Of the 336 sites potentially affected to Dam operations, it was proposed that 322 of these were potentially eligible for the National Register of Historic Places. Since 1992, the cultural monitoring personnel have been able to refine site impact categories identified by Fairley et al. (Fairley, et al. 1994). To date, 264 sites are considered affected by the operations of Glen Canyon Dam. Any site types with a roasting or thermal feature make up the majority (46%) of the properties monitored along the river corridor. The remaining property types such as small structures, pueblos and historic structures represent 20% or less.

It is sufficient to note that the cultural monitoring program has operated from its inception within a complicated framework of laws, regulations, and other directives that are not always in accord with one another. At times, there has been an inherent conflict between complying with the provisions of Section 106 of NHPA (mitigating the effects of a Federally sponsored undertaking), while at the same time recognizing and adhering to long-standing NPS policies (i.e., Section 110 of NHPA) regarding the "preservation-in-place" of cultural resources.

Therefore, a crucial document created to guide Reclamation's Section 106 compliance in conjunction with other NPS legal mandates is the 1994 Programmatic Agreement (PA). This PA, regarding the operation of the Glen Canyon, was signed by officials of the U.S. Bureau of Reclamation (Reclamation), the Advisory Council on Historic Preservation (ACHP), the Arizona State Historic Preservation Officer (SHPO), the U.S. National Park Service (NPS), and six Indian Tribes and Nations -- the Hopi Tribe, the Hualapai Nation, the Kaibab Paiute Tribe, the Navajo Nation, the Paiute Indian Tribe of Utah for the Shivwits Paiute Tribe, and Zuni Pueblo -- with an interest in the affected cultural resources listed on the National Register of Historic Places. Implementation of this agreement fulfills Reclamation's responsibilities for Section 106 of NHPA relative to Glen Canyon Dam operations and also satisfies NPS needs.

The PA outlines the responsibilities of Reclamation for the mitigation of these adverse effects under Section 106 of NHPA, spelling out the responsibilities of the RCMP as follows:

> The purpose of the Monitoring and Remedial Action Plan shall be to generate data regarding the effects of Dam operations on historic properties, identify ongoing impacts

> to historic properties within the APE [Area of Potential Effect], and develop and implement remedial measures for treating historic properties subject to damage.

Currently, all work conducted by cultural monitors has been completed under stipulations in the Monitoring and Remedial Action Plan (MRAP). Until a final Historic Preservation Plan is completed (HPP), as outlined in the PA, the processes delineated in the MRAP guide the ongoing process for the identification, monitoring, and remedial actions on cultural resources impacted, or potentially impacted, as a result of the operations of Glen Canyon Dam.

The PA identifies more than 300 National Register eligible properties within the APE that are potentially subject to monitoring and remedial action. (This has since been reduced to 264 sites within GRCA.) The PA also recognizes that additional identification and evaluation of properties should take place within the APE, and it directs Reclamation and NPS to conduct appropriate studies to identify Traditional Cultural Properties within the APE.

The PA ratifies a number of important issues relevant to Section 106 compliance. Among these, it states that the legal authority for the PA derives not only from NHPA, but also from the Secretary of the Interior's directive to prepare an EIS for the operation of the Glen Canyon Dam, and the language in the Grand Canyon Protection Act of 1992 ordering continued monitoring and management of resources within the area of the dam's effects. The PA also states that Reclamation is the lead agency for Section 106 compliance regarding the impacts of Glen Canyon Dam, and it notes that Reclamation has acknowledged potential adverse effects on cultural resources from dam operations. The PA declares further that "given their mutual responsibilities [Section 106 and Section 110 of NHPA, respectively], Reclamation and the NPS have determined to coordinate their respective roles in the management and consideration of historic properties which may be affected by the Program [i.e., operation of the Glen Canyon Dam]." In 1992 GRCA contracted with NAU to conduct the joint Reclamation-NPS (GRCA) project referred to as the RCMP. The administrative structure for the RCMP is established by a cooperative agreement between GRCA and NAU. This agreement provides the framework by which the National Park Service at Grand Canyon contracts with NAU to conduct the RCMP as a collaborative venture.

It is clear that the RCMP is unusual and cannot be considered a routine Section 106 compliance project. This project is considerably more complex than most Section 106 actions. This is because of the various legal requirements that guide the specifics of Section 106 compliance in this instance (e.g., the EIS, the ROD, and the GCPA), and because compliance is sought by one agency (Reclamation) within the jurisdiction of a second agency (NPS) bound by stringent preservation requirements. This theme -- the tension between a traditional model of Section 106 compliance, and the obligation to preserve the unique, highly significant, and fragile cultural resources of Grand Canyon National Park (GRCA) -- will surface repeatedly in subsequent chapters of this report.

All monitoring and remedial efforts pursued under the PA are subject to approval by the PA signatories. All proposed efforts must also comply with Wilderness Act requirements due to the proposed wilderness area designation of the Colorado River in the Grand Canyon. Remedial efforts are to be recommended by NPS and Reclamation on a site-specific basis in consultation with SHPO and Tribes that have signed the PA. Since its inception the RCMP has operated in a framework of intensive tribal consultation. Tribal concerns have been incorporated into the project in multiple ways, ranging from determination of monitoring schedules to proposed remedial actions.

The existence and significance of each tribe's traditional cultural properties (TCPs) have been documented through intensive ethnographic research (Ferguson 1998, Hart 1995, Havatone 1992, Hualapai 1992, Masayesva 1992, Roberts, et al. 1995, pg. 22, Secakuku 1997, Stevens 1996, Stoffle, et al.

1994). Tribes affiliated with or having an interest in river corridor sites have indicated that the entire Grand Canyon is crucial to maintaining the cultural identity of each tribe's community. The tribes have endorsed the long-term monitoring and preservation of archaeological sites in the River Corridor due to the accelerated erosion caused by dam operations (Ferguson 1998, Hart 1995, Roberts, 1995 #262, pg. 22, Secakuku, 1997 #259, Havatone 1992, Hualapai 1992, Masayesva 1992, Stevens 1996, Stoffle, et al. 1994).

The tribes have also stated their position when dealing with properties that have religious or cultural significance (Ferguson 1998, Hart 1995, Hualapai 1992, Masayesva 1992, Roberts, et al. 1995, Secakuku 1997, Stevens 1996, Stoffle, et al. 1994). The preferred actions are preservation measures and continued long-term monitoring of the resources. The consultation process has indicated that the tribes have certain TCPs that are off limits to any mitigation measures, but these are clearly identified in tribal reports and do not include most of the archaeological sites (Ferguson 1998, Hart 1995, Hualapai 1992, Masayesva 1992, Roberts, et al. 1995, Secakuku 1997, Stevens 1996, Stoffle, et al. 1994). Overall, the tribes maintain that mitigation should be performed due to the adverse effects of man-made disturbances caused by Glen Canyon Dam. If the physical erosion were entirely a natural process at these sites then the tribes would feel much differently about mitigation options.

With the passage of the GCPA in 1992, cultural resources staff at GRCA-NAU were presented with a considerable challenge. Law now mandated monitoring of cultural resources, yet there were virtually no precedents to be found anywhere in the world regarding reliable methods for monitoring the condition of archaeological sites through time, especially within a legal framework that involved multiple agencies, Indian tribes, and uncertainties regarding the potential effects of human-induced hydrological regimes. Historically, there has been very little attention to systematic, detailed monitoring of the condition of archaeological sites anywhere in the world (Downum, et al. 1997).

The RCMP thus embarked on its monitoring program fully aware that its efforts would be experimental in many respects, and that much would be learned as the project progressed. According to J. Kunde (Kunde 1999a) efforts at monitoring cultural resources are primarily limited to short-term programs, and previous monitoring programs for federal agency resource management have no guidelines for implementing monitoring protocols. Furthermore, several programs gathered data for resource management in terms of human impact only. Examples of these types of monitoring projects can be seen in (Des Jean 1991, Des Jean and Wilson 1991, Gale 1985, Goldsmith 1991). No programs have yet moved beyond the information stage to develop a trigger mechanism for implementing management actions. Additionally, their short-term nature did not lead to the identification of trends through time, or the formulation of predictive models (Kunde 1999a).

Although the general theoretical and methodological frameworks of natural resource monitoring are useful, they also have their limits when it comes to cultural resources. As with natural resources, monitoring the condition of cultural resources is an indispensable tool for their effective management. Cultural resource monitoring is difficult, however, because such resources are fragile, irreplaceable, and their information content is in a steady (though often exceedingly slow) state of decline. Unlike many biological or other natural resources, cultural resources cannot be replenished, cleansed, or re-generated to repair damage or degradation of their information potential. Because they are composed of human-made or altered objects and deposits, subject to decay, breakage, disarrangement, and loss, information conveyed by cultural resources also inevitably degrades through time. At least with respect to information potential (and probably other areas of significance as well), all cultural resources are, in some measure, in worse condition today than when they were initially created.

From a scientific standpoint, understanding past human activities at archaeological sites relies on patterning, i.e., it relies on an ability to decipher the relationship between material objects (architecture,

hearths, refuse, human burials, etc.) and the human behavior that produced and arranged those objects in 3-dimensional space. Thus, at the time of site abandonment, the interpretable "structure" of a site -- the patterned relationship between and among material objects and the human behavior that produced them -- is at its peak. As time passes, various agents, some physical and some human, act to destroy the original patterns, breaking down the material remains and organized structure of the site and making it less interpretable (Schiffer 1987). This fact of decreasing quantity and structure of material remains through time applies to all archaeological sites, not just those within the Colorado River corridor where operation of the Glen Canyon Dam has had some effect.

Since 1992, the RCMP staff have made 33 monitoring trips (approximately four rowboat trips each fiscal year) to assess the condition of cultural resources in GRCA. On average, RCMP staff have monitored 130 sites per year. The individual trips lasted 16 to 18 days, for a total of 65 to 70 days spent each year on the river conducting the business of the RCMP. A total of 1,042 monitoring visits have been made, during which an estimated total of over 80,000 observations have been made on site condition variables. Thus far, an estimated total of 9,000 photographs have been taken. The photo record, especially photos taken with a medium format camera, have produced an immensely useful database for future environmental studies based on repeat photography.

To systematically assess site condition, a monitoring form was developed that made reference to the site condition variables recorded during the initial survey. This form has been revised and refined since 1992, but its core variables have remained. Generally, site impacts are divided into two categories: (1) Physical impacts, and (2) Visitor-related impacts. Physical impacts include surface erosion, gullying, arroyo cutting, bank slump, eolian or alluvial deposition or erosion, and side-canyon erosion. A final category of physical impacts is an "other" category, intended to encompass impacts such as spalling of bedrock or boulders, and displacement of artifacts and features due to root growth.

Physical impacts recorded by the RCMP have been documented since the archaeological survey. During the course of the survey, numerous observations were made on the geomorphic settings, site sediments, and other factors that might relate to site erosion. These observations laid the foundation for a later collaborative study between NPS and USGS (Hereford, et al. 1993) that proposed a model for relating Dam operations to site erosional processes.

Geomorphic studies conducted in the late 1980s (Balsom, et al. 1989) and early to mid 1990s (Hereford 1993, Hereford 1996, Hereford, et al. 1993, Hereford, et al. 1995, Hereford, et al. 1996b) influenced RCMP staff and NPS survey personnel to pay particular attention to archaeological sites situated on alluvial deposits (river terraces) of the Colorado River that contain gullies and arroyos (two of the main physical forces actively eroding sites). Entrenched channels of small tributary streams referred to as arroyos or gullies cross the terraces. These channels are erosional features that dissect terraces as they extend headward. "The process of arroyo development destroys or damages surface and subsurface archeologic sites" (Hereford 1993, pg. 9).

Geological mapping by Hereford and others (Hereford, et al. 1993, Hereford, et al. 1995, Hereford, 1996 #182) has been completed to determine how the ongoing erosion of terraces and archaeological deposits by arroyos and gullies is affected by regulated streamflow, which began in 1963 with the closure of Glen Canyon Dam. Regulated streamflow as defined by Hereford and others (Hereford, et al. 1993) is the water and sediment discharge regimen of the Colorado River since 1963. It has substantially reduced in sediment load, sediment concentration, duration of high flow, and peak-flow rates compared with the unregulated streamflow of the pre-dam era (Hereford 1993). In the present discharge regimen, sediment load has been reduced by a factor of six and the annual flood, which was the principal agent of natural geologic change, has been eliminated (Hereford 1993).

Hereford (Hereford, et al. 1993) denotes two types of channels (gullies and arroyos): terrace-based and river-based. Channels furnish examples of streams that begin with a catchment (collecting pool) and/or subsequent cutting into terraces that flow downward toward some effective baselevel, or lowest point. Several factors determine this baselevel, including the size of the catchment, the length of the channel, and the type of soil the stream flows over. For instance, a large collecting pool will hold more water, which will have the gravitational power to create a longer, deeper channel with a lower baselevel. However, if the water flows over porous (e.g., sandy) soil or over a relatively large, flat terrace, the baselevel will be higher (Hereford 1993, Hereford, et al. 1993, Kieffer 1990, Thompson, et al. 1998).

With increased rainfall or size of the collecting pool, the channel may deepen and widen, smoothing out the course of the stream. This permits more efficient water transportation, allowing the stream to finally reach the river. Once the stream reaches the river, the channel continues to widen and deepen, becoming a permanent feature of the landscape (Hereford 1993, Hereford, et al. 1993, Thompson, et al. 1998).

The aforementioned factors determine whether a channel will remain terrace-based or will become river-based. This presents an especially important consideration for cultural resource management because monitoring efforts can identify and mitigate terrace-based streams with tools such as checkdams. River-based streams represent a more or less permanent feature (Hereford 1993, Thompson, et al. 1998). According to Hereford, sites with river-based drainages have a small chance of being preserved, whereas all other sites, including sites with terrace-based drainages have a better chance of preservation in place.

The effects of Glen Canyon Dam, specifically the lowered baselevel of the Colorado River and the lack of sediment-replenishing floods common during the predam era, have exacerbated these natural processes. This results in artificial acceleration of downcutting by channels seeking this new baselevel. The downcutting of both terrace-based and river-based streams exposes archaeological remains, especially those within the striped and pueblo terraces. This promotes deterioration and loss of these non-renewable resources.

Based on the work completed by Hereford, RCMP staff grouped all 264 sites, monitored within the past eight years and located within the APE, by drainage type. Four groups were defined: sites with river-based drainages, sites with terrace-based drainages, sites with side canyon-based, and sites with no drainages. Hereford did not acknowledge areas with side canyon-based drainages due to the small number. RCMP staff recognize this group individually, although small, within this synthesis; however, during the various data analyses, sites with terrace- and side canyon-based drainages were consolidated.

Seventy sites have been identified as having river-based drainages. RCMP staff consider sites with river-based drainages to be directly related to Dam operations. Since these drainages reach the river, the river directly controls their depth and width. If river flows are high, the drainages retreat, if flows are low, drainages deepen to reach the river. It is a direct cause and effect relationship. Sites with river-based drainages have always been a high priority in the monitoring effort due to Hereford's hypothesis regarding baselevel lowering (Hereford, et al. 1993).

Characteristics of river-based drainages include a catchment area about 12 times larger than terrace-based drainages (median size 16,000 m^2) and a less variable channel length than terrace-based streams (median length 220m) [Hereford, 1993:17]. Once a channel becomes river-based, the drainage adjusts to a lower baselevel, erosion increases, and the drainage becomes a permanent feature of the landscape. Lowered baselevel intensifies exposure and deterioration of cultural resources once covered by the terrace alluvium. In predam times, large sediment-laden floods plugged river-based drainages. Currently, the Colorado River does not "naturally" regulate the drainages.

The original cultural resource inventory and subsequent monitoring efforts have lead to the identification of 70 sites containing terrace-based drainages. RCMP staff consider sites with terrace-based drainages to be indirectly impacted by Dam operations. Terrace-based drainages do not drain to the river, but instead die out on the older and higher baselevel of the Colorado River, analogous to the river level prior to the construction of Glen Canyon Dam. This baselevel is above the river at the level of the predam terraces. These drainages are the most critical to preserve according to R. Hereford, and K. Thompson and others (Hereford 1996, Hereford, et al. 1993, Hereford, et al. 1995, Hereford, et al. 1996b, Leap 1996f, Thompson, et al. 1996).

Characteristics of terrace-based drainages include smaller catchment basins, averaging 1,300m^2 though varying in size over three orders of magnitude (Hereford, et al. 1993). This implies that there is a high degree of variability among the size of terrace-based drainage systems. Terrace-based drainages also have short channel lengths, averaging approximately 60 meters (Hereford, et al. 1993). All terrace-based drainages have the potential for increased arroyo cutting and breaching of the terrace level. Terrace-based drainages become river-based drainages when their catchment area is larger than 3,000 m^2 and the channel ends less than 100 meters from the river (Hereford, et al. 1993). As Hereford, et al. report, "any terrace-based stream can probably degrade to the lower effective baselevel of the post-dam era through downcutting and subsequent expansion of the drainage network, increasing catchment area and channel length" [Hereford, 1993:18 #20].

Approximately two years ago K. Thompson (geomorphologist) began identifying streams that drained directly into side canyons as "side canyon-based drainages." It is presumed that these drainages follow a similar drainage development pattern as river-based drainages. Side canyon baselevel is controlled by the Colorado River, as is the baselevel of a side canyon-based drainage. Side canyons are extremely variable drainages that are shaped by high energy, catastrophic changes. For example, when side canyons flood, cutbanks are often vertically truncated and the channel lowered. If the side canyon truncates a side canyon-based drainage, the drainage will respond by adjusting to its new lowered baselevel. This response is often in the form of channel initiation and active headcuts. For this reason, sites with side canyon-based drainages are considered, for RCMP purposes, indirectly impacted by dam operations and directly impacted by side canyon floods.

Monitors have recorded the effects of large tributary floods on archaeological sites since 1992. Most tributary floods and debris flows occur during July to October due to localized thunderstorms with rainfall intensities up to 40 mm/hr (Griffiths, et al. 1997). Researchers have identified at least 600 tributaries in the Grand Canyon from Lees Ferry to Surprise Canyon where debris flows occur (Griffiths, et al. 1997, Melis, et al. 1997). Upon re-evaluation of the RCMP data, archaeologists identified six sites with side canyon-based drainages.

Sites with undeveloped drainages comprise forty percent (118 sites) of the 264 archaeological sites. These sites do not have a drainage(s) deeper than 10 cm. Instead, water drains into dunes or shallow, ephemeral channels. Sites within this group, while they do not, at the present time, exhibit gully or arroyo cutting, have the potential to do so if their current drainage network transitions from surface runoff to a downcutting process. RCMP staff consider these sites potentially impacted by Dam operations.

Using these four site groups, several frequency calculations were completed for this synthesis. For example, by comparing a site's condition identified during the survey (Fairley, et al. 1994) with RCMP's current site evaluations, 49 sites (19%) have deteriorated over the past eight years. Sites that show the most change are the ones with river-based drainages. Since the survey there has been an increase by 144% in the number of sites in poor condition. Sites indirectly and potentially impacted by Dam operations demonstrate small variations in the numbers, however, sites directly and indirectly impacted by Dam operations show general deterioration over the years.

Overall, the majority of sites with river-based drainages are in fair to poor condition, 67% of which are actively eroding. Sites with terrace- and side canyon-based drainages commonly have sites in good or fair condition, but 38% show active erosion. Sites with no drainages show that the majority are in excellent or good condition while 17% are documented as actively eroding.

Eighty-six percent of the sites with river-based drainages are in poor condition and are actively eroding. Sites with terrace- and side canyon-based drainages illustrate four sites in poor condition and all but one are actively eroding. Fourteen sites with no drainages are in poor condition, however, only one site is physically eroding. It is likely that visitor impacts account for the other 13 sites in poor condition.

Of the 264 sites, 87 sites have been placed on RCMP's inactive monitoring list. The inactive list represents sites located within the APE but for various reasons are not monitored by this program. Reasons for placing sites on the inactive monitoring list include: the site is under GRCA management, site integrity is questionable, data potential is exhausted, or the site is in stable condition. Of the 87 sites placed on the inactive list, 78 sites have not shown active erosion and are considered stable.

Members of the PA have expressed concern regarding visitor-related impacts at sites along the river. SWCA's data synthesis report points out that tribes see visitation as the "primary impact" to cultural resources (Neal, et al. 1998, pg. 39). The RCMP monitoring data, however, demonstrate that only 25% of the sites monitored have active visitor-related impacts.

Visitor-related disturbances recorded by RCMP personnel include collection piles (artifacts gathered by visitors and placed in piles), trails, on-site camping, and criminal vandalism. Any visitor disturbance is unacceptable, however, trailing remains the most frequently recorded impact. Trail maintenance and obliteration remain a priority because RCMP staff have observed and documented that if trails are not maintained or obliterated they can easily become entrenched river- or terrace-based gullies.

The operations of Glen Canyon Dam determine which beaches remain conducive to camping. Researchers have recorded the loss of "suitable campsites" due to accelerated erosion for many years (Beus, et al. 1985, Kearsley and Warren 1993, Schmidt, et al. 1992, Schmidt 1989, Webb, et al. 1987). The reduction of "suitable campsites" since the construction of Glen Canyon Dam was demonstrated by Kearsley and Warren in 1993 (Kearsley and Warren 1993). Researchers inventoried existing river corridor campsites in 1991 and compared the inventory results with previous inventories in 1973 and 1983 (Brian and Thomas 1984, Weeden 1975). Their comparison of the 1991 inventory with the 1983 showed a 48% decrease in the number of campsites. The comparison of the 1991 data to the 1973 data revealed a 51% reduction in the number of large campsites (Kearsley and Warren 1993, pg. 12).

The reduction of sediment in the river and absence of annual floods that replenish beaches cause erosion that is directly related to dam operations. For this reason, the reduction of campsites in the river corridor is directly linked to the operations of the Dam (Kearsley and Warren 1993). This reduction translates into higher concentrations of river runners at a limited number of campsites. Higher concentrations of recreationists at limited campsites translates into higher occurrences of visitor-related impacts at the archaeological sites located within the vicinity of these camps (Coder, et al. 1995a, Coder, et al. 1995b, Hubbard 1999b, Kunde 1998, Leap, et al. 1997, Leap, et al. 1996, Leap, et al. 1998).

Other evidence of a reduction in the number of beaches is illustrated by historic photographs (Stone, Belknap, Kolb, Hillers). Replications of these photographs indicate a reduced number of beaches, which affects the availability and quality of camping locations. Some predam beaches still exist; however, the absence of large annual floods no longer controls the vegetation cover of the shoreline, making many beaches "uncampable."

The effects of the 1996 beach and habitat building flow illustrate the importance of sediment replenishment. The high flow redeveloped existing beaches and created new camping beaches, a process that happened annually prior to the construction of Glen Canyon Dam. The 45,000 cfs flow experiment indicates that the absence of pre-dam floods effects what beaches exist, and which beaches river runners prefer due to certain variables (beach size, location to attraction sites, and camping use/beach aesthetics).

RCMP staff attribute the majority of the visitor-related impacts in the river corridor to river runners. RCMP data indicate that archaeological sites with consistently high frequencies of impacts are often located directly above primary river camps (Kearsley and Warren 1993). Sixty-eight percent of the sites with active visitor-related impacts have a river runners camp in proximity. Proximity is defined as less than one kilometer away (Coder, et al. 1994b). It should be noted that many of the sites in this group have camps that are located less than 500 meters away. Archaeological sites with no history of visitation are often located far from river camps. Some archaeological sites with consistently high visitor-related impacts have primary camps below the sites and nearby backcountry trail systems. Data indicate that the combination of backcountry trails and primary river camps results in the highest frequencies of impacts to archaeological sites (Coder, et al. 1995a, Coder, et al. 1995b, Leap, et al. 1997, Leap, et al. 1996, Leap, et al. 1998, Hubbard 1999b, Kunde 1998).

PA members have discussed the responsibility for managing visitor-related impacts at sites along the river corridor for several years. Although this debate remains, the RCMP staff will continue to record and mitigate visitor-related impacts during regularly scheduled monitoring visits. Taking no action would simply be irresponsible. The RCMP staff have taken the lead in recording visitor-related impacts, and the GRCA rehabilitation crews have mitigated visitor-related impacts by conducting trail and revegetation work. GRCA acknowledges its responsibility to mitigate visitor-related impact in the National Park as part of its Section 110 responsibility. However, the RCMP staff also believe that there is a connection between the Dam's existence and operations, and the frequency of visitor-related impacts in the river corridor.

Future visitor-related impact research should focus on clearly defining how the Dam's operations effect the frequency of impacted sites in the river corridor. In the mean time, the NPS and Reclamation will continue working together to develop effective approaches to deter on-going visitor-related impact.

Based on the various physical and visitor-related impacts observed and recorded by the RCMP, several remedial actions (preservation and data recovery treatments) have been implemented. Treatments related to this project officially began in fiscal year 1995.

The RCMP recognizes the preservation mandate of the NPS and agency responsibilities of Reclamation under NHPA. The current goal of the existing PA (U.S. Department of the Interior, et al. 1994), MRAP (U.S. Department of the Interior and Service 1997) and draft Historic Preservation Plan (U.S. Department of the Interior, et al. 1997) is preservation in-place in leu of excavation.

Preservation actions have been completed at 96 sites. Treatments include checkdam construction, planting vegetation, and trail work. Other forms of treatment that could be considered preservation in nature include medium format photography (48 sites) and mapping of archaeological sites with a total station instrument (68 sties). Most preservation work has been completed on sites with river-based drainages and on sites in fair to poor condition.

Another method involving preservation is educating the public about archaeological sites, factors that erode a site, and management actions implemented to preserve or retrieve archaeological data. Public education of archaeological sites along the river corridor has consisted of several formal and informal

presentations. These include talks at professional archaeological conferences, Guides Training Seminars (annual seminars with approximately 200 commercial river guides attending), with GRCA park employees and visitors, and at educating centers such as NAU and various elementary and high schools in the Flagstaff area. Written updates and general comments have also been submitted to and published in handbooks (Harmon 1997), as abstracts (Archaeology 1996), and in the *Boatmen's Quarterly* (Bulletts 1995 Summer, Jackson and Leap 1996 Summer), *Nature Notes* (Andrews n.d., Hubbard n.d., Kunde n.d., Leap n.d.-a, Leap n.d.-b), *Arizona Highways* (Kuhn 1999), and science magazines (Balsom n.d.-a, Balsom n.d.-b, Randall 1992).

To date, RCMP staff have not observed whole site improvement since the implementation of preservation treatments beginning in FY95. As recognized by the NRC (Council 1999), when evaluating a long-term monitoring program, discussing the success of preservation actions can be premature, and will not yield significant results. However, RCMP staff have acknowledged and documented sediment collection in gullies and arroyos with checkdams, vegetation growth from transplanting and planting new seedlings, and successful trail projects.

The only real way to evaluate the success of preservation actions completed for short-term results is by conducting frequent visits to a site and attaining very detailed information (Council 1999). This type of monitoring was completed in the past two years using a total station instrument, but due to the redistribution of funds and the disinterest of some PA members, this method of tracking success or failure by quantifying change has been discontinued. Other methods for tracking the success of preservation treatments are currently being investigated by project personnel and GCMRC.

Currently, preservation treatments have not affected the frequency of monitoring. Yearly monitoring by the Zuni Conservation Project and GRCA revegetation crews has occurred in cases where checkdams are located and in some cases where trail work is completed. It is presumed that the success of these treatments should be evaluated intensely for several years. After these evaluations, a decline in the monitoring schedule is anticipated.

Data recovery has been completed at 42 sites. These actions are in the form of feature-based excavations (excavation of a single feature on site that cannot be preserved, not excavation of the entire site), radiocarbon collections, or testing specific features for intact, subsurface cultural deposits. The majority of the work has been conducted at thermal and roasting sites. Twenty sites have had carbon samples taken from them in the late 1980s and early 1990s in conjunction with the research completed by R. Hereford.

The RCMP staff have identified basic prioritization of treatments (preservation and data recovery) based on the findings of this report. Although each site is individually assessed for various treatments, certain descriptive generalizations can be made in order to initiate priority treatment. Based merely on descriptive analyses, it is clear that the stages of erosion are more advanced at sites with river-based drainages. They exhibit sites most actively eroding and in poor condition. This is demonstrated, at two sites (C:13:099 and C:13:100) even after the implementation of checkdams. However, this observation is solely based on preliminary results in this report. (Preliminary results demonstrate that maintenance was performed on checkdams within river-based drainages more often than sites with terrace or side canyon-based drainages.) All checkdams installed in the various drainage types need to be researched much more closely to determine their effectiveness. This entails detailed mapping of the areas to measure volumetric change in sediment. It is possible that this work will be completed by GCMRC this fiscal year.

Until this work is completed, no conclusive evidence exists that suggests river-based drainages cannot be stabilized. However, because of the advanced stages of erosion, RCMP staff recommend that all sites having river-based drainages and recommended for data recovery be the PA's first responsibility for data

recovery work. Nineteen sites are recommended for data recovery. Six of these have already been proposed for excavations prior to the findings in this report [Leap, 1999 #355].

It has been difficult for Reclamation to obtain the necessary funds to complete data recovery. As a result, very few data recovery projects have been initiated, and very few have been completed. In the meantime, project staff are doing what they can to delay the destruction of these archaeological sites until monies are allotted for the proposed excavations. Sites recommended for data recovery will continue to be monitored and emergency data recovery be conducted until funds are allotted for the excavations. It is better to retrieve what little information is left, than to let information about the history of the Canyon erode.

The PA's first priority for preservation treatments should be conducted on sites with terrace- and side-canyon-based drainages, then on sites with no drainages. The goal is to prevent any drainage system from becoming river-based. Once drainages are river-based, R. Hereford speculates that erosion control is nearly impossible because the drainages are too advanced. They are connected to a much larger erosive force, the Colorado River. RCMP staff recognize the need to focus on these sites for preservation treatment. The status of these sites is very fragile and if preservation in place is postponed, it is very likely that these sites will be listed for data recovery in the future.

There are several additional factors to consider prior to conducting any remedial tasks. For example, prior to conducting archaeological excavations, PA members should consider the research design that should be in place prior to any recovery. This will aid in completing excavations on sites that will benefit the archaeological record within the corridor and within the area. Some corridor considerations include site type, site condition, site location, and cultural affiliation.

For preservation work, PA members should not only consider the archaeological potential of the site, but they also need to consider a couple other factors. First, the geomorphological setting is extremely important. The work completed by Thompson et al. [Thompson, 1998 #278] is a good starting point. Gathering information consisting of sediment type, catchment systems, slope, and general drainage cross-sections are all factors that should be considered prior to implementing a preservation treatment. Supplementing this data would be identifying the vegetation in the area. The maturity of the plants and the root systems can also aid in the success or failure of a preservation project.

Much of this additional archaeological, geomorphological and botanical information is supplied on the original survey form. The task of incorporating this data with the monitoring data would take a substantial amount of time, however, RCMP staff feel it will provide necessary and valuable information.

The history of the RCMP and the findings of this report reveal a steady refinement in our knowledge of how the operation of the Glen Canyon Dam is impacting cultural resources in Grand Canyon National Park, and how best to mitigate those impacts. The RCMP personnel continue to investigate and consider methods with the potential to improve and streamline documentation, monitoring, and treatment of cultural resources along the river corridor in Grand Canyon.

Voluntarily, several specialists representing multiple professions have offered expertise to improve the monitoring program. Personnel from various tribes, NAU, U.S. National Forest Service (USFS), USGS, Reclamation, private contractors, GCES, and GCMRC have worked with RCMP staff in the field and lab. Students from the university have also enhanced the ideas, methods and concepts of this program. They shared with RCMP staff their knowledge and personal experience in managing archaeological sites, preservation treatments, geological aspects, and research methods. These methods and concepts have all been interwoven to create an archaeological monitoring program grounded in identifying and observing processes affecting cultural resources and appropriate treatments for preserving sites in place.

To date, two independent research projects have formally reviewed portions of the RCMP database to evaluate and assess the reliability of data collected thus far. SWCA, Inc., of Flagstaff is currently evaluating portions of the RCMP database for a research contract administered through the GCMRC (Neal, et al. 1998). A Master's thesis at Northern Arizona University has recently been accepted by Jennifer Kunde which evaluates and analyzes monitoring methods in the natural resources realm and applies a model to cultural resource monitoring [Kunde, 1999 #297:1]. Neither of these projects reviews the database in its entirety, though each has contributed valuable feedback to the RCMP program.

The RCMP staff have fulfilled virtually all of the assigned responsibilities outlined in the PA, MRAP and draft HPP, and has initiated a program of remediation at a limited number of sites. Under the current methods used to fulfill the requirements of the PA, minor changes are anticipated to further refine the project's methods and database. For example, remedial efforts need to be expanded to include more vigorous attempts to control erosion and recover scientific data from those sites most severely impacted by Glen Canyon Dam. The RCMP can also expect changes upon the completion of the Protocol Evaluation Panel (PEP) scheduled for the spring of 2000 and the completion of the Historic Preservation Plan scheduled for 2001.

However, it has recently been brought to the attention of the RCMP staff that a change in philosophy may be appropriate. Whole site excavation as opposed to feature-based excavation (only excavating eroding features, not the entire site) is the current issue. Reclamation has suggested that whole site excavation is more suitable given the Secretary of the Interior's Standards for Archaeology and Historic Preservation and their Section 106 responsibilities. However, the current PA and MRAP clearly state preservation in place is the preferred method. If only portions of a site cannot be preserved, excavate only those portions eroding and leave the stable areas alone. This has been the philosophy of the RCMP since its inception.

If whole site excavation is supported by the PA signatories, adjustments will be made to the current long-term monitoring program to address large-scale data recovery strategies. A shift to whole site excavation would change the monitoring emphasis and add significantly to the proposed excavation priorities and costs. This would be initiated by implementing a comprehensive testing program for the sites suggested for excavation to define the lateral and vertical extent of the sites, and to identify whether there is a multi-component aspect to the site. Testing for these attributes has not been done in the past because the PA program practiced an "as needed" data recovery program, feature specific, not site specific. It will be very important for the project staff to identify site extent so that appropriate research designs can be developed.

At the request of Reclamation, RCMP personnel submitted a budget estimate and work plan for FY2000 at approximately 25% less than the FY99 level. The reductions are achieved by focussing on the most urgent monitoring aspects of the program.

This year RCMP staff propose three trips for the upcoming year, with a reduction in the number of sites evaluated and no site assessments or preservation treatment implementation. The only sites that will be evaluated are those regularly scheduled for FY00 (47 sites) and those where invasive preservation treatments have occurred (29 sites with checkdams). This altered program will allow for consistency in assessments of the most heavily impacted archaeological sites; however, no evaluations of sites listed on the three to five year schedule (21 sites) will be completed.

With the onset of FY00, project staff have already been occupied with completing this extensive eight-year data synthesis report, compiling multiple budgets and proposals, preparing for the PEP review, and reviewing numerous GCMRC reports. It has been critical to focus staff time on the PEP review and preparation of the HPP. However, the reduction of funds will impact the abilities to provide the same

level of service for all of the affected entities. The PEP review will require considerable staff time in the preparation of materials and compilation of site records, photographs, etc….

The FY2000 scope of work precludes any new work such as completing preservation assessments, quantifying checkdam effectiveness, creating total station base maps, recording newly uncovered archaeological site, conducting limited and repeat medium format photography, completing limited data recovery, and collaborating with NPS base programs and the Hualapai Nation and Navajo Nation. Further, there is minimal to no participation in public outreach or professional and nonprofessional presentations. Thus, work completed in FY00 will be lacking in scope. Although it will be critical to refine the current MRAP and to complete an HPP; cultural resources fieldwork will be sacrificed because of a budget cut. Postponing the types of remedial actions mentioned above will only increase the backlog of the identified work presented in this report.